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Organization of this Publication

The first part of this manual contains introductory information about pesticides, sprayer calibration, and references pertaining to crop protectant efficacy and use characteristics for each pest category (diseases, insects, etc.). This is followed by a section on nutrient management and fertilizer recommendations for apple orchards. Information on forecasting, sampling and monitoring is included for selected pests. This is followed by a section on nutrient management and fertilizer recommendations for apple orchards. Next, for each crop, a section on General Pest Management Considerations contains numbered comments on biology, cultural notes, monitoring, and pesticide use for each pest, in the following order:

- Diseases
  - Disease 1
    - Biology & Cultural
    - Monitoring & Forecasting
    - Biological & Non-chemical Control
    - Pesticide Application Notes
    - Pesticide Resistance
  - Disease 2, etc.
- Insects and Mites
  - Insect 1, Etc.

Diseases are addressed first, followed by insects and mites (as a group), each in alphabetical order. Reference may be made here to additional publications available for further information. This section is followed by a Pesticide Spray Table, which lists specific products for the control of each disease, insect and mite pest of this crop, giving products (alphabetically by trade name), rates, re-entry and pre-harvest intervals, and comments keyed to specific sections of the written notes in the preceding General Pest Management Considerations. Pests are addressed in order as above, proceeding phenologically through the season.

Weed control guidelines are listed next, separately for each crop.

Lastly is an appendix of tables listing common names, product names, EPA registration numbers, Personal Protective Equipment guidelines, and spray mixture compatibility suggestions for the materials included in this publication, followed by a list of other fruit reference materials, diagnostic services, and faculty and extension programs.

A key to the abbreviations and footnotes used in this publication is found in the back of this book.

1 Integrated Crop and Pest Management

1.1 Introduction

The purpose of this publication is to help growers make informed choices best adapted to their individual orchards. The best way to use this guide is to become familiar with it as a whole before using it to answer specific questions during the busy growing season. Integrated Pest Management (IPM) is the guiding philosophy behind this publication. It is a multifaceted approach to maintain pest damage below economically damaging levels.

The word "Integrated" refers to the fact that individual management decisions are not isolated, but take into account, to the greatest extent possible, all aspects of the existing and potential pest situation in relation to the overall farm operation. Integration also applies to combining multiple tactics in a way that reinforces their efficacy. The word "Pest" refers to insects, mites, weeds, pathogens that cause disease, and animals such as deer and voles.

Instead of focusing on how to eradicate pests, IPM considers pest biology and all feasible preventive and curative options, and brings them together into an overall "Management" plan. The goal of IPM is to make informed decisions leading to results that meet economic, environmental, and social objectives.

1.2 Practicing IPM

Using IPM requires integrating management tools in a complementary way to create an overall management plan that is efficient, effective, and sustainable. By using multiple tactics, the chance of successful results is increased, and the chance that a pest population will adapt to a specific tactic is decreased. Horticultural practices, such as sanitation and habitat management, are a first line of defense in preventing many types of pest problems.

Using an IPM approach requires accurate identification and risk assessment of pest threats. Services in New England that provide insect and disease diagnosis and soil and tissue analysis are listed at the end of this publication. An understanding of pest biology and ecology and the influence of factors such as weather and natural enemies on pest abundance will aid in choosing management tactics.

Instead of total eradication, IPM programs stress suppression of pest populations to levels that do not cause economic damage. Use of pesticide and other pest control options reaches a point of diminishing returns at which additional suppression is exceeded by the additional cost and negative impacts. In the case of insect pests, it may be important to have at least some pests present to ensure that natural enemies will remain in the orchard to suppress subsequent pest infestations.

1.3 Components of IPM

1.3.1 Monitoring (Scouting)

Scouting is making observations to identify and measure pest populations. For some insect pests, traps can be used to indicate population density to compare against treatment thresholds and to identify optimum timing for control measures. For diseases, weeds and some insect pests, inspecting foliage, fruit, or groundcover is required. Monitoring individual orchard blocks throughout the season is the most effective way to assess the insect, disease, and weed situation and, therefore, the need and timing for chemical treatment. Scientifically based, accurate, and efficient monitoring methods are available for many tree-fruit pests. Brief descriptions of recommended monitoring methods are included in the "General Pest Management Consideration" notes for each crop in this publication.

1.3.2 Pest Models and Forecasting

Weather-based pest development models for some pests can be used to estimate the best timing for monitoring, prevention, or control. A record of daily maximum and minimum temperatures and rainfall can provide useful input for pest models and to estimate depletion of protective residue from a previous pesticide application. Alternatively, site-specific weather data are available from private companies (see IPM Resources). An on-line tool called Orchard Radar processes weather data through IPM models, and is available through the PRONewEngland.org website. Information on the potential for pest outbreaks can also be obtained from Cooperative Extension newsletters and regional crop advisors.

1.3.3 Action Thresholds

A pest threshold is an estimate of the population density at which treatment is justified because the cost of economic damage is likely to outweigh the cost of prevention/control. Thresholds have been scientifically determined for some pests. For other pests, generally accepted "best guess" thresholds are used. By comparing pest monitoring observations with thresholds, tree fruit growers have been able to reduce pesticide use by as much as 50% without jeopardizing crop quality or yield. In fact, the risk of damage can be decreased by early detection and evaluation of pest threats. The term ***suggested action threshold*** in this publication denotes situations in which the decision to apply a pesticide or not can be made primarily on the basis of a properly timed visual inspection of the orchard. Grower judgment is needed to apply general recommendations to individual orchard situations. Your knowledge and records of block history are very important to make decisions appropriate for your orchard.

1.3.4 Management Tactics

Appropriate management tactics to prevent or control pests include cultural, biological, and physical methods, as well as chemical control (i.e.pesticide) when needed. Chemical control is deferred unless other tactics are not sufficient in order to minimize the social, environmental, economic, and safety concerns associatedi wth pesticide use. Implementing some of the simple and relatively inexpensive non-chemical pest management methods described in this manual can yield significant savings in pesticide use and crop loss. Preventive measures taken before pest damage occurs can be much less expensive than the cost of rescue treatment later.

1.3.5 Recordkeeping

A yearly record of pest monitoring observations, treatment actions, and an end of season damage assessment provides a valuable reference for future decisions. Written records are likely to be more complete and accurate, and are more easily shared than memory. Having a pest management records to refer to can not only improve results and decrease costs, they also serve as documentation to justify actions and verify compliance with regulatory or customer requirements, and be used in business planning. Post harvest evaluation of the season's pest management supports learming from mistakes and building on successes.

1.4 IPM Tactics

Actions taken at planting and before and during each growing season can affect the degree of pest risk and need for pesticide use. Here is an outline of methods that can be integrated into an overall management plan.

1.4.1 Cultural and Physical Controls

There are commercially viable scion cultivars available that are resistant to apple scab and other major apple diseases. Among susceptible cultivars, the degree of susceptibility to different diseases and even some insect pests varies.

Rootstock selection should account for desired horticultural traits, soil conditions and low temperature hardiness, but can also include consideration of the degree of management needed to prevent fire blight and Phytophthora diseases.

Consider pest pressure in selecting sites to plant trees. For example, low spots that hold fog and dew have increased risk of fungal diseases.

Orient orchards to provide maximum air drainage and circulation. If possible, remove hedgerows of wild shrubs and trees immediately adjacent to the orchard. Dense vegetation close to the orchard block sunlight and wind, keeping the orchard trees wet longer which encourages growth of some disease organisms.

Use deer fencing and open mesh vole guards, especially for young orchards that are particularly vulnerable to vertebrate pest damage.

Remove materials that provide overwintering sites for pests: dead or dying wood, branch cankers, prunings, mummified fruit, root suckers, and alternate host trees near the orchard.

Support tree health and regulate vegetative vigor through careful management of fertilizer, water, and groundcover.

Avoid stresses such as overwatering, drought, mechanical trunk damage, overcropping or other conditions that may predispose trees or fruit to damage by insects, diseases, physiological disorders or environmental stresses such as rapid temperature changes and low winter temperatures.

Manage irrigation schedules to avoid long periods of leaf wetness or high relative humidity that favor growth of fungal diseases.

1.4.2 Biological Control

Conserve natural enemies of insect and mite pests by only using insecticides, miticides, and fungicides when needed. Select pesticides that are effective against the targeted pest(s) with minimal negative impact on predators, parasites, pollinators and other beneficial organisms. Consider the impact of groundcover management decisions on beneficial organisms.

Consider "seeding" releases of predator mites if practical.

1.4.3 Chemical Control

Only use pesticides if monitoring and economic thresholds, model forecasts, block history or other information indicates a need.

Choose pesticides according to applicator and worker safety; required protective equipment, reentry and preharvest intervals; pest efficacy; resistance management; impact on the environment and natural enemies; tankmix compatibility and suitability for the application equipment that will be used

Ensure complete and uniform spray coverage by using recommended pesticide dosage, accurately calibrated equipment, optimum spray pattern, travel speed, droplet size, and sufficient water per acre to insure good coverage for protective surface residue or absorption for locally systemic materials.

Try to time spray applications for maximum impact on pests and minimum off-target impacts, and for weather conditions that allow for optimum coverage and drying.

Do not apply pesticide when wind velocity is more than five miles per hour to avoid drift to nontarget sites. Avoid making foliar sprays when high temperatures and high humidity can increase the risk of phytotoxicity. Test new tankmix combinations with a jar test or trial application to a few trees.

2 Organic Tree Fruit Production In New England

2.1 Introduction

There is more interest in organic tree fruit production than the actual number of certified orchards reflect and some growers are taking a new look at organic production, particularly organic apple production, given some recent research advances that address long-standing obstacles.

In the past, very few growers in the northeast have attempted to produce apples and other tree fruits organically because of the practical difficulties involved in managing pests in this region with organically-approved pesticides. Wet weather in the spring and summer coupled with the predominant apple cultivar grown in New England, 'McIntosh', present significant challenges in disease management, particularly apple scab. A large number of both native and introduced pest species attack apples and other tree fruits grown in commercial orchards.

Management of this pest complex is particularly challenging in New England, because unlike more arid production regions in the country, fruit orchards in New England are commonly in close proximity to semi-wooded areas with an abundance of naturalized and wild host species that can harbor populations of certain tree fruit pests. However, during the last 10-15 years studies have been conducted to develop management tactics that address key pests that can be incorporated into an organic program. For example recent studies have shown that the predaceous mite, *Typhlodromus pyri*, which is native to apple production regions in western New York and New England, can successfully manage populations of the key mite pest, European red mite, in commercial apple orchards so that no applications of miticides are required. Also, the trend of planting apple cultivars less susceptible to disease than 'McIntosh', may make organic production more feasible.

In addition, recent research in New York state and elsewhere has shown that pheromones can be deployed in orchards to disrupt mating of key lepidopteran species such as oriental fruit moth, and borer species, and substantially reduce damage from these pests. In addition, traditional management methods such as selective fruit thinning, pruning, sanitation (frequent removal of pest infested dropped fruit), removal of wild hosts near commercial plantings, and exclusion of pests, have been shown to reduce populations of some types of pests. Experience in Vermont has shown that non-managed *Malus* species can present significant inoculum for development of apple scab, fruit rot, and European apple sawfly outbreaks in adjacent organically managed apple blocks.
Ideally, organic fruit production is the synthesis of an entire suite of practices intended to take advantage of natural ecosystem interactions and minimize chemical intervention. In apples, such a system might start with the selection of disease-resistant cultivars to circumvent the need for the majority of normal disease sprays. This one tactic could eliminate or substantially reduce the need to manage apple scab, powdery mildew, cedar apple rust, and/or fire blight (Ellis et al., 1998). In lieu of resistance, a combined strategy of orchard sanitation and frequent applications of organic fungicides, such as elemental sulfur, throughout most of the season would be necessary.

2.2 What is Organic Agriculture?

In 1995, the USDA National Organic Standards Board (NOSB) defined organic agriculture as "an ecological production management system that promotes and enhances biodiversity, biological cycles, and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain, or enhance ecological harmony…. The primary goal of organic agriculture is to optimize the health and productivity of interdependent communities of soil life, plants, animals and people." Before a product can be labeled "organic," a Government-approved certifier must inspect the farm where the food is grown to make sure the farmer is following all the rules necessary to meet the USDA organic standards. Detailed records are required and reviewed by the certifier. It takes three years of organic management before a farm product can be "certified" as organic. Please note that the labels "natural" and "eco-friendly" which have been used to describe agricultural products may imply that some organic methods were used in the production of the product, but this labeling does not guarantee complete adherence to organic practices as defined by law.

IMPORTANT: It is the grower's responsibility to ensure that any crop production practice or material used in the orchard is acceptable in their particular state's organic certification program. Some materials deemed organically acceptable on the National List may not be acceptable in some states. *Contact your certifier to know what is acceptable and to ensure compliance with regulations in your state.*

Federally accredited certifying agencies for the New England states include the following:

Maine
MOFGA Certification Services, LLC
294 Crosby Brook Rd.
P.O. Box 170
Unity, ME 04988-0170
Contact: Mary Yurlina
207-568-4142
E-mail: certification@mofga.org
Scope: crop, livestock, wild crop, handling

Connecticut and Massachusetts
Baystate Organic Certifiers
683 River St.
Winchendon, MA 01475
Contact: Don Franczyk
978-297-4171
E-mail: baystateorganic@earthlink.net
Scope: crop, livestock, wild crop, handling

New Hampshire
NH Dept. Agriculture Markets, & Food
25 Capitol St.
P.O. Box 2042
Concord, NH 03302-2042
Contact: Victoria M. Smith
603-271-3685
E-mail: vsmith@agr.state.nh.us
Scope: crop, livestock, wild crop, handling

Rhode Island
Rhode Island Department of Environmental Management
Division of Agricultural and Resource Marketing
235 Promenade St.
Providence, RI 02908
Contact: Matt Green
401-222-2781
E-mail: matt.green@dem.ri.gov
Scope: crop and handling

Vermont
Vermont Organic Farmers, LLC
NOFA Vermont
P.O. Box 697
Richmond, VT 05477
Contact: Nicole Dehne
802-434-4122
E-mail: nicdehne@hotmail.com
Website: www.nofavt.org
Scope: crop, livestock, wild crop, handling

Detailed recordkeeping is critical in organic production to receive certification and to maintain it. Contact your state certifier to find out what is required.

Organic apple production guidelines for New England have yet to be established. This publication uses the symbol **"§"** to indicate materials that are considered organic options under at least *some* state certifying programs. Again, before using any product or production practice, consult with your certifying agency. Look for remarks or estimates of potential levels of efficacy in the footnoted comments associated with these materials, located in the "General Pest Management Considerations" sections preceding the Pesticide Spray Tables, and also in the respective tables giving the activity spectrums for the different pesticide classes (e.g., Tables 6.1.1, 7.1.1 and 7.1.2).

2.3 Fungicide Options in Organic Apple Production

Ideally, organic fruit production involves a whole systems approach not just a substitution of materials. Research is currently underway in New England to examine the challenges and opportunities of organic apple production. Information from this and other research will be incorporated into future extension publications. The following information on organically acceptable fungicides is based on observations by researchers and extension specialists in New York.

Sulfur is effective for controlling many fruit diseases, but it must be applied prior to infection. Sulfur is easily removed by rain. Thus, coverage must be renewed much more frequently than is required with conventional fungicides with better rain resistance. Sulfur is not very effective for controlling rust diseases on apples. Rust diseases in organic apple orchards can be minimized if cedars within 500 ft can be removed or if new orchards are established in areas isolated from existing or potential cedar habitat. In more southern areas of the region, sulfur is also relatively ineffective for controlling flyspeck, bitter rot, black rot and white rot on apples during July and August, but sulfur may provide adequate suppression of these diseases in more northern areas. Liquid lime sulfur applied at 2 qt/100 gal on a 21-day interval or at 1 qt/100 gal on a 10-day interval provided good control of flyspeck in a 2006 trial in New York's Hudson Valley. However, the liquid-lime sulfur sprays did not control summer fruit decays. Copper fungicides applied once or twice during late July or August should help to control both flyspeck and summer fruit decays, but this strategy needs further evaluation under New England conditions.

Whereas wettable sulfur has no post-infection activity, liquid lime sulfur provides 60–70 hours of post-infection activity against apple scab (counting from the beginning of an infection period). Liquid lime sulfur is also useful to "burn out" scab infections when they appear on leaves, but it has no activity against scab during the incubation period between 70 hours post-infection and appearance of symptoms. Unfortunately, research has shown that both sulfur and lime sulfur can suppress photosynthesis which can reduce yield. Therefore, the number of sprays should be kept to a minimum.

Copper fungicides also control many tree fruit diseases, but copper causes phytotoxicity under certain conditions. Copper is extremely phytotoxic to foliage on sweet cherries. On apples, copper applied between half-inch green and bloom usually causes fruit russetting. Copper applied between bloom and roughly July 4 will cause blackening at the lenticels. Copper applied later in July will provide excellent control of sooty blotch and flyspeck on red apple cultivars, but July applications may still cause severe fruit discoloration of yellow cultivars. Note: Very few copper fungicides have labels that allow application to apples after bloom.

Summer applications of copper fungicides have been used effectively to control bacterial leaf spot on peaches, but care is required to avoid a build-up of copper residues that can result in severe leaf injury on peaches. Repeated summer applications of copper on peaches should be avoided unless rainfall has removed the residue from the previous application. Copper has also been used to control cherry leaf spot on tart cherry.

Bacillus subtilis (Serenade**)** is a biofungicide labeled for control of fire blight, apple scab and powdery mildew. Serenade is a wettable powder formulation of the bacterium *Bacillus subtilis*, a common soil resident. The bacterium acts by releasing cell contents during growth in order to eliminate or reduce competitors in its immediate environment. Serenade is relatively ineffective for controlling fungal diseases under the climatic conditions that exist in the Northeast. When used alone, Serenade provides only partial control of fire blight. In alternation with streptomycin, it sometimes provides control approaching that of a full streptomycin program. Serenade should be applied as a preventive and can be applied up to and including the day of harvest.

Hydrogen dioxide (StorOx and OxiDate) works like hydrogen peroxide and kill fungi and bacteria via surface contact with the organism. OxiDate is labeled for control of diseases in the field whereas StorOx is labeled for use as a surface disinfectant and as an antimicrobial for hydro coolers and water flumes. Hydrogen dioxide does not have residual activity, nor will it control fungi or bacteria that have already penetrated host tissue. Thus, it must be applied after pathogens have been deposited on plant surfaces but before they can initiate infections. Field applications to apples are not recommended because OxiDate can cause severe fruit russetting under certain conditions. Controlled inoculation trials indicate no significant effect of OxiDate on fire blight infection of apple.

Streptomycin is a bactericide used for control of blister spot on 'Crispin' apples and fire blight of apples and pears. It is formulated as streptomycin sulfate in a 17% wettable powder. Streptomycin is commonly used during bloom at the rate of 1/2 lb/100 gal for fire blight control, but can be used at 1/4 lb/100 gal in combination with 1 pt of Regulaid/100 gal dilute spray. It can be applied to pears until 30 days before harvest and to apples until 50 days before harvest. However, summer sprays of streptomycin are NOT recommended, except following a hailstorm.

Tests of streptomycin applied during bloom at a constant amount in different volumes of water indicated that control of fire blight was reduced at concentrations in excess of 6X. Thus, concentration of streptomycin sprays greater than 6X is specifically not recommended.

Resistance to streptomycin is widespread among populations of the blister spot bacterium. Resistance is also widespread among populations of the fire blight bacterium in Pacific Coast and Midwest production districts, and has recently been detected in NY. Indiscriminate use of this material (e.g., summer sprays) will hasten the development of resistance. Growers must contact their certifying agency to determine acceptable streptomycin formulations since some are not allowed under organic rules.

In a review of biocontrols labeled for use against **fire blight**, University of Massachusetts research showed that overall, biocontrols were not as effective as streptomycin against blossom blight. Biocontrols were effective in far fewer tests, and if effective, generally controlled blossom blight half as well as streptomycin.

2.4 Insecticide Options in Organic Apple Production

Kaolin clay (Surround**)**, when used properly, has proven an effective organic option to deter pear psylla on pears, and plum curculio and first generation codling moth damage on apples. Later season use can suppress apple maggot damage and second generation codling moth, but when used past early July when apple maggot becomes a threat, the increased chance of a bothersome amount of Surround residue remaining on apples at harvest becomes a limitation.

Azadirachtin (Aza-Direct, Neemix)is derived from the seeds of the neem tree, Azadirachta indica, which is widely distributed throughout Asia and Africa. Azadirachtin has been shown to have repellent, antifeedent, or growth regulating insecticidal activity against a large number of insect species and some mites. It has also been reported to act as a repellent to nematodes. Neem extracts have also been used in medicines, soap, toothpaste and cosmetics. It shows some activity against leafminers, leafhoppers, mealybugs, aphids, caterpillars, tarnished plant bug and pear psylla, but repeated applications at short intervals are probably necessary for acceptable control of most pests. Azadirachtin is relatively short-lived and mammalian toxicity is low (rat oral LD50 >10,000). It can be used up to and including the day of harvest and reentry is permitted without protective clothing after the spray has dried. It is relatively nontoxic to beneficials, but toxic to fish, aquatic invertebrates, and bees exposed to direct treatment, although relatively non-toxic when dried. It is therefore categorized as having a moderate bee poisoning hazard.

Clarified Neem oil (Trilogy) is labeled for a wide range of pest control or suppression uses, including use as a fungicide, insecticide, and miticide. Specific uses have not been well-studied for every labeled pest; rates suggested on the label also vary widely. Neem oils have been found to suppress European apple sawfly and may deter feeding or egg laying of other insect pests. Research on its use as a scab fungicide has shown that it is ineffective as a stand-alone material. Because Trilogy is an oil-based material cautions against mixing with other pesticides incompatible with oil, such as sulfur,, should be followed. Trilogy

applications have been found to form a persistent film on fruit and foliage that may make removal of residues such as kaolin difficult at harvest or packout. This product is toxic to bees if exposed to direct treatment and is hazardous to fish and aquatic invertebrates.

Bacillus Thuringiensis (Bt, Dipel, Deliver, Biobit, Javelin, Agree) is a microbial insecticide specific for the control of caterpillars. It contains spores and crystalline endotoxin that must be ingested by larvae with high gut pH to provide control. It is effective against many fruit pests, including leafrollers and fruitworms. Although this material will control codling moth and other internal lepidopterous apple pests, it does not provide as effective control as do most conventional insecticides. One exception is the obliquebanded leafroller, which has become so difficult to control with conventional toxicants that the Bt products work at least as well as any material available. Compared to conventional insecticides used against these pests, Bt insecticide coverage should begin earlier and requires shorter intervals between spray applications. This material is exempt from requirements for a tolerance on all raw agricultural commodities, thus it can be sprayed up until harvest. It is harmless to humans, animals, and beneficial insects, including the honey bee.

Entrust is an organically accepted formulation of spinosad, the same active ingredient in the conventional insecticide SpinTor. Entrust can provide good control of codling moth, leafollers, and fair control of apple maggot and spotted tentiform leafminer.

Pyrethrin (Pyganic**)** is a material that has been used against European apple sawfly and for short term (relative to conventional insecticides) control of plum curculio, codling moth and apple maggot. For the duration of control it provides, Pyganic would be more expensive than conventional insecticides or other organic options as the foundation for an insect pest management program.

Insecticidal soaps (M-Pede) are concentrates made from biodegradable fatty acids and are contact insecticides that can be effective against such soft-bodied arthropods as aphids, mealybugs, and psyllids. They can provide suppression of pear psylla when used in a seasonal spray program, but the residual period is short, and uniform drying conditions are required to prevent droplet residues on the fruit surface. They have a low bee-poisoning hazard.

Horticultural oil is an effective tool against mite pests, San Jose scale, and pear psylla, and can contribute to suppression of codling moth and spotted tentiform leafminer. M-Pede, an insecticidal soap, is also useful against pear psylla, and can contribute to control of aphids, leafhoppers, redbanded leafroller, and San Jose scale.

Codling Moth Granulosis Virus (Carpovirusine, Cyd-X) These products contain an insecticidal baculovirus, *Cydia pomonella* granulovirus, which is specific to the larval form of the codling moth, and is registered for use in apples, pears, and (Cyd-X only) plums. This biological insecticide must be ingested in order to be effective, after which the viral occlusion bodies dissolve in the larval midgut and release infectious virions. These enter the cells lining the digestive tract, where they replicate; eventually, the other tissues are infected and the larva stops feeding and eventually (within 3–7 days) dies. After death, the larva disintegrates, releasing billions of new occlusion bodies, which may infect other codling moth larvae upon ingestion. No adverse effect to fish, wildlife or beneficial organisms has been observed; it has a low bee-poisoning hazard.

Synthetic pheromones are available for disrupting the chemical communication of certain insect pests, thereby preventing them from mating and producing larvae that injure the crop. Pest-specific pheromones are released from dispensers or microcapsules placed or sprayed in the orchard before the initiation of flight, and can reduce or in some cases eliminate the need for supplementary insecticidal sprays. This approach works best in large (5-10A or more), rectangular plantings, where the pheromone concentration in the air is more uniform and can be maintained at a high level. Border insecticide sprays may be needed in orchards adjacent to sources of adult immigration or in other high pressure situations. Growers should contact their certifying agencies to determine which specific pheromone materails are acceptable in their state.

While the organically accepted insecticides individually do not offer the same degree of efficacy or longevity as their conventional counterparts, used in concert with each other along with conservation of biological control agents, it is possible to produce a high percentage of fruit free of insect damage within organic certification restriction on allowable materials.

2.5 New England Organic Apple Production Resources:

- OrganicA Project: http://www.uvm.edu/organica/index.html
- Organic Apple IPM: http://www.uvm.edu/organica/OrganicOrchardInformation/OrganicIPM/organicIPM.html
- An Organic IPM Checklist for Vermont: http://www.uvm.edu/organica/OrganicOrchardInformation/OrganicIPM/checklist.html

General Information on organic production can be found on the following websites:

- The National Organic Program: http://www.ams.usda.gov/nop/IndexIE.htm
- The National List of Allowed and Prohibited Substances: http://www.ams.usda.gov/nop/NationalList/ListHome.html

- The Organic Materials Review Institute (OMRI) Products List: http://www.omri.org/OMRI_brand_name_list.html
- Organic Food Production. Alternative Farming Systems Information Center: http://www.nal.usda.gov/afsic/ofp/

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3 Pesticide Information

3.1 Pesticide Classification and Certification

Putting it simply, a pesticide is substance used to control pests. Federal law, the Federal Insecticide, Fungicide and Rodenticide Act, or FIFRA, created two classifications of pesticides -- general-use and restricted-use. General-use pesticides may be purchased and used by anyone, but only a certified applicator may purchase a restricted-use pesticide. Restricted-use pesticides must be used by a certified applicator or someone under their supervision.

The same federal law that classified pesticides divided applicators into two groups: private and commercial. Private Applicators use or supervise the use of pesticides to produce agricultural commodities or forest crops on land owned or operated by the private applicator or their employer. A farmer must be certified as a private applicator in order to purchase and use restricted-use pesticides on agricultural commodities. (No certification is needed if a farmer does not use restricted use pesticides.)

A Commercial Applicator uses or supervises the use of pesticides for any purpose or on any property not covered by the private applicator classification.

Certification training, exams, and recertification courses are continually given in each state in New England. Please consult your Cooperative Extension or the state pesticide regulating agency if you have questions concerning certification.

Please refer to the state pesticide regulating agency, in the state that you are spraying in, for specific rules and regulations in that state.

3.2 Use Pesticides Safely

Using a pesticide imparts a great responsibility on the user to be a good steward of your health and that of others. Keep in mind that there is more to "pesticide use" than the application. Pesticide use also includes mixing; loading; transporting, storing or handling after the manufacturer's seal is broken; cleaning of pesticide application equipment; and any preparation of a container for disposal. All of these actions require thoughtful planning and preparation. They are also regulated by state and federal laws that are intended to protect the user, the community, and the environment from any adverse effects pesticides may cause.

3.2.1 Plan Ahead

Many safety precautions should be taken *before* you actually begin applying pesticides. Too many pesticide applicators are dangerously and unnecessarily exposed to pesticides while they are preparing to spray. Most pesticide accidents can be prevented with informed and careful practices. Always read the label on the pesticide container before you begin to use it. Make sure that you understand everything you need to know about the pesticide ahead of time so that you are a responsible user. Carefully follow all the directions and precautionary advice on the label. Be sure that you are prepared to deal with an emergency exposure or spill before you begin using pesticides. Be sure to know the first aid procedures for the pesticides you use.

3.2.2 Move Pesticides Safely

Carelessness in transporting pesticides can result in broken containers, spills, and contamination. Once pesticides are in your possession, you are responsible for safely transporting them. Accidents can occur, even when transporting materials a short distance. If a pesticide accident occurs, you are responsible. Do all you can to prevent a problem when transporting pesticides. Be prepared in case an emergency should arise.

3.2.3 Personal Protective Equipment

The need for personal protective equipment depends mainly on the pesticide being handled. Personal protective equipment requirements are printed on pesticide labels. These requirements are based on the toxicity, route of exposure, and formulation of that pesticide. The requirements posted on the label are the minimum that must be worn during the pesticide use. A pesticide user always has the option of wearing more protection than the label requires.

The activity, the environment, and the handler also influence the choice of protective equipment. The activity-related factors are type of activity, duration of the activity, equipment, and deposition pattern of the pesticide onto the handler. Mixing/loading procedures often require extra precautions when the pesticide is in concentrated form. Studies show that you are at a greater risk of accidental poisoning when handling pesticide concentrates. Pouring pesticide concentrates from one container to another is the most hazardous activity. A closed mixing/loading system can reduce this risk. Closed mixing systems are part of an array of protective devices call "engineering controls." You may learn more about engineering controls at this web site: http://hosts.cce. cornell.edu/txnc170/engineering.html Access this web site for more information on personal protective equipment: http://hosts.cce.cornell.edu/txnc170/handlers.html.

3.2.4 Avoid Drift, Runoff, and Spills

Pesticides that fall anywhere but on the target area can injure people, crops, and the environment. Choose weather conditions, pesticides, application equipment, pressure,

droplet size, formulations, and adjuvants that minimize drift and runoff hazard.

3.2.5 Avoid Equipment Accidents

Properly maintained and carefully used equipment contribute to safe pesticide application:

- Be sure to turn off your machinery before making any adjustments.
- Do not allow children, pets, or unauthorized people near the pesticide equipment.
- Between jobs, depressurize tanks or systems.
- Always return equipment to appropriate areas for cleaning and storage when pesticide applications are completed.

3.2.6 Pesticide Storage

Most pesticide applicators use existing buildings or areas within existing buildings for pesticide storage. Whether you choose a site to build a new storage area or use existing buildings, you need to consider several points:

- The site should be in an area where flooding is unlikely.
- It should be downwind and downhill from sensitive areas such as houses, ponds, and play areas.
- There should be no chance that runoff or drainage from the site could contaminate surface or groundwater.

Storage facility check list:

- ❑ Is the facility separated from offices, workshops, and livestock areas?
- ❑ Is the facility separated from wells, streams, lakes, ponds, wildlife?
- ❑ Is the facility separated from food and feed?
- ❑ Is the facility made of fire resistant building materials?
- ❑ Does the facility have impermeable flooring?
- ❑ Does the facility have liquid spill containment (berms to hold 25% of liquid storage)?
- ❑ Can the doors be locked?
- ❑ Is the facility fenced in?
- ❑ Are warning signs posted?
- ❑ Is a spill kit readily available?
- ❑ Are fire extinguishers readily available?
- ❑ Is personal protective equipment readily available?

3.3 Protect Honey Bees from Insecticides

Honey bees, wild bees, and other insects are important for proper pollination of many vegetables. Vine crops, for example, must be pollinated because they have male and female flowers, and pollen must be transferred from the male to female flowers if fruit is to set. Poor pollination results in small or odd-shaped fruit as well as low yields. Each flower must be visited eight or more times for adequate pollination to occur.

To avoid harming bees with insecticide treatments, remember these points:

- Do not spray crops in bloom;
- Mow blooming weeds before treatment or spray when the blossoms are closed;
- Avoid application during the time of day when field bees are most numerous;
- Make application in the early morning or evening; and
- Always read the label before use.

If pesticides that are highly toxic to bees are used in strict accordance with label directions, little or no harm should be done to bees. Label statements on pesticides that are highly toxic to honey bees may carry a caution statement such as: "This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area."

3.4 Verifying Pesticide Registration and Restricted-Use Status

Any pesticide used must be currently registered with the state pesticide regulating agency and the USEPA. Applicators can easily verify whether pesticides are currently registered and classified as restricted-use by contacting the state pesticide regulating agency, in the state that you are spraying in, for specific rules and regulations in that state.

3.5 Pesticide Recordkeeping/Reporting

Each state in New England has pesticide recordkeeping requirements and reporting. Contact the state pesticide regulating agency if you have questions concerning pesticide recordkeeping requirements and reporting.

3.6 Reduced-Risk Pesticides, Minimum-Risk Pesticides, and Biopesticides

Since 1993 EPA has expedited the registration of conventional pesticides with characteristics such as very low toxicity to humans and nontarget organisms including fish and birds, low risk of groundwater contamination or runoff, low potential for pesticide resistance, demonstrated efficacy, and compatibility with IPM. Materials meeting these criteria are referred to by EPA as "reduced-risk." The "reduced-risk" designation applies only to certain uses of a particular pesticide, which may not be all label uses for that product.

Minimum-risk pesticides are products that are exempted from EPA registration (and therefore have no EPA registration number). They contain only active ingredients outlined in FRFRA 40 CFR 152.25(g) ("the 25b list") and inert ingredients currently identified on Federal Register Notice 59 FR 49400 ("the 4a list"). The lists can be accessed from the following link: http://www.epa.gov/pesticides/biopesticides/. All ingredients and percent concentrations must also be listed on the label. Policies may differ in each New England state, which sometimes require such products to carry a state registration number. Contact the state pesticide regulating agency for specific rules and regulations.

Biopesticides, or biological pesticides as defined by EPA, are certain types of pesticides derived from such natural materials as animals, plants, bacteria, and certain minerals. These include microbial pesticides, which contain bacteria, fungi, virus, etc., as the active ingredient; plant-pesticides, i.e., pesticidal substances that plants produce from added genetic material (such as corn genetically modified to produce *Bacillus thuringiensis* toxins); and biochemical pesticides comprised of naturally occurring substances that control pests by nontoxic mechanisms (such as pheromones or some insect growth regulators). Biopesticides must be registered with EPA. More information on biopesticides is available at http://www.epa.gov/pesticides/biopesticides/.

3.7 FIFRA 2(ee) Recommendations

Certain limited variations from the use directions specified on pesticide labels are authorized under FIFRA Section 2(ee).

These "2(ee) recommendations" allow:

1) Use at any dosage, concentration, or frequency less than specified on the labeling.
2) Use against any target pest not specified on the labeling.
3) Methods of application not prohibited on the labeling.
4) Mixtures with fertilizer unless prohibited on the labeling.

No fee is required for a 2(ee) recommendation request.

3.7.1 Requirements:

1) Anyone receiving approval of a 2(ee) recommendation is responsible for distributing the recommendation to all users of the product pursuant to the approved recommendation.
2) Any user must have the 2(ee) recommendation in his or her possession at the time of application.

3.7.2 Information required for submission of 2(ee) recommendations:

1) Requests for approval of 2(ee) recommendations must be made in writing by recognized research institutions, certified crop advisers, manufacturers (registrants), or organizations representing individual users. Individual users may not request approval of 2(ee) recommendations.
2) Requests must be accompanied by data demonstrating that the use will be effective.

3.8 Prepare for Emergencies

Call a POISON CONTROL CENTER or physician in ALL cases of suspected poisoning. It is better to be too cautious than too late.

During an emergency call, tell the physician the chemicals listed on the label, the EPA registration number, antidotes given on the label and other information about the accident that could aid in treatment. Be prepared! READ and POST SAFETY RULES. Fill in the phone number of your local ambulance service, doctor and hospital as well. Inform your doctor of the *Notes to Physicians* on labels of the pesticides you plan to use, and get his/her advice on whether antidotes should be kept on site.

3.9 Organophosphate Poisoning

The effects of organophosphate and carbamate poisoning are rapid. Poisoning must be recognized early for effective treatment. Early symptoms are usually a headache, feeling of weakness, blurred vision, excessive perspiration, and nausea. Abdominal cramps, vomiting, and excessive salivation may set in with, or without, diarrhea. The throat and chest will feel constricted, making breathing difficult. In mild poisoning, some of these symptoms may be absent. Heat stress causes symptoms similar to pesticide poisoning.

If breathing stops, artificial respiration is the most important first-aid. While waiting for medical help, give first-aid as indicated on the label. Never try to give anything by mouth to an unconscious person. Get the victim to a doctor as soon as possible. If you know which pesticide is involved, take the container along so the doctor can read the label. If this is impractical, remove the label and take it with you. Re-label the container as soon as possible.

Cholinesterase is an enzyme necessary for the proper function of the nervous system in humans and several other animals. Organophosphate pesticides (dimethoate, diazinon, azinphosmethyl, phosmet, chlorpyrifos and methidathion) and carbamate pesticides (carbaryl, methomyl, oxamyl), and many other natural and synthetic chemicals, interfere with the action of cholinesterase. An applicator that uses these types of pesticides regularly would be wise to have a cholinesterase activity test. This is a simple blood test that can be taken at many hospitals. The test finds the base line

or "normal" level of cholinesterase in your blood. If pesticide poisoning is suspected, the cholinesterase level can be checked again at that time for confirmation. The best time to establish the base line is before the spray season. The important level is the total or true cholinesterase. Discuss this with your physician beforehand. Inform your doctor of the *Notes to Physicians* on labels of the pesticides you plan to use, and get their advice on whether antidotes should be kept on site.

3.10 Your Responsibility as a Pesticide User

This guide summarizes information from product labels and other sources, but it **does not include** all of the information for which users are responsible.

Contact Cooperative Extension for pesticide safety training materials, and your state Department of Agriculture for current pesticide regulations. A primary requirement is that no owner or lessee shall permit pesticide application in such a manner as to directly, or through drift, expose workers or other persons to spray or dust.

Pesticide product labels are the legal documents governing proper usage. Always read the label before using any pesticide. If you are unsure about any aspect of safe or proper use, contact the dealer, manufacturer or Cooperative Extension before use.

Wear the appropriate personal protective equipment (PPE) listed on the label when working with any pesticide.. At a minimum you should wear long sleeve shirt, long pants, shoes plus socks and chemical resistant gloves. Do not allow pesticides to contact your skin. Read and follow all safety precautions on labels.

After handling pesticide, wash hands and face before eating, smoking, or using a restroom. Instruct your family, coworkers and farm laborers on pesticide safety procedures. Post safety rules and emergency information where workers will see them.

Tree fruit growers sometimes need to use pesticide in areas where residences, cropland, pasture, or bodies of water are nearby. Pesticide drift from orchards to off-target areas presents a hazard. Avoid application when conditions favor drift.

3.11 Field Use and Care of Respirators

Wear the label-recommended respirator with a filter for powders and an activated charcoal filter for organic vapors. Write the date of first use on the cartridge. Change the filters and cartridges after the number of hours specified, or more often if breathing becomes difficult or if pesticide odor is detected. Respirators do not provide adequate protection from inhalation of pesticide dust, mist or vapors when mixing pesticide in closed or poorly ventilated areas. The respirator should be fitted properly on the face, not too high on the nose, with narrow portion over the bridge of the nose, and chin cup contacting under side of the chin. Headbands should be adjusted just tight enough to insure a good seal. Refer to the directions for respirator fit testing which should be included with the respirator packaging. Remove filters and cartridges and wash face piece with soap and warm water after use. Dry face piece with a clean cloth and/or place face piece in a well-ventilated area to dry. Store respirator, filters, and cartridges in a clean, dry place, preferably in a tightly closed plastic bag.

3.11.1 Other Safety Equipment

- Chemical resistant gloves.
- Personal protective clothing, such as rubber apron, coveralls and cap.
- Chemical resistant work shoes or boots.
- Chemical resistant goggles.

3.12 Acute Toxicity of Pesticide

A pesticide's hazard to warm-blooded animals, including humans, is usually determined in relation to the way it enters the body. Methods of entry include the respiratory system, digestive system and skin. The greatest hazard is from pesticide entry via the respiratory system (inhalation).

Pesticide toxicity by this route is not much different from that of intravenous injection because membranes of the lungs that separate air from blood are extremely thin, and absorption is therefore very rapid (this is also true for the eyes). Oral absorption (through the digestive tract) is the next most hazardous avenue for poisoning. Dermal (skin) absorption is less immediate than respiratory or oral. However, there is considerable variation in the rate of penetration through the skin by different materials and formulations, and by different areas of the body.

When spraying, many airborne spray particles are trapped in the secretions of the upper respiratory tract and swallowed, thereby providing exposure by inhalation and ingestion. Assuming that the person applying the pesticide takes adequate precaution (respirator, goggles, etc.) to prevent inhalation and oral exposure, dermal toxicity is probably a more realistic index of occupational hazard than oral toxicity.

3.12.1 Danger — Poison; Warning; Caution:

One of these "signal words" appears on the label of every pesticide. Acute (or immediate, single dose) toxicity is reported as an LD50 value. The LD50 for a chemical is the dose that has been found in controlled experiments to kill 50% of a large number of test animals. The LD_{50} dose is usually expressed as the number of milligrams (mg) of pure active ingredient per kilogram (kg) body weight of the test animals. The lower the LD_50, the more toxic the chemical is.

Because the LD_{50} is based on animal tests, uses pure active ingredient rather than formulated product, and does not account for individual sensitivity, it does not necessarily represent the toxic dose for an individual human. The LD_{50} of a chemical gives no information on the possible long-term chronic health effects from repeated exposure at low levels.

Toxicity Category & Signal Word on Label	LD_{50} Oral (mg active ingredient per kg body weight)	LD_{50} Dermal (mg active ingredient per kg body weight)
I DANGER – POISON	0 to 50	0 to 200
II WARNING	>50 to 500	>200 to 2,000
III CAUTION*	>500 to 5,000	>2,000 to 20,000
IV none*	>5,000	> 20,000
* Category IV materials may have Caution signal word due to skin irritation or other hazard.		

READ THE LABEL FOR PRESCRIBED SAFETY EQUIPMENT AND PRECAUTIONS!

In addition to oral or dermal acute toxicity, a pesticide may also carry the **DANGER - POISON**, **DANGER**, or **WARNING** signal words because of other potential hazards, such as inhalation toxicity or the ability to cause severe eye or skin damage.

3.13 Label Compliance

Under the present EPA regulations, pesticides may be applied:

- At a different rate per 100 gallons dilute than stated on label as long as the application stays within the dose per acre limit;
- At a lower rate per acre than on label; and
- Less frequently than on label.

IMPORTANT — it is **illegal** to:

- Increase amount applied per acre (overdosage);
- Use shorter intervals between sprays than minimum interval stated on label; and
- Shorten intervals to harvest (illegal residues on crop).

State regulations may be more restrictive than those of the EPA.

3.14 Protecting Water Quality

Tree fruit growers have a responsibility to prevent pesticide from contaminating surface bodies of water and groundwater supplies. Over 90% of the rural population in the U.S. depends on groundwater as their supply of drinking water. Groundwater is very difficult to clean if it does become polluted. Listed below are a few practices that can help prevent water contamination. Contact Extension for more information.

- Consider the potential for rinse water, spills, application or erosion to create pesticide laden runoff which can reach a surface body of water. If you do not have a self-contained mixing pad, use an area where the run-off risk is low. If you are working near a stream or pond, do not allow runoff to occur.
- Use an anti-backflow device when filling the spray tank.
- Periodically change the location of field mixing areas. Be aware of the location and condition of wells; stay at least 50 feet away from wells. Special caution is needed around wells with cracked casings.
- Be aware of the soil types, geology, and depth of water table in your local area. The potential for pesticide leaching into groundwater is generally greater on ledge, sandy soils, or other soils low in organic matter. The risk increases when the water table is close to the surface. Try to choose pesticides with a low leachability hazard if you are working under these conditions.
- Keep spray equipment accurately calibrated.
- Use proper procedures for pesticide storage and disposal. Keep pesticide storage and mixing areas away from streams, ponds, and springs.

3.15 Restricted Entry Interval

Manufacturers may write the label with a longer REI than required by the EPA, or the EPA may change its minimum REI requirement. To know the use restrictions for a pesticide you must READ THE LABEL!

3.16 Pesticide Residue Tolerances

Federal laws warn that food shipments bearing residues of pesticide chemicals in excess of established tolerances will be contraband and subject to seizures as “adulterated.” This applies to both raw and processed foods.

The amount of pesticide residue in or on a food material at harvest must fall into established tolerances, expressed in “parts per million” (ppm). The actual amount of pesticide chemical found in a food at harvest depends in part on the amount applied to the crop and the length of time since the last application. Therefore, growers are responsible for strictly following label information as to:

- Maximum spray dosage, and
- The preharvest interval: which is the required length of time between the final pesticide application and harvest.

3.17 EPA Worker Protection Standard

This section is adapted from *Worker Protection Standard Brochure #1: Duties of Employers* by the Maine Board of Pesticides Control. **This is only a very brief summary of the WPS.** Check with the pesticide regulatory agency in your state for complete information.

3.17.1 Who Must Comply?

The U.S. Environmental Protection Agency (EPA) has issued rules governing the protection from occupational exposure to agricultural pesticides of workers on farms, in forests, nurseries, and greenhouses. Chemical growth regulators and thinning agents are included as "pesticides." These regulations apply if you are an employer with workers that fit in either of the two following categories:

- **Agricultural workers** – performing tasks related to the cultivation and harvesting of plants on farms, greenhouses, nurseries, or forests; or
- **Pesticide handlers** – assigned to mix, load or apply agricultural pesticides; clean or repair equipment, act as flaggers, or IPM scouts, etc.

Employers are responsible for making sure that workers and handlers receive the protection required by the pesticide labeling and the WPS. There are two types of employers:

- **Agricultural employers** – employ or contract for the services of workers or own/operate an establishment that employs workers, and;
- **Handler employers** – hire pesticide handlers or are self-employed as handlers. This definition includes commercial applicators and companies that supply crop advisory services.

3.17.2 What Must an Employer Do?

It is the responsibility of the employer to provide the following to all employees who meet the WPS definition of an agricultural worker or pesticide handler.

1) Pesticide Safety Training:
Handlers and workers must be trained every 5 years unless they are certified applicators. Handlers must be trained before they do any handling activity. Workers must be provided with basic pesticide safety information before entering an area of your agricultural establishment that is or has been under a restricted entry interval (REI) within the last 30 days. Full WPS training must be done within 5 days of employment.

- Information at a Central Location:
  a. Facts about each pesticide application – product name(s), EPA registration number(s), and active ingredient(s); location and description of treated area(s); the time and date of the application and the restricted-entry interval (REI);
  b. The name, address and telephone number of the nearest emergency medical facility;
  c. An EPA WPS safety poster.

2) Decontamination Sites:
  a. A decontamination site must be provided within 1/4 mile of the employee's work site.
  b. A decontamination site must contain enough water for routine and emergency whole-body washing (3 gallons for handlers and 1 gallon for workers) and for eye flushing; plenty of soap and single-use towels; and a clean overall, for use by handlers.
  c. Handler employers must also provide a decontamination site where handlers remove their personal protective equipment (PPE) at the end of a task and at each mixing site.

3) Emergency Assistance:
  a. Employer must provide product name(s), EPA registration number(s) and active ingredient(s);
  b. All first aid and medical information from the label(s);
  c. Description of how the pesticide was used and;
  d. Information about the victim's exposure.
  e. Transportation to the hospital if necessary.

4) Restrictions During Applications:
An employer must keep all workers, other than trained and equipped handlers, out of areas being treated with pesticides.

5) Restricted-Entry Intervals (REI):
The restricted-entry interval is the period immediately after a pesticide application during which entry into the treated area is limited. The REI is located on the product label. **During an REI, do not allow workers to enter a treated area** or contact anything treated with the pesticide to which the REI applies. Pesticide handlers may reenter during the REI, but only if they wear the personal protection equipment required for early entry as stated on the label.

REIs for many labels have changed in the past 2 years, so read the label!

6) Notice About Applications:
Employers must notify workers and handlers about pesticide applications on the establishment. In most cases, employers may choose between oral warnings or posted warning signs, but they must tell employees which warning method is in effect. For some pesticides, employers must provide both oral warnings and posted warning signs.

Posted warning signs must be:
  a. At least 14" x 16" in size, with an EPA-mandated design;

b. Posted 24 hours or less before application; posted during the REI; removed before workers enter and within 3 days after the end of the REI;
c. Posted so they can be seen at all normal entrances to treated areas, including entrances from labor camps.

Oral warnings must be delivered in a manner understood by workers and handlers, using an interpreter if necessary. Oral warnings must contain the following information:

a. Location and description of treated area;
b. The REI; and
c. Specific directions not to enter during the REI.

3.17.3 Additional Duties for Handler Employers

Handler employers are also required to provide the following protection to their employees.

7) Application Restrictions:
Do not allow handlers to apply pesticide so that it contacts, directly or through drift, anyone other than trained and PPE-equipped handlers.

8) Monitoring:
Sight or voice contact must be made at least every two hours with anyone handling pesticides labeled with a skull and crossbones (signal word: DANGER-POISON).

9) Specific Instructions for Handlers:
Handler employers must make sure that before any handling task, the handlers are given: information from the pesticide labeling regarding its safe use; access to the label during the entire handling task; and instructions on the safe operation of the equipment they will be using.

10) Personal Protection Equipment (PPE):
a. When personal protective equipment is required by the product label, the handler employer must provide the PPE; clean and maintain it correctly; make sure each handler wears and uses the PPE correctly; provide a clean place to change and store PPE; take action to prevent heat stress resulting from wearing PPE; and not allow the PPE to be worn or taken home.
b. The employer must make sure that PPE is cleaned according to manufacturer's instructions; inspected and repaired before each use; that non-reusable or uncleanable PPE, or PPE that is drenched with pesticide concentrates labeled DANGER or WARNING, are properly disposed of; that PPE is washed and dried appropriately and stored separately from personal clothing; and that respirator filters, cartridges, and canisters are replaced as often as required.
c. The employer must make sure anyone cleaning PPE is informed of the potential hazards associated with the possible pesticide residues on the PPE.

11) Equipment Safety and Maintenance:
a. Handler employers must make sure that equipment used for mixing, loading, transferring, or applying pesticides is inspected and repaired or replaced as needed.
b. Only appropriately trained and equipped handlers may repair, clean, or adjust pesticide handling
c. Equipment that contains pesticides or pesticide residues.

3.18 OSHA Hazard Communications Standard

This law (often called the "worker's right-to know law") requires employers to inform employees of any chemical hazards they may be exposed to while performing their work. The Bureau of Labor Standards (or the comparable agency in your state) is responsible for administering and enforcing this law.

Farmers who employ 11 or more people during a year, or who have temporary labor camps, must comply with the law by the following means:

1) Develop a written policy on how you comply with the law.
2) Inventory all hazardous materials held.
3) Obtain the Material Safety Data Sheets (MSDS) for each hazardous material or product to be used. (Request pesticide suppliers to provide MSDS).
4) Provide warning labels for secondary containers used to hold hazardous materials. Never put pesticides in secondary containers.
5) Provide documented annual training for each employee, including:
a. Explanation of the written hazard communication program, chemical inventory, MSDS, and secondary warning labels. Inform employees of the location and provide access to these documents.
b. The physical and health hazards of the chemicals used.
c. Description of areas or tasks where hazardous materials are present.
d. Methods of detecting presence or release of hazardous chemicals in work areas.
e. Protective measures, including the use and limitations of personal protective equipment.
f. Emergency procedures.
6) Report on chemicals used, and other information as requested, to the proper state agency.

4 Sprayer Information

4.1 Solutions For Safer Spraying

4.1.1 Reducing Risk of Pesticide Exposure Through use of Engineering Controls

4.1.1.1 Why Use Engineering Controls?

Because handling and applying pesticides is risky business, keeping pesticide exposure to a minimum should be a chief concern of any pesticide applicator. To reduce the risks associated with handling and applying pesticides, devices known as engineering controls can be used that help to reduce or practically eliminate exposure to toxic chemicals. This section describes various engineering controls that can help reduce applicator exposure to pesticides in five areas of potential contamination.

1. Loading the Sprayer

Closed Transfer Systems - Closed transfer systems allow concentrated pesticide to be moved from the original shipping container to the sprayer mix tank with minimal or no applicator contact. Many systems provide a method to measure the concentrated pesticide. Some systems also include a container rinsing system. Currently available closed transfer systems use a probe inserted into the pesticide container, a connector on the container that mates to a similar connector on the application equipment, or a vacuum-type (venturi) system that uses flowing water to transfer the chemical from the container.

Induction Bowls - Induction bowls are metal, plastic or fiberglass hoppers attached to the side of the sprayer or nurse tank that allow pesticides to be added to the mix tank without the applicator climbing onto the spray rig. Pesticides are poured into the bowl and water is added to flush out the bowl and carry the pesticide to the spray tank. Often a rinse nozzle is mounted inside the bowl for rinsing out empty pesticide containers. Typically induction bowls are raised out of the way during spraying and lowered to about 3 feet above ground when loading the sprayer.

Direct Pesticide Injection System - Direct pesticide injection systems allow pesticides to be mixed directly with water in the sprayer plumbing system rather than in the main spray tank. The pesticide is pumped from its container and mixed with the water either in a manifold or at the main water pump. Only clean water is held in the main tank of he sprayer. An electronic controller and up to four pumps adjust the amount of concentrated pesticide that is injected into the water stream, allowing for variable application rates.

Container Rinse System - Container rinse systems consist of a rinse nozzle and a catch bowl that traps the container washings (rinsate). The empty container is placed over the rinse nozzle and a jet of water cleans the inside of the container. The rinsate caught in the bowl is pumped into the spray tank to be used along with the spray mixture. Often rinse nozzles are installed in chemical induction bowls. Most closed transfer systems also provide a way of rinsing containers and piping the rinse water into the spray tank.

2. Reducing Contamination at the Boom

Boom Folding/Extending - Manually folding booms can be a major source of operator contamination because the boom can be covered with pesticide from drift or dripping nozzles. Consider the use of hydraulic or mechanical folding methods.

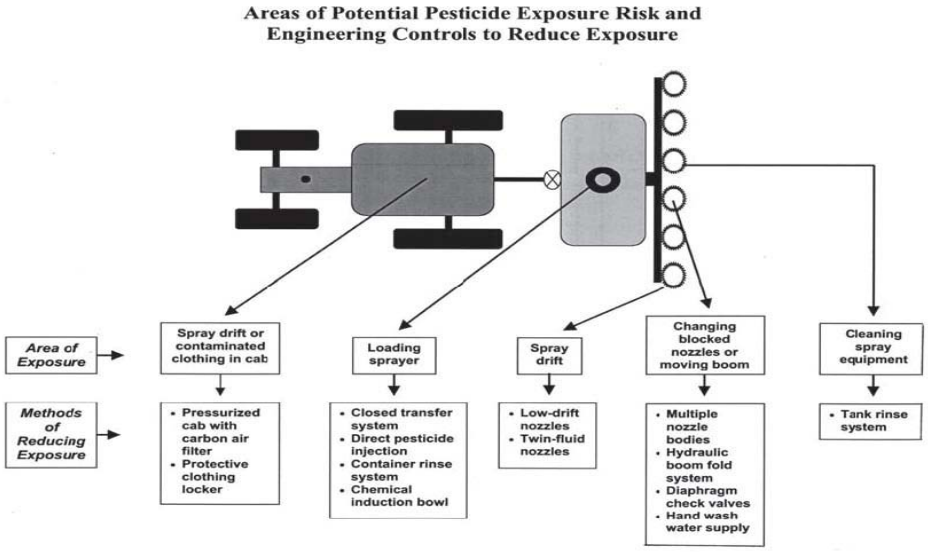
Diaphragm Check Valves - Typically, when a sprayer is shut off and as the system pressure drops, any liquid remaining in the boom piping drips from the nozzles, possibly dripping onto the boom or even the operator. Diaphragm check valves installed at each nozzle prevent this by using a spring-loaded rubber diaphragm to close off the flow of liquid once the system pressure drops below about 10 pounds per square inch. When the sprayer is switched on and system pressure builds up, the valve opens and allows the liquid to flow through the nozzles.

Multiple Nozzle Bodies - Contamination can occur when operators change or unclog nozzles during an application. Multiple nozzle bodies (or turret nozzles) allow operators to switch between nozzles with a turn of the nozzle body rather than having to unscrew or undo a threaded or a bayonet fitting.

Hand Wash Water Supply - Providing adequate wash water is essential (and often required). A simple container with a hand-operated valve can be mounted on the side of the sprayer to provide clean water for hand washing and personal hygiene.

3. Protecting from Drift and Contaminated Clothing in Cabs

Cab Filtration Using Carbon Filters - Carbon filtration systems are used to remove pesticide odor and pesticide-laden mist from fresh air used in a tractor or self-propelled sprayer cab. Carbon filtration systems are often a standard feature on self-propelled sprayers. Now many factory installed tractor cabs offer optional filtration systems. In 1998, the American Society of Agricultural Engineers (ASAE) adopted testing standards for operator cabs used in pesticide application. Cabs certified under this standard meet the requirements for enclosed cabs contained in the Worker Protection Standard.



Protective Clothing Lockers - To prevent contamination of the tractor or sprayer cab interior, entering the cab. A few sprayer companies offer a simple compartment (or locker) mounted to the side or front of the sprayer where protective clothing can be stored. Alternatively a locker can be fitted to the nurse tank.

4. Controlling Drift

Low-Drift Nozzles - Low-drift nozzles create larger-size droplets than conventional nozzles. The larger droplet sizes are less prone to drift, reducing environmental and operator contamination.

Air Induction (Twin Fluid) Nozzles - These nozzles allow air to mix with the spray liquid, creating large, air-filled droplets that have virtually no fine, drift-prone droplets. The droplets explode when they contact their target and offer similar coverage to droplets from conventional, finer-spray nozzles.

5. Cleaning the Sprayer

Tank Rinse Systems - Tank rinse systems consist of a clean water supply tank mounted to the sprayer and one or more rotating discs or nozzles mounted inside the main sprayer tank. Water is pumped from the clean water tank to the rinse nozzles, which spray water around the inside of the spray tank. These systems are designed for in-field rinsing of the sprayer so that the tank washings can be applied to the field at label rates.

4.2 Minimizing Pesticide Drift in Orchards Part I

Disease and insect control is a critical factor in most commercial orchards. While such control may, in some seasons, be a small proportion of crop value, there is a demand from growers for increased efficiency of spraying. Attention to detail is necessary to improve efficiency of deposition, reduce drift and increase sprayer output.

As an apple grower on Long Island once stated, drift management is all in the mind; it requires the grower to think about reducing drift before the legislators apply controls.

Spray drift of pesticides is an important and costly problem facing pesticide applicators. Drift results in damage to susceptible off-target crops, environmental contamination to waterways and a lower than intended rate to the target crop, thus reducing the effectiveness of the pesticide.

Pesticide drift also affects neighboring properties, often leading to concern and debate. As more people choose to live in the picturesque setting of an orchard and growers continue to sell plots to increase their revenue, so the debate will continue.

There are two types of drift, airborne drift, often very noticeable, and vapor drift. The amount of vapor drift will depend upon atmospheric conditions such as humidity, temperature and the product being applied, and can occur days after an application is made. Drift is influenced by many interrelated factors including droplet size, nozzle type and size, sprayer design, weather conditions and, last but not least, the operator.

a) droplet size

In the past, trees were drenched with high volumes and coarse droplets at 200–400 gallons per acre, resulting in trees dripping with excess pesticide. The belief that too much is better than too little is misplaced. Dripping trees lead to environmental pollution such as soil contamination and an excessive number of tank loads per acre results in poor time management.

Lower volumes must be used, which may result in smaller droplets, although there is a limit to droplet size because of

concerns about drift. Droplets under 150 microns generally pose the greatest hazard; droplets less than 50 microns have insufficient momentum for impaction as they remain suspended in the air indefinitely or until they evaporate. Research in England concluded that a 100-micron droplet takes 11 seconds approximately to fall ten feet in still air; when a similar size droplet is released into a 5mph wind it will drift about 75 feet before hitting the ground.

The higher the operating pressure, the smaller the droplet; conversely, low pressure produces large droplets that may bounce off the target. Traditional air blast sprayers give the greatest cause for concern as they produce many small droplets, which are often off-target. Certain spray surfactants can change the droplet spectrum, reducing the number of driftable droplets.

b) nozzle type and size

Modern nozzle technology such as air inclusion nozzles produce larger droplets than conventional cone nozzles. Large droplets normally roll off the leaf, but air inclusion nozzles create air bubbles within the larger droplets, which then collapse on contact with the leaf, dissipating the energy and dispersing the liquid. Recent research in England and Germany has shown promising results using air inclusion nozzles with air blast sprayers in trees and bushes, although further trials are necessary in apple orchards.

Rotary atomizers create smaller, more uniform droplets, which would normally drift. When used in conjunction with a tower and cross-flow fan design, the smaller droplets are actually directed into the canopy. This type of sprayer, referred to by some as controlled droplet application, produces 95–98% of its droplets all of the same size. The size produced depends on the speed of the spinning cage. Advantages include less water, resulting in better timeliness and a more targeted spray. Research in the US and Europe shows that small droplets on target are effective at controlling diseases and insects.

c) sprayer design

Tower sprayers and tunnel sprayers are better at targeting the spray into the canopy, reducing drift and increasing deposition. The conventional air blast sprayer sends droplets in an air blast from a central fan upwards into the canopy. The tower sprayer, using an air curtain, and rotary atomizer, was developed by agricultural engineers at Michigan State University ten years ago and has shown excellent results at disease and insect control. Horizontal penetration into the canopy is preferential to vertical penetration from an air blast sprayer. Tunnel sprayers, developed many years ago in Europe and the US, have tremendous advantages in managed orchards using trellis designs and dwarf trees. The use of a spray collection device at the base of the tunnel canopy results in the ability to recirculate spray with subsequent savings in pesticide and a reduction in drift. Many growers believe that tunnel sprayers are only suitable for level land, but an increasing number are to be found in orchards on undulating land.

Drift problems increase when a space occurs within the row. Air blast sprayers, with or without a tower, can be fitted with ultrasonic or laser canopy sensors. The sensors also detect the shape of a tree and adjust the spray pattern accordingly. The advantages include reduced drift and ground deposition, reduced pesticide use and improved logistics.

Herbicide drift from weed control practices should not be forgotten; shielded herbicide sprayers prevent drift from contaminating apples and damaging leaves. Shields can vary from the simple to the complex, from hydraulic flat fan nozzles to controlled droplet applicators using reduced herbicide rates. Shielded sprayers allow growers to apply herbicides in variable weather conditions.

d) sprayer calibration

Correct calibration will ensure that all the nozzles are discharging the correct amount of liquid at the correct distance and angle to the target and at the correct forward speed. Operators must set the air deflectors correctly to confine airflow, spray and disturbance to the tree canopy.

e) weather

Wind speed and direction, relative humidity, temperature and atmospheric stability affects drift. Applying the correct product to the correct target at the correct time with the correct equipment is the key to good spraying.

Research in England and New Zealand has been conducted to measure the effectiveness of shelterbelts (windbreaks). Natural and artificial belts were used and drift is reduced closer to the shelterbelt. Shelter belt height and density will affect drift, and may, in certain conditions, create additional air currents and eddies. There are so many variables such as topography and wind direction that it is difficult to conclude that research at one site is transferable to another. It is worth noting that German growers face federal drift-measuring programs to ensure a safe buffer zone of up to 150 feet, resulting in severe restrictions for some growers.

f) forward planning

Forward planning is the key to good management", a phrase often used by successful business managers, also applies to orchard management. Choose the correct size sprayer with good back-up support to ensure that spraying may be done in a timely manner. Far too often, growers are racing around orchards in an attempt to apply pesticides after a problem disease or insect attack has occurred. Good logistical support in reducing the need to return for frequent refills is so important. The use of orchard field cards, detailing: the block, pesticide required, application rate, quantity required per tank fill, etc., will reduce stress levels found amongst some applicators and will improve efficiency and safety. Integrated pest management (IPM),

including monitoring of pests and disease forecasts, should be conducted to allow sufficient time to apply a needed pesticide in the area to be sprayed.

Continuing development of spray application techniques will improve the efficiency of orchard spraying. Many of the factors that affect application and drift are interdependent. Airflows must be optimized, particularly where smaller droplets are used; crop canopies and water volumes must be carefully considered if growers are to take advantage of new technologies. Investment levels in modern technology must be maintained if the grower is to remain competitive.

4.3 Minimizing Pesticide Drift in Orchards Part II

4.3.1 Before Spraying:

1. Train the operator to use the sprayer correctly on your farm under your conditions.
2. Plan the spraying operation; consider the use of orchard field cards as a good management tool.
3. Read and follow the pesticide label.
4. Select the correct nozzle for the target. Adjust the size and position of the nozzles to achieve correct distribution within the canopy, particularly as the growing season progresses.
5. Consider the use of sprayers that direct the spray to the target, such as towers and tunnels. Check that air deflectors are set properly to confine disturbance to the target.
6. Consider spray additives to reduce drift.
7. Improve spraying logistics to ensure adequate time to spray within "ideal" conditions.
8. Only spray when weather conditions are ideal; avoid spraying on days when conditions are favorable for atmospheric inversion or wind drift.
9. Calibrate the sprayer with water to ensure that everything is working correctly.
10. Start planting windbreaks!

4.3.2 During Spraying:

1. Stay alert: ensure the spray is not allowed to drift on to non-target areas and watch for changes in wind speed and direction.
2. Keep spray pressure as low as possible and ensure an accurate gauge is used.
3. Maintain a constant speed and pressure, if an automatic regulator is fitted; remember, small increases in speed result in large increases in pressure. The delivered air and spray must be given time to penetrate the canopy.
4. Avoid spraying near sensitive crops or waterways; use a 50–100-ft buffer zone. Spray inwards, with one side of the sprayer, for at least 50 feet from the boundary to create a "headland".

4.3.3 A case study

The orchard that the spray drift has been coming from has 20-foot row spacing, 17-foot tree spacing, 9- to 10-foot high trees, and a no-spray buffer zone with a 10-foot wide hedgerow acting as a windbreak. Farmer Brown would like to stop any drift from reaching his neighbor's property.

4.3.3.4 Method:

1. Monitoring equipment. Purchase and use good quality instruments for wind speed, temperature and humidity.
2. Nozzle orientation: To see where the spray is actually going, Farmer Brown needs to set up a system to check his sprayer plume. One method is to use a patternator. Another method is to use a 16-foot high pole (two 8' 2"x4" boards end to end) with a paper tape stapled along the leading edge. Place the pole between two trees within the row and spray a mixture of clean water and food coloring. Travel between the rows, spraying out the mixture. The spray will stain the paper where it hits. By looking at the colored spray droplets on the paper, Farmer Brown can alter the orientation of the nozzles or deflectors until the spray is only hitting the portion of the vertical pole/trees that is desirable.
3. Air Induction Nozzles (AI): These nozzles, when used properly, can reduce drift by at least 50 percent. The principle behind these nozzles is to create a larger droplet that won't drift as far but still maintain good leaf and fruit coverage. Note, not all AI nozzles are the same. Remember, it is critical to orientate the nozzles as in step 1 above. Wilger and Lechler manufacture air-assist units to enable AI and hollow cone nozzles to be switched on/off from the tractor.
4. End Plates: In situations where only one side of the sprayer is required, a shroud can be used to block any air on the opposite side of the sprayer. On the last couple of rows in the orchard you can spray inwards. This way you can reduce drift by 50 percent.
5. Foliage Sensors: These sensors tell whether or not the sprayer is next to a tree, automatically shutting the spray off if no tree is present. There are ultrasonic or infrared sensor types that, if used properly, reduce your overspray and drift by 50 percent.
6. Hail Nets: The use of hail nets is a good way to reduce drift. Overhead hail nets can reduce drift up to 75 percent. Hail nets can also be used as a barrier to break up the wind.
7. Tower sprayers are better at targeting the spray into the canopy than a conventional air blast. The conventional air blast sprayer sends droplets in an air blast from a central fan upwards into the canopy, whereas the tower sprayer uses a horizontal air curtain.

8. Tunnel Sprayers: Tunnel sprayers are the best way to reduce drift. Very little spray gets out of the tunnel spraying system, allowing for a 90 percent reduction in drift. If AI nozzles are used with the tunnel sprayer, 99 percent of drift can be reduced.
9. Axial fan size and speed: Using an axial fan producing 30,000m3/hr and in conjunction with AI nozzles will result in a 75 percent reduction of drift.
10. PTO speed: Regulating the PTO speed of the tractor is an inexpensive way to reduce drift. Lowering the PTO speed reduces fan speed, preventing excessive amounts of air from blowing pesticides through the target and allowing good deposition to occur. On an airshear type sprayer, reducing PTO speed by 25% reduced drift by 75%. The reduced speed also increased droplet size, further reducing the effects of drift (see NY Fruit Quarterly, Vol. 12 #3, Autumn 2004).
11. Hydraulic Drive: Using a hydraulic motor to drive the sprayer fan will allow you to regulate wind velocity.
12. Cornell Doughnuts: These attachments restrict air intake to reduce air flow through the sprayer. For early season, the 1/2 air intake doughnut can be used to only allow enough air to penetrate just the target row. A 2/3rd air intake hole can be used for early/mid-season to allow more air. Finally, in full canopy, no doughnut is required.
13. Drift-reducing additives. A number of manufacturers supply drift reducing agents; most work via increasing droplet size. Beware, not all of them can withstand the higher pressures associated with fruit sprayers and need independent verification.
14. Calibrate and check that the sprayer is functioning correctly.

4.3.3.5 Conclusion:

Drift is impossible to eliminate but can be minimized. Implementing just one of these methods will greatly reduce the effects of drift and improve your efficiency of spray application, saving you time, money, and future problems.

German Drift Reduction Methods – Adapted from: Registration of BBA – approved plant protection equipment for orchards in the list of loss reducing equipment.

Key: ID = Lechler Air Induction; AD = Lechler Drift Reducing; TD = Agrotop by GreenLeaf; DG = Drift Guard by TeeJet; AVI = Albuz Air Induction; Website: www.bba.de

Drift Reduction Class	Sprayer	Nozzle Types	Regulations of Use
50%	All air assisted sprayers	ID, TD, AVI, DG, AD Various Sizes	First 5 rows without air towards field edge.
	Foliage Detector	All Types	
	Air assisted sprayers with axial fan.	ID Various Sizes, TD 80-02 Keramik, AVI 80-03	Spray pressure max 58-73 PSI. First 5 rows with reduced air (max 30,000m3/h
	All air assisted sprayers	All Types	Hail nets above orchards.
75%	All air assisted sprayers	ID, TD, AVI, DG, AD Various Sizes	Hail nets above orchards.
	Sprayers with axial fan with max 30,000 m3/h, at least with first gear.	ID, TD, AVI, Various Sizes	Spray pressure max 58-73 PSI. First 5 rows with reduced air (max 20,000m3/h). AVI 80-015 max 44 PSI, ID 90-015 max 44 PSI
	Tower Sprayer	ID, TD, AVI, DG, AD Various Sizes	First 3 rows spraying without air towards field edge.
	Sprayers with cross flow fan	ID, TD, AVI, DG, AD Various Sizes	First 3 rows spraying without air towards field edge.
90%	Sprayers with cross flow fan.	ID, TD, AVI, DG, AD Various Sizes	First 5 rows spraying with reduced/sealing #4 towards filed edge; sealing #8 inwards.
	Tower sprayers with fan Lipco Tunnel sprayers	ID, TD, AVI, DG, AD Various sizes	First 5 rows spraying without air towards field edge. Partly with reduced spray pressure.
99%	Lipco Tunnel sprayers	ID, TD, AVI, DG, AD Various Sizes	

4.4 Preparing the Air Blast Sprayer for Work

4.4.1 Checking the Sprayer

Sprayers must be regularly checked over to ensure that proper maintenance has been carried out and that no outstanding repairs need to be done. Faulty sprayers contribute to increased drift levels and waste money through inefficiency and overuse of chemicals.

Before attempting any work on a machine make sure that it is fully supported on stands and that all necessary protective clothing is on hand.

The cost of replacing a faulty pressure gauge which has been indicating at 15% below the actual pressure is recouped in around two hours' operation.

Maintenance measures such as fitting a new set of nozzles at the beginning of each season also save money. Even when there is overdosing by as little as 5%, the cost of a new set of nozzles would be recovered in less than a day's work.

Caution

- ☐ Take great care when adjusting a sprayer while the tractor engine is running.
- ☐ Always ensure that the fan is stationary before approaching the rear of the sprayer.
- ☐ Engage the handbrake when leaving tractor seat.

4.4.2 Fitting the Sprayer to the Tractor

The selected tractor must always be powerful enough to operate the sprayer efficiently under the working conditions that will be encountered. All its external services–hydraulic, electrical and pneumatic–must be clean and in working order. Tractors fitted with cabs must have efficient air filtration systems. All protective guards must be in place. Trailed sprayers are often close-coupled to the tractor, so it is essential that the drawbar and the PTO shaft are correctly adjusted for turning. PTO shafts must be disengaged when making very tight turns.

4.4.3 Checking the Operation of the Sprayer

Part fill the tank with clean water and move the sprayer to uncropped waste ground. Remove the nozzles. Although not using any chemical at this point, get into the habit of wearing a coverall, gloves and a face visor when working with the sprayer. Engage the PTO and gently turn the shaft, increasing speed slowly to operating revs. Test the on/off and pressure relief valves, and check the agitation system. Flush through the spray lines, then switch off the tractor. Refit the nozzles and check the liquid system again for leaks.

It is a valuable exercise to assess the spray deposits at various points in the canopy and on upper and lower leaf surfaces of the trees to be sprayed. This is particularly important if the foliage is dense or if the trees are grown in beds of three or more rows. Water-sensitive papers, food coloring or fluorescent tracers are available for this purpose. An increase in spray volume or adjustment of the nozzles and their locations may be necessary in order to achieve the correct deposits.

4.4.4 Pre-Season Maintenance

Follow the checklists before you begin spraying

Hoses

check…

- ☐ for splits and cracks
- ☐ connections to ensure they are water-tight
- ☐ for hose chafe, particularly in routing clips

Filters

check…

- ☐ for missing filter elements and seals
- ☐ for leakage
- ☐ for blocked or damaged filters

Tank

check…

- ☐ for fractures and any other damage
- ☐ the tank sits firmly in its mount
- ☐ the securing straps are correctly adjusted
- ☐ the agitation is working
- ☐ the tank is clean

Controls

check…

- ☐ the control circuitry (electrical, hydraulic or air) for correct operation
- ☐ valves for both internal and external leaks

Pump

check…

- ☐ lubrication levels
- ☐ for leaks
- ☐ the air pressure in the pulsation chamber (if fitted) is at the recommended level
- ☐ the pump rotates freely without friction or noise. Do so by rotating manually or starting at low speed (corrosion may cause seizing up)

Pressure Gauge

The pressure gauge is vital for indicating whether the nozzles are delivering the correct amount of chemical per

unit time while spraying. If you have any doubts about the pressure gauge, replace it or refer the problem to the manufacturer or supplier.

Nozzles

check…

- ☐ all nozzles are the same
- ☐ all nozzles are in good condition, with no leaks around the body
- ☐ all nozzles are clean and free from obstruction (note: clean with a soft brush or airline – don't damage nozzles by using wires or pins)
- ☐ all nozzles deliver to within + or - 5% of the manufacturer's chart value

Using water only, set to 'spray' at the specified pressure and collect the output from each nozzle in turn for a period of 60 seconds. Record each output and replace those outside the 5% tolerance stated in the manufacturer's chart.

Calibration

Where your sprayer has automatic controllers to monitor the speed of the sprayer and the flow, pressure and area sprayed:

check…

- ☐ they are in good condition and properly maintained
- ☐ they are frequently calibrated for accuracy, leaks, blockages, variations in pressure or any minor damage during spraying

Routine Maintenance

The following checks should be carried out routinely:

- ☐ All hoses are tightly connected and free from sharp bends; cracked or damaged hoses must be replaced.
- ☐ All controls move freely and are fully adjustable.
- ☐ Pressure gauge reads zero.
- ☐ Pump can be turned over by hand.
- ☐ Fan turns freely and is not obstructed; bearings are sound and lubricated.
- ☐ Air pressure in pump accumulator (if fitted) is correctly adjusted.
- ☐ Drain plugs and clean filters are in position.
- ☐ Tires on trailed machines are sound and correctly inflated; wheel nuts are tight.

4.4.5 Sprayer Calibration

Accurate calibration of orchard spray equipment is important for efficient use of pesticides. The selection of the right chemical and timing of its application are equally important. Tree spraying requires a sprayer with adequate capacity to distribute the spray evenly throughout the trees. Individual sprayers can be designed to operate most effectively over a range of gallonages per acre. The best spray coverage and deposit are obtained within the manufacturer's recommended operating range. Sprayer performance will be limited by pump output, maximum pressure, fan capacity, and travel speed.

4.4.6 Dilute Spraying

The amount of dilute spray required to adequately cover trees varies with the size, density of canopy, and stage of growth of the trees. Unless adjustments are made in the spray delivery, spray pattern, and fan output required by differences in tree size, difficulties such as inadequate pest control or excessive application of material will result. Approximate dilute gallonages required in different orchard situations are indicated in Table 4.4.1.

4.4.7 Concentrate Spraying

Table 4.4.1 shows how the amount of dilute spray required to cover an acre of orchard will vary according to tree size. This table also can be used to adjust the per-acre rate of pesticides for orchards of different tree sizes when concentrate sprays are applied. For instance, in an orchard with rows 30 ft apart and trees 20 ft wide x 15 ft tall, the minimum dilute spray per acre is shown to be 300 gallons. Thus, if you are applying a pesticide recommended at a rate of 2 lb/100 gal dilute basis, the appropriate per acre rate in such an orchard would be 6 lb, which could be applied in 75 gal of water at a 4X concentration or in 50 gal of water at a 6X concentration.

However, in a more compact orchard with 22 ft between rows and trees 14 ft wide x 10 ft tall, the minimum dilute spray per acre is shown to be 200 gal. Thus, the same pesticide would be applied at a rate of only 4 lb per acre in this orchard (2 lb/100 gal dilute basis x 200 gal dilute coverage). If concentrate spraying, the 4 lb of pesticide would be applied in 50 gal of water per acre at a 4X concentration or in 33 gal of water at a 6X concentration.

Concentrate spraying must be considered in terms of reducing the gallons of water per acre for the row-spacing and tree-size combination being sprayed. As the gallonage of water is reduced, errors become more critical. Concentrate sprays reduce or eliminate run-off, depending upon the degree of concentration. From a practical viewpoint, the acceptable concentrate level depends on several factors including the pest being controlled, density of foliage, weather conditions, and material being applied. Dilute sprays are generally more effective and are preferred for applying growth regulators, nutrient sprays, acaricides, and insecticides for control of pests such as scales and woolly aphid. In most other instances, concentrate sprays in the range of 6X to 8X usually provide satisfactory results.

Additional savings in cost of application above this level of concentration are minimal, and frequency of poor spray performance increases.

Table 4.4.1. Gallonage of dilute spray per acre required to provide equivalent coverage for mature trees of different sizes and spacings.

Distance Between Rows (feet)	Tree Width (feet)	Tree Height (feet)	Dilute spray Per acre1 (gal/acre)
40	28	20	427
40	28	16	342
30	20	15	305
25	16	14	273
22	14	13	252
20	12	12	220
18	10	12	203
16	8	10	152
14	6	10	131
12	5	10	127
11	4	10	111
10	3	9	82

[1]Minimum dilute gallons per acre=tree width x tree height x linear feet of row per acre (43,560 divided by distance between rows) x approximately 0.7 gallon per 1,000 cu ft of tree volume.

4.4.8 Travel Speed Calibration

Travel speed is a critical factor in maintaining accurate application rates and will influence spray deposition depending on location within the canopy. The slower a sprayer travels, the greater the uniformity in spray deposition. Although there is inconsistency in research results that try to determine the effect of travel speed on average spray deposition, all studies to date have been in agreement that the higher the travel speed, the greater the variability in spray deposit. Variation in spray deposit is an important factor where uniformity of spray coverage throughout the canopy is required. Conclusions from research were drawn using travel speeds of 1–4 mph.

Factors that will affect travel speed include:

- weight of sprayer to be pulled
- slope of terrain
- ground conditions traveled over (wheel slippage!)

The best way to measure travel speed is to pull a sprayer with tank half filled with water on the same type of terrain that the sprayer will be operated on.

Set up test course at least 100 feet long, measure the course with a tape measure. Do not pace the distance. The longer the course the smaller the margin of error. Run the course in both directions.
Use an accurate stop watch to check the time required to travel the course in each direction. Average the two runs and use the following formula to calculate the speed in MPH.

Formula: $\text{MPH} = \frac{\text{ft traveled}}{\text{sec traveled}} \times \frac{60}{88}$

Your figures:

Tractor gear _____ Engine revs._____

MPH = _____ $\frac{\text{ft traveled}}{\text{sec traveled}} \times \frac{60}{88} =$ ___

A modern alternative to using the above method is to purchase a hand-held GPS receiver. A number of systems are available, costing $80-150 and are available from electronics stores, hunting equipment suppliers and the internet. The small device is potable so can be used in all tractors to determine forward speed in specific tractor gears at known engine r.p.m. They may also be used to measure row length and determine block size.

4.5 Rate of Output (GPM)

The gallons of spray desired per acre and the time required to spray an acre determine the rate of output for which the sprayer must be nozzled. Since volume of spray needed per acre varies with tree size, the most common row-spacing for the tree size to be sprayed should be used in calibrating the sprayer. The gallons of dilute spray required for various row-spacing and tree-size combinations are indicated in Table 4.4.1. Gallons of concentrate spray required is determined by dividing dilute gallonage by the concentration desired. The rate of output by the sprayer is calculated by dividing the gallons of concentrate spray by the time required to spray 1 acre, Table 4.5.1.

Table 4.5.1. Approximate time required to spray 1 acre of orchard (two-sided sprayer operation, spraying both sides of trees).

Distance between Rows (feet)	Linear feet of Row/ acre[1]	Travel speed (mph)				
		1	1.5	2	2.5	3
		minutes per acre[2]				
40	1089	12.4	8.2	6.2	5.0	4.1
30	1452	16.5	11.0	8.2	6.6	5.5
25	1742	19.8	12.4	9.9	7.9	6.6
22	1980	22.5	15.0	11.2	9.0	7.5
20	2178	24.8	16.5	12.4	9.9	8.3
18	2420	27.5	18.3	13.8	11.0	9.2
16	2723	30.9	20.6	15.5	12.4	10.3
14	3112	35.4	23.6	17.7	14.1	11.8

[1]Linear feet of row per acre = 43,560 divided by distance between rows.

[2]Minutes per acre = linear feet of row per acre divided by speed in feet per minute. Speed in feet per minute = mph x 88.

4.5.1 Example for Calibrating Rate of Output:

Rows 30 feet apart, trees 20 feet wide x 15 feet high. A 4X concentrate application is to be made at a speed of 2.5 miles per hour.

1. Table 4.4.1 indicates 300 gallons of dilute spray required per acre.
2. 300 (gal) divided by 4(X) = 75 gallons of 4X concentrate per acre required.
3. Table 4.5.1 indicates 6.6 minutes required to spray 1 acre of 30-foot rows at a speed of 2.5 mph.
4. Total sprayer output for 2-sided operation = 75 (gal/acre) divided by 6.6 (min/acre) = 11.36 gallons per minute.
5. Output required per side = 11.36 divided by 2 = 5.68 gallons per minute per side.
6. Rate of output = 5.68 gal/min/side.

4.6 Tree Row Volume

4.6.1 Dilute Applications

A standard dilute application uses 400 gallons account for the trees' actual stature and density per acre (GPA) on standard size trees. Modern per unit of land area, is defined as canopy width, orchards contain smaller trees and therefore don't times the tree height, times row length per acre. require so much spray volume. Tree row volume, Row length per acre is 43,560 square feet per acre a measurement of tree canopy size designed to divided by the distance between rows, in feet.

Tree row volume = canopy width x tree height x row length per acre

$$\text{Tree row volume (cu ft/acre)} = \text{tree canopy diameter (feet)} \times \text{Tree height (feet)} \times \frac{43{,}560 \text{ sq ft/acre}}{\text{distance between rows (feet)}}$$

An example:
Trees 10 feet wide and 8 feet tall in rows 18 feet apart

$$= 10 \text{ ft} \times 8 \text{ ft} \times \frac{43{,}560 \text{ sq ft/acre}}{18}$$

$$= 80 \times 2420 = 193{,}000 \text{ cu. ft.}$$

Note:
It takes 0.7 – 1.0 gallons to treat 1,000 cubic feet of tree canopy volume. Therefore, the minimum of 0.7 gallons/ ,000 cu ft should be used in well pruned trees. The maximum of 1.0 gallon/1,000 cu ft should be used in an unpruned orchard with a thick canopy.

Example: A well pruned orchard using minimum spray volume

$$\text{Minimum spray volume (gal/acre)} = \text{your tree row volume (cu ft/acre)} \times \frac{0.7 \text{ gal}}{1{,}000 \text{ cu ft}}$$

$$\text{Minimum spray volume (gal/acre)} = 193{,}600 \text{ cu ft} \times \frac{0.7 \text{ gal}}{1{,}000 \text{ cu ft}} = 136 \text{ gal/acre}$$

Example: A traditional, un-pruned, dense orchard using maximum spray volume

$$\text{Maximum spray volume (gal/acre)} = \text{your tree row volume (cu ft/acre)} \times \frac{.01 \text{ gal}}{1{,}000 \text{ cu ft}}$$

$$\text{Maximum spray volume (gal/acre)} = 193{,}600 \text{ cu ft} \times \frac{0.1 \text{ gal}}{1{,}000 \text{ cu ft}} = 194 \text{ gal/acre}$$

4.6.2 Concentrate Applications (Low Volume Application)

Concentrate spraying is reducing the gallons of water per acre to reduce or eliminate leaf run-off, often referred to as low volume application. The acceptable concentrate level depends on several factors, including the pest being controlled, density of foliage, weather conditions and the material being applied.

$$\text{Concentration} = \frac{\text{dilute volume of water per acre}}{\text{concentrate volume of water per acre}}$$

If we are using a pesticide that is recommended at 2 lbs/100 gallons on a dilute basis, then in the traditional orchard above we would use 4 lbs in 200 gallons of water (approx.).

If our sprayer is applying at 60 gallons/acre, then our concentration is:

$$\frac{200 \text{ gal water/acre}}{60 \text{ gal water/acre}} = 3$$ Therefore, a 3X application

or

If our sprayer is applying at 50 gallons/acre, then our concentration is:

$$\frac{200 \text{ gal water/acre}}{50 \text{ gal water/acre}} = 4$$ Therefore, a 4X application

Remember the debate that exists between all concerned:

1. It is the amount of water that changes, not the amount of pesticide per acre, or
2. The amount of pesticide reduces in proportion to the water, to maintain a constant concentration.

3. Is a standard dilute application uses 400gpa on "standard" trees but some suggest that these big old traditional trees are no longer and a modern "standard " tree should be regarded as 300 gpa.

4.7 Nozzles on the Net

http://www.albuz.com.fr/
This web page contains product information on agricultural and industrial nozzles. Albuz offer a variety of nozzles and whirl plates for application systems. There are also a number of educational fact sheets about Albuz nozzles located on the webpage: www.hypropumps.com. Albuz nozzles are distributed throughout America by this company. Also on the web page they offer technical training and information about the use of each nozzle.

http://www.delavanagspray.com/Index.htm
This web page contains product information on nozzles, nozzle accessories, sprayer accessories, high pressure guns/nozzles, pumps and high pressure washers. They offer educational material on calibration of nozzles and sprayers. They also have a nozzle type selection guide that is very useful to help select the right nozzle for your specific application. There are conversion factors for broadcast nozzle spacing and metric and imperial gallon conversion.

http://www.hardi-us.com/html/home.html
This web page contains product information on sprayers for all crops, nozzles, pumps and electronic controllers. They feature new products in the marketplace and educational materials, which provide knowledge on servicing your sprayer. Also, there is an online nozzle selection guide that is very useful in selecting the correct nozzle for your specific application.

http://www.hypropumps.com/Agriculture/default.cfm
This web page contains product information on Ag pumps, boom and sprayer components, nozzle bodies, pressure washer pumps, and spray tips. They also list educational guides that help you select the correct nozzle for your specific application. They are the distributor for Albuz nozzles in US.

http://www.lechlerusa.com/whois.asp
This web page contains product information on nozzles and sprayer components. They offer many educational resources including a conversion program for sprayers and other aids to assist you in nozzle selection and sprayer use. They have catalogs you can download about their nozzles and other sprayer components such as nozzle bodies. They have a section that features all their new products; you can also shop online for spray nozzles and parts.

http://www.teejet.com/ms/teejet/
This web page contains product information on all different types of nozzles, spray guns, valves, manifolds, boom components, electronic controls and guidance systems. They provide educational support with the use of a spray calibration calculator. They also have a nozzle selection guide you can download to help you in making a decision on which nozzle is good for your application.

http://www.turbodrop.com/index.html
This web page contains product information on nozzles for turf, vegetables and other crops. The featured products are the turbodrop, spraymax and airmix nozzles. There is a nozzle guide to assist you in locating a nozzle for your application. There are educational materials such as droplet size data, independent test data and news articles you can look through.

http://www.wilger.net/home.html
This web page contains product information on various sprayer parts and nozzles. Some of their featured products include tips, caps, strainers, nozzle bodies and flow indicators. Their web page also has a nozzle selection calculator called tip wizard, which helps you locate the correct nozzle for your application. Tipnology is another link on the web page that explains everything about each nozzle.

http://www.nysaes.cornell.edu/ent/faculty/landers/pestapp/
This webpage contains information on various types of sprayers (air-blast, boom and knapsack etc). There are links to most of the manufacturers of orchard, vineyard, turf and vegetable spraying equipment. The website contains useful information on sprayer calibration, nozzles, sprayer manufacturers and agricultural links for that particular crop. In each one of the specific crop spraying sections also there are extension publications and research publications covering research projects conducted on sprayers in the northeast.

4.8 Selecting Nozzles from the Nozzle Catalogue – Airblast sprayers

We need to select hollow cone discs with a core or whirl plate.

Nozzle output is based upon gallons/acre required above.

$$\text{Gallons/minute} = \frac{\text{GPA} \times \text{mph} \times \text{row width in feet}}{495}$$

WHERE

GPM = total sprayer output in gallons/minute

mph = travel speed in miles per hour

row width = width between rows of trees in feet

495 = a mathematical constant to correct units of measurement

Example
Take the example of the dilute application in a well pruned orchard. We need to apply at 136 gallons/acre. We have an airblast sprayer with 7 nozzles each side and a comfortable forward speed for our ground conditions is 3mph. Rows are 18 feet apart.

$$\text{Gallons/minute} = \frac{\text{GPA} \times \text{mph} \times \text{row width in feet}}{495}$$

$$\text{GPM} = \frac{136 \times 3 \times 18}{495} = 14.84$$

GPM = 7.42 per side

GPM per nozzle = 7.42 divided by 7 nozzles = 1.06
As an example, using the hollow cone nozzle table in the Spraying Systems catalogues: # 49A, pages 40-41, #49, pages 38-41 or # 201, pages 10-11.

1. Read along the pressure row at the top of the table. Read down the column for 80 psi until you read 1.07 gpm, look across to the left, you will see we need a D10 disc with a DC25 wirl plate or core.
2. Alternatively you may read down the column for 60 psi until you read 1.04 gpm, look across to the left and you will see we need a D8 disc with a DC45 wirl plate or core.
3. Alternatively you may read down the column for 60 psi until you read 1.04 gpm, look across to the left and you will see we need a D8 disc with a DC45 wirl plate or core.

			GPM												
			10 PSI	20 PSI	30 PSI	40 PSI	60 PSI	80 PSI	100 PSI	150 PSI	200 PSI	300 PSI	20 PSI	40 PSI	80 PSI
D1	DC13	.031″	—	—	.059	.066	.078	.088	.097	.115	.128	.152	—	51°	62°
D1.5	DC13	.036″	—	.057	.067	.075	.088	.098	.110	.127	.142	.167	38°	55°	66°
D2	DC13	.041″	—	.064	.075	.08	.10	.11	.12	.14	.16	.18	49°	67°	72°
D3	DC13	.047″	—	.071	.08	.09	.11	.12	.13	.16	.18	.20	53°	70°	75°
D4	DC13	.063″	.070	.09	.11	.12	.14	.16	.17	.20	.23	.27	69°	79°	83°
D1	DC23	.031″	—	—	.064	.072	.080	.096	.107	.124	.139	.164	—	47°	58°
D1.5	DC23	.036″	—	.064	.076	.086	.103	.117	.130	.155	.175	.210	34°	51°	62°
D2	DC23	.041″	—	.078	.092	.10	.13	.14	.16	.19	.21	.25	51°	63°	70°
D3	DC23	.047″	.065	.087	.10	.12	.14	.16	.18	.21	.24	.28	58°	69°	75°
D4	DC23	.063″	.082	.113	.14	.15	.19	.21	.23	.28	.32	.38	68°	82°	87°
D5	DC23	.078″	.095	.13	.16	.18	.22	.25	.28	.34	.38	.46	79°	89°	94°
D6	DC23	.094″	.112	.15	.19	.21	.26	.29	.32	.39	.45	.54	84°	93°	98°
D1	DC25	.031″	—	—	.088	.101	.122	.138	.156	.185	.210	.255	—	27°	43°
D1.5	DC25	.036″	—	—	.118	.135	.162	.185	.205	.245	.280	.33	—	38°	49°
D2	DC25	.041″	—	.12	.14	.16	.19	.22	.25	.29	.34	.41	39°	51°	58°
D3	DC25	.047″	.10	.14	.17	.19	.23	.26	.29	.35	.40	.48	52°	61°	67°
D4	DC25	.063″	.15	.21	.25	.29	.35	.40	.45	.54	.62	.75	67°	74°	80°
D5	DC25	.078″	.18	.25	.30	.35	.42	.48	.54	.65	.75	.90	73°	79°	84°
D6	DC25	.094″	.23	.32	.39	.44	.54	.62	.70	.85	.97	1.19	79°	85°	89°
D7	DC25	.109″	.26	.37	.45	.52	.63	.73	.81	.98	1.18	1.37	85°	91°	93°
D8	DC25	.125″	.31	.43	.53	.61	.75	.89	.97	1.19	1.36	1.68	91°	96°	97°
D10	DC25	.156″	.38	.54	.65	.76	.93	1.07	1.21	1.48	1.71	2.1	97°	102°	103°
D12	DC25	.188″	.46	.61	.80	.93	1.15	1.32	1.47	1.81	2.09	2.55	103°	109°	112°
D14	DC25	.219″	.51	.72	.88	1.03	1.26	1.47	1.65	2.02	2.34	2.89	108°	113°	114°
D1	DC45	.031″	—	—	—	.125	.148	.170	.190	.225	.257	.310	—	22°	34°
D1.5	DC45	.036″	—	—	.14	.16	.20	.23	.25	.31	.35	.43	—	33°	44°
D2	DC45	.041″	—	.14	.18	.20	.25	.28	.32	.38	.44	.53	32°	46°	55°
D3	DC45	.047″	—	.17	.20	.23	.28	.33	.36	.44	.51	.62	40°	53°	60°
D4	DC45	.063″	.18	.25	.31	.36	.43	.50	.56	.68	.78	.95	62°	69°	72°
D5	DC45	.078″	.23	.32	.39	.45	.55	.64	.71	.86	.99	1.22	67°	73°	76°
D6	DC45	.094″	.29	.41	.50	.58	.72	.83	.93	1.15	1.33	1.64	73°	79°	81°
D7	DC45	.109″	.33	.48	.59	.68	.84	.97	1.11	1.35	1.57	1.94	81°	86°	87°
D8	DC45	.125″	.41	.59	.72	.84	1.04	1.21	1.35	1.68	1.94	2.40	86°	90°	90°
D10	DC45	.156″	.54	.77	.94	1.10	1.35	1.57	1.77	2.18	2.50	3.10	90°	93°	93°
D12	DC45	.188″	.67	.95	1.17	1.36	1.68	1.95	2.20	2.69	3.11	3.80	97°	100°	102°
D14	DC45	.218″	.75	1.07	1.32	1.53	1.89	2.19	2.45	3.00	3.49	4.30	101°	104°	105°
D16	DC45	.250″	.86	1.25	1.54	1.79	2.20	2.57	2.89	3.54	4.11	5.20	108°	111°	112°
D1	DC46	.031″	—	—	—	.145	.178	.205	.23	.28	.32	.39	—	13°	15°
D1.5	DC46	.036″	—	—	—	.213	.260	.300	.33	.41	.46	.56	—	15°	17°
D2	DC46	.041″	—	—	.24	.27	.33	.37	.42	.50	.57	.68	—	18°	21°
D3	DC46	.047″	—	.23	.28	.32	.39	.45	.51	.61	.70	.86	14°	20°	24°
D4	DC46	.063″	.28	.39	.48	.56	.68	.78	.88	1.07	1.23	1.52	23°	29°	33°
D5	DC46	.078″	.38	.54	.66	.77	.94	1.10	1.25	1.50	1.73	2.13	33°	39°	42°
D6	DC46	.094″	.55	.78	.95	1.10	1.35	1.58	1.73	2.16	2.50	3.06	42°	48°	50°
D7	DC46	.109″	—	.98	1.22	1.39	1.72	1.97	2.22	2.73	3.15	3.85	48°	53°	56°
D8	DC46	.125″	—	—	1.59	1.84	2.25	2.62	2.93	3.60	4.17	5.05	—	60°	62°
D10	DC46	.156″	—	—	2.15	2.48	3.05	3.53	3.96	4.83	5.59	6.80	—	66°	68°

A better alternative to consider would be to use a one-piece hollow cone nozzle tip. These one-piece tips are easier to fit into the cap and are much easier to remove for cleaning, changing tips etc.

Example
To continue with the worked example from above for a nozzle tip with a flowrate of 1.07 gpm. As an example, using the Conejet hollow cone nozzle table in the Spraying Systems TeeJet catalogues:
49A, page 39, or # 202, page15

1. Read along the pressure row at the top of the table.
2. Read down the column for 240 psi until you read 1.05 gpm, look across to the left, you will see we need a blue TXVK-26 one-piece nozzle.

		GPM																	
		30 PSI	40 PSI	50 PSI	60 PSI	70 PSI	80 PSI	90 PSI	100 PSI	120 PSI	140 PSI	160 PSI	180 PSI	200 PSI	220 PSI	240 PSI	260 PSI	280 PSI	300 PSI
TXVK-1	100	0.015	0.017	0.018	0.020	0.021	0.022	0.023	0.024	0.026	0.028	0.030	0.031	0.032	0.034	0.035	0.036	0.037	0.038
TXVK-2	100	0.029	0.033	0.037	0.040	0.043	0.045	0.047	0.050	0.054	0.058	0.061	0.064	0.067	0.070	0.073	0.075	0.078	0.080
TXVK-3	100	0.044	0.050	0.055	0.060	0.064	0.068	0.071	0.075	0.081	0.086	0.092	0.096	0.101	0.105	0.109	0.113	0.117	0.120
TXVK-4	50	0.058	0.067	0.074	0.080	0.086	0.091	0.096	0.101	0.110	0.118	0.125	0.132	0.139	0.145	0.151	0.157	0.162	0.167
TXVK-6	50	0.088	0.100	0.111	0.120	0.129	0.137	0.145	0.152	0.165	0.177	0.188	0.199	0.208	0.218	0.226	0.235	0.243	0.251
TXVK-8	50	0.116	0.133	0.148	0.162	0.174	0.186	0.196	0.207	0.225	0.243	0.259	0.274	0.288	0.301	0.314	0.326	0.338	0.349
TXVK-10	50	0.145	0.167	0.185	0.202	0.218	0.232	0.246	0.258	0.282	0.303	0.323	0.342	0.360	0.376	0.392	0.408	0.422	0.437
TXVK-12	50	0.174	0.200	0.223	0.243	0.261	0.279	0.295	0.310	0.338	0.364	0.388	0.410	0.432	0.452	0.471	0.489	0.507	0.524
TXVK-18	50	0.260	0.300	0.335	0.367	0.396	0.423	0.449	0.473	0.517	0.558	0.597	0.633	0.667	0.699	0.730	0.759	0.788	0.815
TXVK-26	50	0.376	0.433	0.484	0.530	0.572	0.611	0.648	0.683	0.747	0.807	0.862	0.914	0.963	1.01	1.05	1.10	1.14	1.18
TX†800050VK	100	0.044	0.050	0.055	0.060	0.064	0.068	0.071	0.075	0.081	0.086	0.092	0.096	0.101	0.105	0.109	0.113	0.117	0.120
TX†800067VK	50	0.058	0.067	0.074	0.080	0.086	0.091	0.096	0.101	0.110	0.118	0.125	0.132	0.139	0.145	0.151	0.157	0.162	0.167
TX†8001VK	50	0.088	0.100	0.111	0.120	0.129	0.137	0.145	0.152	0.165	0.177	0.188	0.199	0.208	0.218	0.226	0.235	0.243	0.251
TX†80015VK	50	0.131	0.150	0.167	0.182	0.196	0.209	0.221	0.232	0.254	0.273	0.291	0.308	0.324	0.339	0.353	0.367	0.380	0.393
TX†8002VK	50	0.174	0.200	0.223	0.243	0.261	0.279	0.295	0.310	0.338	0.364	0.388	0.410	0.432	0.452	0.471	0.489	0.507	0.524
TX†8003VK	50	0.260	0.300	0.335	0.367	0.396	0.423	0.449	0.473	0.517	0.558	0.597	0.633	0.667	0.699	0.730	0.759	0.788	0.815
TX†8004VK	50	0.347	0.400	0.447	0.489	0.528	0.564	0.598	0.630	0.690	0.745	0.796	0.843	0.889	0.932	0.973	1.01	1.05	1.09

†Specify "A" or "B." See pages 37 and 38 for more information on ConeJet spray tips.
***Note:** Always double check your application rates. See pages 149-163 for useful formulas and information.*

***Please note:** Where trade names appear, no discrimination is intended and no endorsement by the author or Cornell University is implied.*

4.9 Air Blast Sprayer Calibration (Use Clean Water)

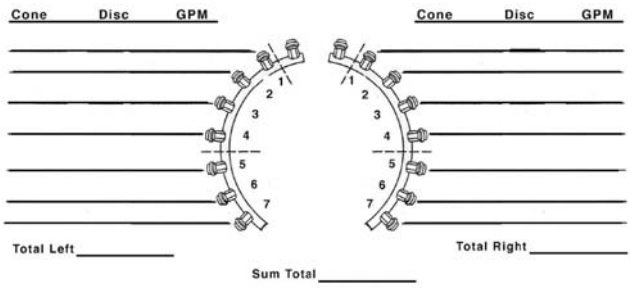
A simple vertical patternator can be constructed in the farm workshop using readily available materials; a build list and photographs can be found at: <http://www.nysaes.cornell.edu/ent/faculty/landers/pdf/Patternator.pdf>

Videos showing calibration and nozzle selection may be found on the internet at: <www.youtube.com>. Type in: "Calibration of airblast sprayers for orchards part 1 selecting and changing nozzles" or "Calibration of airblast sprayers for orchards part 2 measuring liquid flow"

1) Pressure check
   Place the pressure gauge on the nozzle fitting farthest away from the pump and turn the sprayer on. If pressure is lower at the nozzle than specified, increase pressure at the regulator. _____
   Pressure at nozzle _____ psi
   Pressure at sprayer gauge _____ psi
2) Nozzle output
   a. Use a flow meter (obtainable from Gemplers, Spraying Systems, etc.) attached to individual nozzles OR
   b. Connect hoses to each of the nozzles and measure the flow from each nozzle into a calibrated jug for one minute.

Remember 128 fl. oz. in one gallon. Example: If the output of one nozzle has been measured at 34.5 fl. oz. in one minute, then output per minute is divided by 128 = 0.27 GPM.

Replace all nozzle tips that are more than 10% inaccurate.



Formula: $\frac{\text{Total GPM X 495}}{\text{mph X row spacing (ft)}} = \text{GPA}$

Your figures: $\frac{\text{\_\_\_\_\_ X 495}}{\text{mph X ft}} = \text{GPA}$

GPM = gallons per minute = gal/min

GPA = gallons per acre = gal/acre

4.9.1 Calibrating A Kinkelder Sprayer (Use Clean Water)

$$\frac{\text{Rate of spray gals/acre} \times \text{Forward speed mph} \times \text{Row spacing ft} \times 60}{500} = \text{gals/hr delivery or index setting}$$

$$\text{Your figures: } \frac{\text{gallons/acre} \times \text{mph} \times \text{ft} \times 60}{500} = \text{gals/hr delivery or index setting}$$

This figure should be set on both scales.

Both taps should be set on the distribution conduit in such a way that the index is set on the sign 162 on the index plate of the distribution conduit. The emission indication on the index plate has been fixed at a working pressure of 21 lbs (1.5 bar).

Check the output of the sprayer:

1. Divide the gallons/hour figure obtained above by 60 to give output/minute e.g., 162 gpm divided by 60 = 2.7 gallons/minute total of left and right side then divide 2.7 gallons/minute by 2 = 1.35 gallons/minute/side
2. Remove the plastic pipes from the nozzles on the left or right side, tie together and place in a measuring jug
3. Run the sprayer for one minute at correct engine speed, collecting the output in a measuring jug

Remember 128 fl. ozs in one gallon. Example: If the output of one side has been measured at 173fl. ozs, then output is divided by 128 = 1.35 gallons per minute.

4. Then check the output of the opposite side.

4.9.2 Calibrating An Agtec Sprayer (Use Clean Water)

1. Calculate the gallons/minute/side:

$$\frac{\text{Speed} \times \text{gallons/acre} \times \text{row width}}{1000} = \text{gallons/minute/side}$$

$$\text{Your figures: } \frac{\text{mph} \times \text{gallons/acre} \times \text{ft}}{1000} = \text{gals/min/side}$$

2. Check AgTec tables for correct meter setting, select the gal/min as calculated above, and then find meter setting, e.g., meter #12 @30 psi gives 1.34 gallons/min.
3. Remove the hoses from the nozzles on the left or right side, tie together and place in a measuring jug
4. Run the sprayer for one minute at correct engine speed, collecting the output in a measuring jug

Remember 128 fl. ozs in one gallon. Example: If the output of one side has been measured at 173fl. ozs, then output is divided by 128 = 1.35 gallons per minute.

5. Then check the output of the opposite side.

4.10 Selecting Nozzles from the Nozzle Catalogue –Boom Sprayers

Step 1. Calculate the required nozzle output.

$$\text{Formula: } GPM = \frac{GPA \times mph \times \text{nozzle spacing}}{5940 \text{ (constant)}}$$

$$\text{Example: } GPM = \frac{20 \times 4 \times 20}{5940} = \frac{1600}{5940} = .27 \text{ GPM}$$

Consider forward speed e.g. 4 mph, if too high: boom bounce and boom yaw

Consider pressure, too high: may lead to drift, too low: may lead to droplet bounce

Example 1: Using a Spraying Systems catalogue #49A, page 10

Look at the columns headed GPA at 20" nozzle spacing. Select the 4 mph column; look down the column until you see a figure close to 20 gpa, then look to the left to find the operating pressure.

For example:

a) select nozzle XR8003VS or XR11003VS at 30psi to give 19.3 gpa
b) select nozzle XR8004VS or XR11004VS at 20psi to give 21 gpa

Select the appropriate nozzle.

Example 2: Using a Spraying Systems catalogue #49A, page 10

Look at column headed: Capacity of 1 nozzle in GPM

Read down column

a) select nozzle XR8003VS or XR11003VS at 30psi to give 0.26GPM or
b) select nozzle XR8004VS or XR11004VS at 20psi to give 0.28GPM

	PSI	Capacity 1 Nozzle in GPM	Capacity 1 Nozzle in oz/min.	GPA 20" 4 mph	5 mph	6 mph	7 mph	8 mph	9 mph	10 mph	12 mph
XR8001VS XR11001VS (100)	15	0.06	8	4.5	3.6	3.0	2.5	2.2	2.0	1.8	1.5
	20	0.07	9	5.2	4.2	3.5	3.0	2.6	2.3	2.1	1.7
	30	0.09	12	6.7	5.3	4.5	3.8	3.3	3.0	2.7	2.2
	40	0.10	13	7.4	5.9	5.0	4.2	3.7	3.3	3.0	2.5
	50	0.11	14	8.2	6.5	5.4	4.7	4.1	3.6	3.3	2.7
	60	0.12	15	8.9	7.1	5.9	5.1	4.5	4.0	3.6	3.0
XR80015VS XR110015VS (100)	15	0.09	12	6.7	5.3	4.5	3.8	3.3	3.0	2.7	2.2
	20	0.11	14	8.2	6.5	5.4	4.7	4.1	3.6	3.3	2.7
	30	0.13	17	9.7	7.7	6.4	5.5	4.8	4.3	3.9	3.2
	40	0.15	19	11.1	8.9	7.4	6.4	5.6	5.0	4.5	3.7
	50	0.17	22	12.6	10.1	8.4	7.2	6.3	5.6	5.0	4.2
	60	0.18	23	13.4	10.7	8.9	7.6	6.7	5.9	5.3	4.5
XR8002VS XR11002VS (50)	15	0.12	15	8.9	7.1	5.9	5.1	4.5	4.0	3.6	3.0
	20	0.14	18	10.4	8.3	6.9	5.9	5.2	4.6	4.2	3.5
	30	0.17	22	12.6	10.1	8.4	7.2	6.3	5.6	5.0	4.2
	40	0.20	26	14.9	11.9	9.9	8.5	7.4	6.6	5.9	5.0
	50	0.22	28	16.3	13.1	10.9	9.3	8.2	7.3	6.5	5.4
	60	0.24	31	17.8	14.3	11.9	10.2	8.9	7.9	7.1	5.9
XR8003VS XR11003VS (50)	15	0.18	23	13.4	10.7	8.9	7.6	6.7	5.9	5.3	4.5
	20	0.21	27	15.6	12.5	10.4	8.9	7.8	6.9	6.2	5.2
	30	0.26	33	19.3	15.4	12.9	11.0	9.7	8.6	7.7	6.4
	40	0.30	38	22	17.8	14.9	12.7	11.1	9.9	8.9	7.4
	50	0.34	44	25	20	16.8	14.4	12.6	11.2	10.1	8.4
	60	0.37	47	27	22	18.3	15.7	13.7	12.2	11.0	9.2
XR8004VS XR11004VS (50)	15	0.24	31	18	14.3	11.9	10.2	8.9	7.9	7.1	5.9
	20	0.28	36	21	16.6	13.9	11.9	10.4	9.2	8.3	6.9
	30	0.35	45	26	21	17.3	14.9	13.0	11.6	10.4	8.7
	40	0.40	51	30	24	19.8	17.0	14.9	13.2	11.9	9.9
	50	0.45	58	33	27	22	19.1	16.7	14.9	13.4	11.1
	60	0.49	63	36	29	24	21	18.2	16.2	14.6	12.1
XR8005VS XR11005VS (50)	15	0.31	40	23	18.4	15.3	13.2	11.5	10.2	9.2	7.7
	20	0.35	45	26	21	17.3	14.9	13.0	11.6	10.4	8.7
	30	0.43	55	32	26	21	18.2	16.0	14.2	12.8	10.6
	40	0.50	64	37	30	25	21	18.6	16.5	14.9	12.4
	50	0.56	72	42	33	28	24	21	18.5	16.6	13.9
	60	0.61	78	45	36	30	26	23	20	18.1	15.1

BUT WHAT ABOUT SPRAY QUALITY ?

4.10.1 Selecting a Nozzle to Give Desired Spray Quality

Example using a Spraying Systems catalogue #49A, page 161

In the previous exercise we considered selecting:

a) nozzle XR8003VS or XR11003VS at 30psi to give 0.26GPM or

b) nozzle XR8004VS or XR11004VS at 20psi to give 0.28GPM

Using the table to the right, you can see:

a) an XR8003VS at 30psi gives a medium spray quality

b) an XR8004VS at 20psi gives a coarse spray quality

but note:

c) an XR11003VS at 30psi gives a fine spray quality

d) an XR11004VS at 20psi gives a medium spray quality

XR TeeJet® (XR) and XRC TeeJet® (XRC)

	PSI 15	20	25	30	40	50	60
XR8001	M	F	F	F	F	F	F
XR80015	M	M	M	F	F	F	F
XR8002	M	M	M	M	F	F	F
XR8003	M	M	M	M	M	M	F
XR8004	C	C	M	M	M	M	M
XR8005	C	C	C	C	M	M	M
XR8006	C	C	C	C	C	C	C
XR8008	VC	VC	VC	C	C	C	C
XR11001	F	F	F	F	F	VF	VF
XR110015	F	F	F	F	F	F	F
XR11002	M	F	F	F	F	F	F
XR11003	M	M	M	F	F	F	F
XR11004	M	M	M	M	M	F	F
XR11005	M	M	M	M	M	M	F
XR11006	C	C	M	M	M	M	M
XR11008	C	C	C	C	C	M	M

Spray classification and target

1. **Fine sprays** can produce enhanced retention on the target and may be used for:

   Foliar acting weed control and cotyledon-stage weed control

   Careful attention must be paid to weather conditions: do not use a fine spray for pesticides labeled toxic, or when drift may cause problems near susceptible or sensitive areas.
2. **Medium sprays** when the leaf is the target.
3. **Coarse sprays** have a low risk of drift but should be used only where recommended as a lot of spray is wasted as the larger droplets bounce off the leaves.

Please note: *Where trade names appear, no discrimination is intended and no endorsement by the author or Cornell University is implied.*

4.11 Boom Sprayer Calibration (Use Clean Water)

Step 1. Check your tractor/sprayer speed

Formula:

$$\text{MPH} = \frac{\text{ft traveled}}{\text{sec traveled}} \text{ X } \frac{60}{88}$$

Your tractor sprayer speed:

$$\text{MPH} \quad \frac{\text{ft traveled}}{\text{sec traveled}} \text{ X } \frac{60}{88} = \underline{\qquad}$$

Step 2. Record the inputs

	Your figures	*Example*
Nozzle type on your sprayer (all nozzles must be identical)	_____	110 04 flat fan
Recommended application volume (from manufacturer's label)	_____	20 GPA
Measured sprayer speed	_____	4 mph
Nozzle spacing	_____	20 inches

Step 3. Calculate the required nozzle output.

Formula:

$$\text{GPM} = \frac{\text{GPA X mph X Nozzle spacing}}{\text{5940 (constant)}}$$

Example:

$$\text{GPM} = \frac{20 \text{ X } 4 \text{ X } 20}{5940} = \frac{1600}{5940} = .27 \text{ GPM}$$

Your figures:

$$\text{GPM} = \frac{\text{X} \qquad \text{X}}{5940} = \frac{\qquad}{5940} = \text{GPM}$$

Step 4. Operate the sprayer

Set the correct pressure at the gauge using the pressure regulating valve.

Collect and measure the output of each nozzle for one minute.

The output of each nozzle should be the approximately the same as calculated in Step 3 above. Remember 128 fl. oz. in one gallon. If output has been calculated at 0.27 GPM then output is 128 multiplied by 0.27 = 34.5 fl. oz. in one minute.

Replace all nozzle tips that are more than 10% inaccurate.

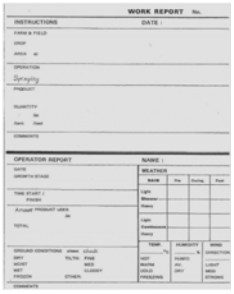
4.12 Going Spraying !

Mixing Procedures

Safety and the Law

- Always remain alert, pesticides are potentially dangerous to the operator and the environment.
- Tractors and sprayers are dangerous machines and care should be taken when operating them.
- Always follow Federal and State laws concerning licensing of operators and handling, application and disposal of pesticides.

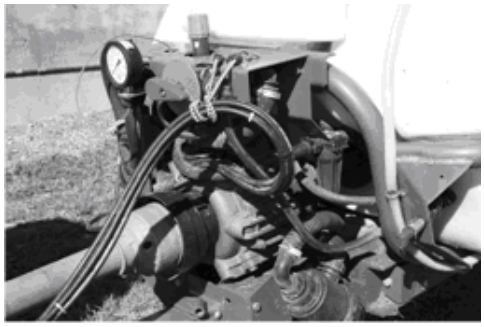
Always read the label for detailed application information and keep a record.



The seven P's of machinery management.

Proper prior planning prevents poor performance.

- Fill the tank on level ground per label instructions. If none are given, fill the tank half full with clean water.

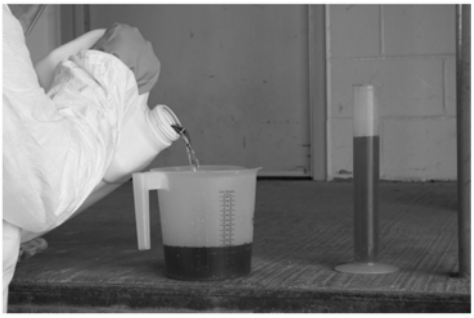


- Prime the pump with water, if needed.

ALWAYS

- Make sure there is no direct connection between the water source and sprayer tank. Direct connections can contaminate the supply by allowing chemicals to siphon back.
- Use a strainer when using water from a stream or pond.

- When opening a package:
  - Avoid using an "implement"; if used, decontaminate after use.
  - Avoid splashing and "glugging" of liquid formulations.
- Always add concentrated pesticides to a partially filled tank.
- If adding more than one product, do so separately and in the recommended order. NEVER mix them together in their concentrated forms
- If available, add product through a low-level induction bowl or through a suction probe.
  - If not available, add pesticides through the tank filter basket, except for soluble packs and some water dispersible granule formulations. Some wettable powders may need to be premised.



- Accurately measure the calculated amount of product.
  - Weigh solid formulations, and measure out liquid formulations, unless they come in pre-weighed packages appropriate for the spraying area.
  - Handle water soluble packages according to directions. Keep packs dry and do not force open the packs.

- If foaming is likely:
  - Fill the tank three-quarters full of water and use gentle agitation.
  - Add the pesticide.
  - Add the surfactant.
  - Continue to use gentle agitation until filling is finished.
  - Do not add water from a height.

- Triple rinse pesticide containers with clean water and put washings into the tank.
- Rinse off any pesticides spilled on the sprayer or container, and avoid contaminating the surroundings or yourself.

- Fill tank to the correct level and agitate while filling. Continue agitating while driving to the field and whilst spraying unless instructions advise otherwise. If spraying is delayed, agitate thoroughly just before use.

- Rinse impermeable protective clothing (rubber boots, gloves, etc.) with clean water after use.

- Remove other protective clothing and store before getting into tractor cab.

- Seal unused chemicals and store in a safe location.

4.13 Equipment for Weed Control in Orchards

Herbicides, although relatively inexpensive, require good application techniques if improved deposition and drift reduction is to occur. Some of the commonly used herbicides can damage young trees and so great care must be taken. Drift has been a major concern for some years, off-target application wastes money, reduces deposition on the target plant, damages young trees, pollutes water courses and may cause nausea to other people.

4.13.1 Boom Applicators

A boom may be fitted either to the front of the tractor or be mid-mounted for spraying one side of the adjacent row. 20–30 gallons per acre are typical spray volumes.

The use of hoods and break-back devices are important. A hood will protect the branches from drift created by the small droplets being emitted from the conventional flat fan nozzle. A break-back device will protect the sprayer boom and nozzle from damage caused by inadvertently striking a trunk or trellis post etc. Break-back devices normally comprise a spring-loaded arm.

Correct nozzle selection is one of the most important yet inexpensive aspects of pesticide application. A nozzle's droplet size spectrum determines deposition and drift and is referred to as spray quality. Modern nozzle catalogues provide information on spray quality for each nozzle, when applying herbicides, we need to select a MEDIUM quality spray. Conventional flat fan nozzles produce droplets in the range of 10–450 microns. There are 25,000 microns in one inch. Drift is a major problem with droplets less than 150 microns.

Increasing the Volume Median Diameter (VMD) will certainly reduce drift, but too large a droplet (>300 microns) will bounce off the leaves to the ground, thus causing pollution, wasting money and resulting in less product on the target.

4.13.2 Conventional flat fan nozzles

Nozzles with 800 angle produce coarser droplets than 1100 at the same flow rate, but 800 nozzles require the boom to be set at 17–19 inches, whereas 1100 nozzles can be set lower at 15–18 inches above the target. (The lower the boom, the less chance of drift). Spray quality is fine – medium at 15–60 psi.

4.13.3 Pre-orifice flat fan nozzles

The internal design of this nozzle reduces the internal operating pressure compared with a conventional flat fan, resulting in coarser droplets (high pressure creates fine droplets, low pressure creates coarser droplets). Available as 800 or 1100 nozzles. Spray quality is medium–coarse at 30–60 psi. Drift-guard is a well-known trade name.

4.13.4 Turbo-teejet

A turbulence chamber produces a wide-angle flat spray pattern of 1500. Spray quality is medium–coarse at 15–90 psi. Nozzles can be set at 15–18 inches above the target.

4.13.5 Air induction nozzles

Air induction, air inclusion or venturi nozzles are flat fan nozzles where an internal venturi creates negative pressure inside the nozzle body. Air is drawn into the nozzle through two holes in the nozzle side, mixing with the spray liquid. The emitted spray contains large droplets filled with air bubbles (similar to a candy malt ball) and virtually no fine, drift-prone droplets. The droplets explode on impact with leaves and produce similar coverage to conventional, finer sprays.

Air induction nozzles reduce drift even when operating at higher pressures of 80–90 psi. They are available at 110º fan angles, so boom height may need to be adjusted to 15–18 inches. The use of adjuvants will certainly help create bubbles. Air induction nozzles work very well for herbicide application; trials with paraquat in the Finger Lakes have shown good deposition with no drift.

4.13.5.1 Boom manufacturers/distributors include:

Phil Brown Welding Corp., The Green Hoe Co. Inc., OESCO, Inc.

4.13.5.2 Nozzle manufacturers include:

Albuz, Greenleaf, Hardi, Lechler, Tee Jet

4.13.6 Sensor-Controlled Applicators

Sensor-controlled pesticide applicators use optical sensors to determine where weeds are located. These sensors, coupled with a computer controller, regulate the spray nozzles and apply herbicides only when needed, thus considerably reducing herbicide use. A computer-controlled sensor detects chlorophyll in plants and then sends a signal to the appropriate spray nozzle, applying the herbicide directly to the weed. The operator calibrates the system to bare soil or pavement, allowing the computer to determine when there is a weed present. Sensor-controlled applicators are often mounted on ATVs, John Deere Gators, etc.; they can also be attached to tractors or trucks. Typically, this type of applicator can be used at speeds up to 10 mph. A complete sensor-controlled system consists of a chemical tank, pump, battery power, computer controller, optical sensors and spray nozzles.

4.13.6.1 Benefits of sensor-controlled applicators:

- Reduced amount of herbicide applied
- Reduced potential for groundwater contamination
- Ability to apply herbicides in dark or light conditions
- If equipped with wind-deflecting shields, can reduce herbicide drift

4.13.3.2 Manufacturers/distributors include:

Patchen/Ntech, OESCO, Zahm and Matson

4.13.7 Controlled Droplet Applicators (CDA)

Traditional flat fan nozzles produce a range of droplets, 10–450 microns; some drift, some roll off the leaves, others will adhere to the target leaves. A CDA herbicide applicator comprises an electrically-driven spinning disc under a large plastic hood or dome. The circumference of the disc has small teeth, which break up the liquid herbicide into droplets, of which 95% are the same size. The speed of the spinning disc dictates droplet size. As there are no large or small droplets in the CDA spectrum, all the droplets stick to the plant and so reduced rates can be applied, e.g. 1–8 GPA.

Various widths of hood or dome can be selected, and are fitted with break-back devices. Where the ground is rough, e.g., stones, then a bristle skirt maybe used. In young trees an optional plastic cover can be fitted over the bristle skirt.

CDA sprayers reduce the amount of water required, thus considerably improving spraying logistics. They are lightweight, relatively inexpensive and very maneuverable.

4.13.7.1 Distributors include:

Bdi Machinery Sales, North-Eastern Equipment, Lakeview Harvesters, Rammelt & Co.

4.13.8 Flame Applicators

Flame applicators simply use a flame to destroy weeds. Most flame applicators burn liquid propane gas to create a flame having a temperature near 2000∞F. The flame is applied directly to the weeds using a hand-held wand or with boom-mounted torches attached to a tractor or ATV. The flame is applied to the weed for only a short period of time, usually about 1/10 of a second. The length of time the flame is applied depends on the age, size and tenderness of the weed. It is recommended that the flame be applied to weeds when they are 1 to 3 inches tall, and typically in the spring and early summer. When the weeds are exposed to the flame, the water inside the plant cells boil, causing them to burst. (The weeds are not burned up.) By destroying the plant cells, the plant is unable to transport water and continue photosynthesis, causing the weed to wilt and die. Flame applicators should only be used when there is little or no potential for setting fire to dry plant material. Beware of setting fire to trellis posts and poison ivy.

4.13.8.1 Benefits of Flame Applicators

- Non-chemical weed control method
- No harmful drift
- No groundwater contamination
- No chemical exposure to workers

4.13.8.2 Manufacturer:

Red Dragon

4.13.9 Where to look/buy

Albuz nozzles:
651-766-6300
http://www.hypropumps.com/

BDi Machinery Sales, Macungie, PA
1-800-808-0454
Bdi@fast.net

Green Hoe Company Inc.
716-792-9433
http://www.greenhoecompany.com/

GreenLeaf nozzles
http://www.turbodrop.com/
1-800-881-4832

Hardi nozzles
563-386-1730
www.hardi-us.com

Lakeview Harvesters, Ontario, Canada
1-866-677-4717
www.gregoireharvesters.com

Lechler nozzles
630-377-6611
http://www.lechler.com/seiten/en/lechler.html

Patchen Weedseeker:
1-888-728-2436
http://www.ntechindustries.com/

Phil Brown Welding Corp.
616-784-3046

NorthEastern Equipment
1-631-765-3865

OESCO Inc., Conway, MA
1-800-634-5557
www.oescoinc.com

Rammelt & Sons
1-800-388-3802

Red Dragon Flame
1-800-255-2469
http://www.flameeng.com/

Rittenhouse, Ontario, Canada
1-800-461-1041
www.rittenhouse.ca

Tee Jet nozzles
http://www.teejet.com/ms/teejet/
Phone # 717-432-7222

4.14 Decontaminating and Storing Crop Sprayers

Sprayers must be thoroughly cleaned inside and out after use. Ideally, a sprayer should be cleaned at the end of each day and especially before switching to a different pesticide. Pesticide residues left on the outside of the sprayer can cause operator contamination. Residues on the inside of the tank or left over pesticides trapped inside the sprayer plumbing system can contaminate the operator and possibly lead to crop damage. Growers should be concerned about this, especially if they are using one sprayer to apply different chemicals to different crops. In some cases, only a small amount of a pesticide remaining in the sprayer can cause significant crop damage or lead to unacceptable residues on a crop. Crop contamination can even occur several months after a sprayer has not been properly cleaned. Where an airblast sprayer is used to spray different fruit crops, residue left in the tank can cross contaminate another fruit crop, resulting in rejection by the processor.

Sprayers can also retain tremendous amounts of pesticide solution. Depending on the size and design of the sprayer, there can be nearly 6 gallons of solution left in an airblast sprayer's plumbing. As illustrated in the table below, research conducted on boom sprayers has shown that, depending on the spray tank size, the total chemical solution retained in the sprayer ranged from just under 3 gallons to over 12 gallons. The parts that retained the most chemical solution are the chemical induction bowl, the booms, the tank and the pump and its related piping.

Tests have shown that triple rinsing the spray tank is better than using just one single rinse. For example, using 100 gallons of clean water in one single rinse to clean a 100-gallon sprayer tank reduced the concentration of the original spray solution from 100% to 5% both in the tank and at the nozzle. If triple rinsing was performed using 33 gallons of clean water per rinse, a concentration of 0.2% to 0.5% was gained. The aim is for maximum dilution with minimal use of water. The following table illustrates how triple rinsing reduces the pesticide concentration at the nozzle and the tank drain.

Concentration of Pesticide in Rinse Water

Rinse Number	Sample Location	Percent Concentration
1	Nozzle	5.5
	Tank Drain	4.8
2	Nozzle	1
	Tank Drain	1
3	Nozzle	0.2
	Tank Drain	0.2

Source: Nilsson, E., Hagenwall H. og Jorgensen L.

Quantity and Location of Chemical Remnants in Crop Sprayers (*in gallons*)

	Sprayer Size		
Location	159 Gallons- 39 foot boom	212 Gallons - 39 foot boom	396 Gallons - 59 foot boom
Tank	0.50	1.32	4.57
Pump and associated piping	0.40	0.85	2.22
Pressure agitation	0.02	0.16	0.27
Manifold	0.04	0.16	0.27
Filter relief valve	NA	0.15	0.23
Chemical induction bowl	1.16	1.69	NA
Total without boom	**2.12**	**4.33**	**7.56**
Booms	0.50	2.32	4.76
Total with booms	**2.62**	**6.65**	**12.32**

Adapted from "Quantity and Location of Chemical Remnants within a Range of Field Crop Sprayers by S.E. Cooper. Available: www.hardiinternational.com/Agronomy/Education_Material/pdf/08a.pdf

Before rinsing a sprayer, read the sprayer manufacturer's instructions for specific guidance on the best methods for cleaning your equipment. Also consult the pesticide label for any special cleaning instructions. When cleaning spray equipment, you should use the protective clothing listed on the pesticide label. Sprayer cleaning should be done so that rinse water does not enter any waterway, field drainage system, or well. Ideally, sprayer rinsate should be applied to a labeled crop rather than dumped at the cleaning location. If rinsing needs to be done at the mixing/loading site, it must be done on an impervious surface. All contaminated rinse water must be trapped and either used to mix another load of the same pesticide at the label recommended rates or disposed of at an approved pesticide waste handling facility.

4.14.1 Reducing Cleaning Problems

The need for cleaning can be reduced by good planning and equipment maintenance. The following are suggestions to help reduce cleaning needs:

- Carefully plan how much pesticide to mix so that all mixed pesticides are used up when you are finished with the field.
- Be sure that the sprayer is clean before you use it.
- Make sure all parts of the sprayer are in good condition. Corroded, cavitated or pitted surfaces are prime areas for pesticide residue to hide. Replace any worn parts.
- Mix the chemicals in the correct order. Some chemicals, when mixed in the wrong order, can actually become more difficult to remove from the equipment. Consult the pesticide label for the proper mixing order.
- Follow any label instructions for cleaning spray equipment.
- Be sure that cleaning solutions contact ALL equipment surfaces.
- Remove and clean filters, strainers and nozzle screens separately from the rest of the sprayer.

4.14.2 Sprayer Cleansers

Several sprayer cleansers are commercially available. These cleansers should be selected based on the pesticide formulation used. Specific recommendations can be found on the pesticide label, by contacting the pesticide manufacturer or through the label or manufacturer of the cleaning agent you wish to use. Some available cleansers are listed in the table on the next page. Household detergents, such as laundry soaps and household ammonia, can also be used, but they may not adequately deactivate and solubalize the pesticides for effective cleaning. Chlorine bleach solutions should not be used. Cleaning agents can be used to wash both the inside and outside of the sprayer. When using commercial cleansers, follow the product's instructions for the best results.

4.14.3 Tank Rinse Systems (Low-Volume Tank Rinsing)

Tank rinse systems consist of a clean water supply tank mounted to the sprayer and one or more rotating discs or nozzles mounted inside the main sprayer tank. Water is pumped from the clean water tank to the rinse nozzles where the water is sprayed around the inside of the spray tank. These systems are designed for in-field rinsing of the sprayer so that the tank washings can be applied to the field and reduce the amount of time spent traveling to and from the farmyard.

A tank rinse system can be purchased as an option on some sprayers or as an add-on kit. Rinse systems can also be made from readily available parts and installed on the sprayer. A sample rinse system layout is shown below. A typical rinse system uses 360-degree tank wash nozzles mounted in the top of the tank. These nozzles are available in flow rates of 10 gallons of water per minute at 20 psi up to 20 GPM at 50 psi. If a spray tank has baffles, at least one rinse nozzle per compartment should be provided. In any case, a sufficient number of rinse nozzles should be installed to provide enough rinse water to contact the entire tank interior.

A 50 to 100 gallon tank is plumbed into the sprayer plumbing system to provide the clean water. This tank should be permanently marked "Clean Water Only" so that only clean water is placed in the tank, reducing the chance for contamination of the rinse system. The tank should be mounted above the pump in order to aid in priming the pump. Ideally, the tank should be mounted on the sprayer.

When using tank rinse systems, you may want to check the pesticide label or with the chemical manufacturer to be sure that low-volume rinsing is suitable for the products you're using. Also, during the rinse process, be sure to open and close the pressure valve and other control valves on the sprayer to ensure that any chemical that may be trapped in the valve is rinsed out, further reducing the chance for contamination of future pesticide mixes. To obtain the best results, practice using the rinse system by placing spray marker dye or food coloring in the spray tank. Using the rinse system, run three rinse cycles, making sure the water discharged from the nozzles is completely clear by the end of the third rinse.

Commercially Available Sprayer Cleansers

Product	Supplier
Protank Cleaner	Agriliance P.O. Box 64089 St. Paul, MN 55164-0089 Phone: (651) 451-5151 Web: www.agriliance.com
All Clear Tank Decontaminator	UAP Loveland Industries, Inc. PO Box 1289 Greeley, CO 80632 Phone: 970-356-8920 Fax: 970-356-8926 Email: webmaster@lovelandindustries.com

Product	Supplier
Wipe-Out	Helena Chemical Company 225 Schilling Blvd. Collierville, TN 38017 Web: www.helenachemical.com
Ag Chem Tank Cleaner	Ag Chem Equipment Co. Ag-Chem Division 202 Industrial Park Jackson, MN 56143 Phone: 800-760-8800 Web: www.sprayparts.com

4.14.4 Cleaning the Sprayer

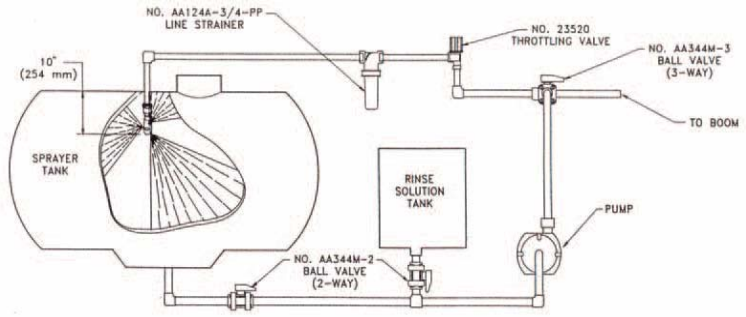
The pesticide applicator should try to keep the volume of tank wash water produced to a minimum. Ideally a tank rinse system should be used. There are two levels of sprayer cleaning:

- where the same or similar products are to be used on consecutive occasions or
- where the type of product is changed for another or at the end of the season.

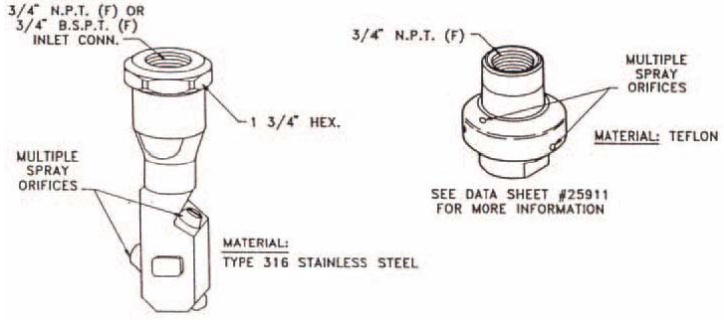
4.14.4.1 Cleaning where Similar Products are to be Used

Reminder: *Before cleaning application equipment, remember to wear the protective clothing listed on the pesticide label.*

1. Be sure that all mixed pesticides have been used up from the sprayer or removed and disposed of properly.
2. Flush sprayer with clean water, making sure to wash all inside surfaces of the tank, including the underside of the lid. Use of a tank rinse system is preferred so that rinsing can be done in the field where the rinse water can be applied to the crop. If a tank rinse system is not available, fill the spray tank about half full with clean water and flush the system for at least 5 minutes using both agitation and spraying. Be sure to open and close any control valves during the rinse process. The rinsate should be applied to the crop at labeled rates. Repeat this procedure two more times.
3. Hose down the outside of the sprayer making sure to reach all parts, scrubbing if necessary.
4. Remove suction, main and in-line filter elements and wash them thoroughly in clean water using a soft bristle brush. Put the filters back on the sprayer when clean.



Sample layout of a sprayer rinse system



Two types of 360-degree tank rinse nozzles

5. Remove the nozzles, nozzle screens and nozzle bar end caps (if used) and wash them thoroughly in clean water with the appropriate cleanser and rinse. Remember to use a soft bristle brush, such as an old toothbrush, when cleaning nozzle parts.
6. Partly fill the sprayer with clean water and run the sprayer to flush out all parts.
7. Reinstall nozzles and nozzle screens.
8. Hose down the outside of the sprayer once again.

4.14.4.2 Cleaning where Product Type is Changed

This procedure should also be followed at the end of a season or before sprayer maintenance. **Reminder:** ***Remember to wear the protective clothing listed on the pesticide label.***

Follow steps 1–6 above.

7. Refill the tank with clean water, adding any detergent recommended by the pesticide manufacturer. Remember, use commercial cleansers according to their directions. Agitate the solution and pump it through the sprayer plumbing system.
8. Discharge the cleaning solution from the sprayer through the plumbing system, making sure to drain the system as thoroughly as possible.
9. Rinse the sprayer and flush the plumbing system with clean water.
10. Inspect the sprayer for deposits that may remain in the tank or plumbing system. If any remain, use some of the cleaning solution and scrub the problem spots. Rinse the sprayer out completely.
11. Repeat steps 7 to 9.
12. Hose down the outside of the tractor and sprayer, scrubbing if necessary.
13. If changing from one type of pesticide to another, refit nozzles, filters and other parts that may have been removed in the cleaning process.
14. When cleaning and preparing the sprayer at the end of the season, safely store nozzles and filters to keep them clean and damage-free. Leave valves open and the tank lid loosely closed.

4.14.5 Tank Rinse Nozzle Suppliers

Spraying Systems (TeeJet)
www.teejet.com/techcent/catalog_english/%20spec_fert.pdf

Delavan www.delavan.co.uk/zCIP.pdf

4.14.6 Disposal of Pesticide Waste

The safe disposal of pesticide waste is a serious responsibility for growers and spraying contractors. It is important, therefore, that everything should be done to keep to a minimum the amount of waste generated.

Pesticide waste is of four types:

- ☐ Concentrated products.
- ☐ Diluted pesticides, including washings.
- ☐ Empty containers.
- ☐ Contaminated clothing and other materials.

Caution
All mounted sprayers tend to be unstable when removed from their tractors. Make sure they are safely chocked before leaving them.

4.14.7 Mechanical Maintenance

Lubrication must be carried out at the time intervals specified by the sprayer manufacturer. The following components must be checked daily when a sprayer is in use:

- ☐ Pump crankshaft oil level.
- ☐ Fan drive gearbox oil level.
- ☐ Fan drive shaft bearings.
- ☐ Agitator shaft bearings.
- ☐ PTO shaft bearings.
- ☐ PTO shaft safety cover.
- ☐ Wheels, wheel bearings and tire inflation.
- ☐ Rotary atomizers for damage and lubrication.

Occasionally, for example, after a complete spray round, check the spray liquid system for leaks and signs of damage or wear; repair should be carried out at once.

4.14.8 Storage of Sprayers

Sprayers should be stored carefully after use. Manufacturers' specific instructions should be followed but in their absence the following general guide should be of use:

1. Thoroughly wash the sprayer inside and out with water, followed by a solution of detergent and water, followed by water. Drain thoroughly. Allow the access of air to all parts of the sprayer system. A more thorough decontamination routine is outlined above.
2. Inspect filters, nozzles, hoses and all other components and order all necessary spares.
3. Pay particular attention to the pump. Inspect rollers or diaphragms (if fitted) and valves and order necessary spares.
4. Check the soundness of all mechanical components, particularly booms and boom hinges, and the wheels.
5. Store sprayer under cover, taking care to prevent dirt and moisture affecting tank or working parts.

4.14.9 References

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4.15 Homeland Security

OPERATION SAFEGUARD - Information from NY State Office of Homeland Security

The following examples of activity relating to spraying equipment, though not fully inclusive, may be of possible concern to law enforcement.

- The unexplained loss or theft or attempted theft of equipment or separate machine components used in agricultural spraying or mosquito extermination (i.e. mist blowers, tanks, axial or centrifugal fans, diaphragm pumps, nozzles, spouts, pressure regulators, etc).
- Inquiries from unknown persons as to the purchase or operation of spraying equipment; approach from a previously unknown customer whose identity is not clear; a customer's use of evasive responses.
- Unusual inquiries about modifying spraying equipment.
- Requests for information or for purchase of pesticides that may be harmful to humans.
- Individual making observations of your spraying operations, who when approached, deliberately leave to avoid questioning.
- A request to purchase spraying machinery by someone who does not appear to have previous experience in such work or a connection to the agricultural industry or mosquito extermination effort (i.e. unable to answer basic questions about intended application and range, water volume rates, desired nozzle output, spray pattern, acreage, crops, soil composition, etc).
- A request to ship spraying equipment to an area or region not normally associated with spraying operations.
- A customer's reluctance to provide information on the locations of the plant or place where the equipment will be stored.

5 Characteristics of Crop Protectants Used On Tree Fruits

5.1 Cross Reference of Chemical vs. Trade Names of Pesticides

(**A**), Acaricide; (**B**), Bactericide; (**F**), Fungicide; (**H**), Herbicide; (**I**), Insecticide;

5.1.1 By Common Name

2,4-D – (*2,4-D Amine 4) Agriliance; (Amine 4) Loveland Products; (*Weedar 64, Formula 40) Nufarm; (*Unison) Helena **(H)**

abamectin – (*Agri-Mek) Syngenta; (*Temprano) Chemtura; (*Abba) Makhteshim Agan (**A,I**)
acequinocyl – (Kanemite) Arysta LifeScience **(A)**
acetamiprid – (Assail) UniPhos (**I**)
azadirachtin – (Aza-Direct) Gowan; (Azatin XL ,) OHP, Certis **(I)**
azinphos-methyl – (*Guthion) Makhteshim Agan (**I**)
azoxystrobin – (Abound) Syngenta **(F)**

Bacillus subtilis – (Serenade) AgraQuest **(B, F)**
bifenazate – (Acramite) Chemtura **(A)**
bifenthrin – (*Brigade) FMC; (*Fanfare) Makhteshim Agan; (*Bifenture) UniPhos (**I, A**)
boscalid + pyraclostrobin – (Pristine) BASF (**F**)
Bacillus thuringiensis (B.t.) – (Agree) Certis; (Biobit) Valent BioSciences; (Dipel) Valent BioSciences; (Deliver) Certis; (Javelin) Certis **(I)**
bromacil – (Hyvar, Hyvar X-L) DuPont **(H)**
buprofezin – (Centaur) Nichino America **(I)**

captan – (Captan) Micro Flo, Drexel, Makhteshim Agan; (Captec) Micro Flo **(F)**
carbaryl – (Carbaryl) Drexel; (Sevin) Bayer (**I**)
carfentrazone-ethyl – (Aim) FMC **(H)**
chlorantraniliprole – (Voliam Flexi) Syngenta **(I)**
chlorpyrifos – (*Lorsban) Dow AgroSciences, Gowan **(I)**
chlorothalonil – (Bravo) Syngenta; (Echo) Sipcam Agro; (Applause) Loveland; (Equus) Makhteshim Agan **(F)**
clethodim – (Select Max) Valent USA **(H)**
clofentezine – (Apollo) Makhteshim Agan **(A)**
clopyralid – (*Stinger) Dow AgroSciences **(H)**
clothianidin – (Clutch) Arysta, Valent (I)
codling moth granulosis virus – (Cyd-X) Certis; (Carpovirusine) Arysta LifeScience **(I)**
copper hydroxide – (Kocide) DuPont; (Champ) Nufarm Americas **(B, F)**
copper oxychloride/copper sulfate – (C-O-C-S) Loveland **(B, F)**
copper salts of fatty and rosin acids – (Tenn-Cop) Miller **(B, F)**
copper sulfate – (Cuprofix Ultra 40 Disperss) UniPhos **(B, F)**
cyfluthrin – (*Baythroid, *Leverage) Bayer **(I)**
cyprodinil – (Vangard) Syngenta **(F)**
cyprodinil+difenconazole – (Inspire Super MP) **(F)**

deltamethrin – (Battalion) Arysta; (Decis) Bayer **(I)**
diazinon – (*Diazinon) Helena, Makhteshim Agan **(I)**
dichlobenil – (Casoron) Chemtura **(H)**
dicloran – (Botran) Gowan **(F)**
dicofol – (Kelthane) Dow AgroSciences **(A)**
difenoconazole – (Inspire Super MP; sold with Vangard (cyprodinil); must be mixed) Syngenta **(F)**
dimethoate – (Dimethoate) Loveland (Dimate) Agriliance; (Dimethoate) Drexel, Helena, Micro Flo **(I)**
diuron – (Direx, Karmex) DuPont: (Diuron) Drexel, Loveland, Agriliance, Makhteshim Agan **(H)**
dodine – (Syllit FL) Agriphar **(F)**

emamectin benzoate – (*Proclaim) Syngenta **(I)**
endosulfan – (Endosulfan) Drexel; (*Thionex) Makhteshim Agan **(I)**
esfenvalerate – (*Asana) DuPont **(I)**
etoxazole – (Zeal) Valent (A)

fenarimol – (Rubigan) Gowan **(F)**
fenbuconazole – (Indar) Dow AgroSciences **(F)**
fenbutatin-oxide – (*Vendex) UniPhos **(A)**
fenhexamid – (Elevate) Arvesta **(F)**
fenpropathrin – (*Danitol) Valent BioSciences **(I)**
fenpyroximate – (Portal) Nichino America **(A,I)**
ferbam – (Ferbam Granuflo) Taminco **(F)**
flonicamid – (BeLeaf) FMC **(I)**
fluazifop-p-butyl – (Fusilade) Syngenta **(H)**
flubendiamide – (Belt) Bayer **(I)**
fludioxonil – (Scholar) Syngenta **(F)**
flumioxazin – (Chateau) Valent **(H)**
fosetyl-Al – (Aliette) Bayer **(F)**

gamma cyhalothrin – (*Proaxis) Loveland **(I)**
glufosinate-ammonium – (Rely) Bayer **(H)**
glyphosate – (Roundup Original, Roundup Original Max, Roundup Ultradry, Roundup Weathermax) Monsanto; (Credit) Nufarm; (Cornerstone) Agriliance; (Gly-4) Universal Crop Protection Alliance; (Touchdown) Syngenta; **(H)**

hexakis – (*Vendex) UniPhos **(I)**
hexythiazox – (Savey, Onager) Gowan **(A)**
hydrogen dioxide – (OxiDate, StorOx) Biosafe Systems **B, F)**

imidacloprid – (*Provado, *Leverage) Bayer; (Sherpa) Loveland **(I)**
indoxacarb – (Avaunt) DuPont **(I)**
iprodione – (Rovral) Bayer; (Iprodione) MicroFlo **(F)**
isoxaben – (Gallery) Dow (H)

kaolin – (Surround) BASF (**A,F,I**)
kresoxim-methyl – (Sovran) BASF **(F)**

lambda-cyhalothrin – (*Warrior) Syngenta; (*Lambda-Cy) UniPhos **(I)**
liquid lime-sulfur – (Allpro Lime Sulfur, Suregard Lime Sulfur) Value Garden Supply; (Sulforix Lime Sulfur, Lime Sulfur Solution) Miller Chemical (**A, F, I**)

malathion – (Malathion) Loveland; (Malathion) Drexel; (*Prentox Malathion) Prentiss **(I)**
mancozeb – (Dithane) Dow AgroSciences; (*Manzate) DuPont: (Penncozeb) UniPhos **(F)**
maneb – (Maneb) UniPhos DuPont **(F)**
mefanoxam – (Ridomil Gold) Syngenta **(F)**
metconazole – (Quash) Valent **(F)**
methidathion – (*Supracide) Gowan **(I)**
methomyl – (*Lannate) DuPont **(I)**
methoxyfenozide – (*Intrepid) Dow AgroSciences **(I)**
metiram – (Polyram) BASF **(F)**
myclobutanil – (Rally,Nova) Dow AgroSciences **(F)**

napropamide – (Devrinol) United Phosphorus **(H)**
neem oil extract – (§Trilogy) Certis **(A,I,F)**
norflurazon – (Solicam) Syngenta **(H)**
novaluron – (Rimon) Chemtura **(I)**

oryzalin – (Surflan) UniPhos; (Oryzalin) FarmSaver.com; **(H)**
oxamyl – (*Vydate) DuPont **(I)**
oxyfluorfen – (Goal) Dow AgroSciences; (Galigan) Makhteshim Agan **(H)**
oxytetracycline – (Mycoshield) NuFarm; (Flameout) UniPhos **(B)**

paraquat – (*Gramoxone MAX, INTEON) Syngenta **(H)**
pendimethalin – (Prowl, Prowl H2O) BASF **(H)**
permethrin – (*Ambush) Amvac; (*Perm-Up) UniPhos; (*Pounce) FMC **(I)**
phosmet – (*Imidan) Gowan **(I)**
pronamide – (*Kerb) Dow AgroSciences **(H)**
phosphite – (Phostrol) NuFarm (**F, B**)
phosphite – (ProPhyt) Luxembourg-Pamol (**F**)
phosphorous acid – (Fosphite) JH Biotech; (Topaz Fungicide) Agriliance (**F**)
phosphorous acid – (Agri-Fos) Agrichem Manufacturing Industries; (Fungi-Phite) Biagro Western Sales; (**F, B**)
propiconazole – (Orbit) Syngenta; (PropiMax) Dow AgroSciences **(F)**
pyraclostrobin+boscolid – (Pristine) BASF **(F)**
pyrethrins/rotenone – (PyGanic, Pyrenone) McLaughlin Gormley King, Bayer **(I)**
pyridaben – (Nexter) Gowan (**A,I**)
pyrimethanil – (Scala) Bayer; (Penbotec) Janssen **(F)**
pyriproxyfen – (Esteem) Valent BioSciences **(I)**

rimsulfuron – (Matrix FNV) DuPont **(H)**
rynaxypyr – (Altacor) DuPont **(I)**

sethoxydim – (Poast) BASF **(H)**
simazine – (Princep) Syngenta; (Simazine) Drexel; (Sim-Trol) Sipcam Agro **(H)**
soap, insecticidal – (M-Pede) Dow AgroSciences **(I)**
spinetoram – (Delegate) Dow AgroSciences **(I)**
spinosad – (SpinTor, §Entrust, §GF-120) Dow AgroSciences **(I)**
spirodiclofen – (Envidor) Bayer **(A)**
spirotetramat – (Movento) Bayer **(I)**
streptomycin – (Agri-mycin, Streptrol) Nufarm; (Firewall) UniPhos; (Agricultural Streptomycin) Farm Saver **(B)**
sulfur- (Microthiol Disperss) UniPhos **(F)**

tebuconazole – (Elite, Adament) Bayer **(F)**
tebufenozide – (*Confirm) Dow AgroSciences **(I)**
terbacil – (Sinbar) DuPont **(H)**
terramycin – (Mycoshield) Nufarm; (Flameout) UniPhos **(B)**
thiabendazole – (Mertect) Syngenta; (Shield-Brite TBZ) Pace International **(F)**
thiacloprid – (*Calypso) Bayer **(I)**
thiamethoxam – (Actara, Voliam Flexi) Syngenta **(I)**
thiophanate-methyl – (Topsin M) UniPhos; (Thiophanate-methyl) FarmSaver, Makhteshim Agan; (T-Methyl) Micro Flo **(F)**
thiram – (Thiram Granuflo) Taminco **(F)**
triadimefon – (Triadimefon) Taminco; (Bayleton) Amvac **(F)**
trifloxystrobin – (Flint) Bayer; (Gem, Adament) Bayer **(F)**
triflumizole – (Procure) Chemtura **(F)**

zeta-cypermethrin – (Mustang Max) FMC (I)
ziram – (Ziram) Uniphos; (Ziram Granuflo) Taminco **(F)**

5.1.2 By Trade Name

*2,4-D Amine 4 – (2,4-D) Agriliance **(H)**

*Abba – (abamectin) Makhteshim Agan **(I)**
Abound – (azoxystrobin) Syngenta **(F)**
Acramite – (bifenazate) Chemtura **(A)**
Actara – (thiamethoxam) Syngenta **(I)**
Adament – (tebuconazole/trifloxystrobin) Bayer **(F)**
§Agree – (B.t.) Certis **(I)**
Agri-Fos – Agrichem Manufacturing Industries (**F, B**)
*Agri-Mek – (abamectin) Syngenta (**A,I**)
Agrimycin – (streptomycin) Nufarm **(B)**
Aim – (carfentrazone-ethyl) FMC **(H)**
Aliette – (fosetyl-Al) Bayer **(F)**
Allpro Lime Sulfur – (liquid lime-sulfur) Value Garden Supply (**A, F, I**)
Altacor (rynaxypyr) DuPont **(I)**
Amine 4 – (2,4-D) Loveland Products **(H)**
*Ambush – (permethrin) Amvac **(I)**
Applause – (chlorothalonil) Loveland (**F**)
Apollo – (clofentezine) Makhteshim Agan **(A)**
*Asana – (esfenvalerate) DuPont **(I)**
Assail – (acetamiprid) UniPhos **(I)**
Atila Plus – (glyphosate) Nufarm **(H)**

Avaunt – (indoxacarb) DuPont **(I)**
Aza-Direct – (azadirachtin) Gowan **(I)**
Azatin XL – (azadirachtin) OHP, Certis **(I)**

Basicop – (copper sulfate) Griffin **(B,F)**
Battalion – (deltamethrin) Arysta **(I)**
Bayleton – (triadimefon) Amvac **(F)**
*Baythroid – (cyfluthrin) Bayer **(I)**
Beleaf – (flonicamid) FMC **(I)**
Belt (flubendiamide) Bayer **(I)**
*****Bifenture – (bifenthrin) UniPhos **(I)**
Biobit – (B.t.) Valent BioSciences **(I)**
Botran – (dicloran) Gowan **(F)**
Bravo – (chlorothalonil) Syngenta **(F)**
*Brigade – (bifenthrin) FMC (**I, A**)

C-O-C-S – (copper oxychloride/copper sulfate) Loveland **(B, F)**
*Calypso – (thiacloprid) Bayer **(I)**
Captan – (captan) Micro Flo, Drexel, Makhteshim Agan **(F)**
Captec – (captan) Micro Flo **(F)**
Carbaryl – (carbaryl) Drexel **(I)**
Carpovirusine – (codling moth granulosis virus) Arysta LifeScience **(I)**
Casoron – (dichlobenil) Chemtura **(H)**
Centaur – (buprofezin) Nichino America **(I)**
Champ – (copper hydroxide) Nufarm Americas **(B, F)**
Chateau – (flumioxazin) Valent (H)
Clutch – (clothianidin) Arysta, Valent **(I)**
Concorde – (chlorothalonil) Griffin (**F**)
Cornerstone – (glyphosate) Agriliance **(H)**
Credit – (glyphosate) Nufarm **(H)**
Cuprofix Ultra 40 Disperss – (copper sulfate) UniPhos **(B, F)**
Cyd-X – (codling moth granulosis virus) Certis **(I)**

*Danitol – (fenpropathrin) Valent BioSciences **(I)**
Decis – (deltamethrin) Bayer **(I)**
Delegate – (spinetoram) Dow AgroSciences **(I)**
Deliver – (Bacillus thuringiensis) Certis **(I)**
Devrinol – (napropamide) United Phosphorus **(H)**
Diazinon – (*Diazinon) Makhteshim Agan ; Helena; (*Prentox Diazinon) Prentiss **(I)**
Dimate – (dimethoate) Agriliance **(I)**
Dimethoate – (dimethoate) Drexel, Helena, Micro Flo, Loveland **(I)**
Dipel – (Bacillus thuringiensis) Valent BioSciences **(F)**
Direx – (diuron) Griffin **(H)**
Dithane – (mancozeb) Dow AgroSciences **(F)**
Diuron – (diuron) Agriliance, Drexel, Loveland Products, Makhteshim Agan

Echo – (chlorothalonil) Sipcam Agro **(F)**
Elevate – (fenhexamid) Arvesta **(F)**
Elite – (tebuconazole) Bayer **(F)**
Endosulfan – (endosulfan) Drexel **(I)**
§Entrust – (spinosad) Dow AgroSciences **(I)**
Envidor – (spirodiclofen) Bayer **(A)**
Equus – (chlorothalonil) Makhteshim Agan (**F**)

Esteem – (pyriproxyfen) Valent BioSciences **(I)**

*Fanfare – (bifenthrin) Makhteshim Again **(A, I)**
Ferbam Granuflo – (ferbam) Taminco **(F)**
Firewall – (streptomycin) UniPhos **(B)**
Flameout – (oxytetracycline) UniPhos **(B)**
Flint – (trifloxystrobin) Bayer **(F)**
Formula 40 – (2,4-D) Nufarm **(H)**
Fosphite – (phosphorous acid) JH Biotech (**F)**
Fungi-Phite – (phosphorous acid) Biagro Western Sales; (**F, B**)
Fusilade – (fluazifop-p-butyl) Syngenta **(H)**

Galigan – (oxyfluorfen) Makhteshim Agan **(H)**
Gallery – (isoxaben) Dow **(H)**
Gem – (trifloxystrobin) Bayer **(F)**
§GF-120 – (spinosad) Dow AgroSciences **(I)**
Gly-4 – (glyphosate) Universal Crop Protection Alliance **(H)**
Goal – (oxyfluorfen) Dow AgroSciences **(H)**
*Gramoxone MAX, INTEON – (paraquat) Syngenta **(H)**
*Guthion – (azinphos-methyl) Makhteshim Agan **(I)**

Hyvar – (bromacil) DuPont **(H)**

*Imidan – (phosmet) Gowan **(I)**
Indar – (fenbuconazole) Dow AgroSciences **(F)**
Inspire Super MP – (difenoconazole) Syngenta **(F)**
*Intrepid – (methoxyfenozide) Dow AgroSciences **(I)**
Iprodione – (iprodione) MicroFlo **(F)**

Javelin – (Bacillus thuringiensis.) Certis **(I)**

Kanemite – (acequinocyl) Arysta LifeScience **(A)**
Karmex – (diuron) Griffin, DuPont **(H)**
Kelthane – (dicofol) Dow AgroSciences **(A)**
*Kerb – (pronamide) Dow AgroSciences **(H)**
Kocide – (copper hydroxide) DuPont **(B, F)**

*Lambda-Cy – (lambda-cyhalothrin) UniPhos (I)
*Lannate – (methomyl) DuPont **(I)**
*Leverage – (cyfluthrin/imidacloprid) Bayer **(I)**
Lime Sulfur Solution – (liquid lime sulfur) Miller Chemical (**A, F, I**)
*Lorsban – (chlorpyrifos) Dow AgroSciences, Gowan **(I)**

Malathion – (malathion) Drexel, Loveland **(I)**
Maneb – (maneb) UniPhos **(F)**
*Manzate – (mancozeb) DuPont **(F)**
Matrix FNV (rimsulfuron) DuPont **(H)**
Mertect – (thiabendazole) Syngenta **(F)**
Messenger – (harpin) Eden Bioscience **(B)**
Microthiol Disperss – (sulfur) UniPhos **(F)**
Mirage Plus – (glyphosate) Platte Chemical **(H)**
Movento – (spirotetramat) Bayer **(I)**
M-Pede – (insecticidal soap; potassium salts of fatty acids) Dow AgroSciences **(I)**
Mustang Max – (zeta-cypermethrin) FMC (I)
Mycoshield – (oxytetracycline) Nufarm **(B)**

Nexter – (pyridaben) Gowan (A, I)
Nova – (myclobutanil) Dow AgroSciences **(F)**

Onager – (hexythiazox) Gowan **(A)**
Orbit – (propiconazole) Griffin **(F)**
Oryzalin – (oryzalin) FarmSaver.com **(H)**
OxiDate – (hydrogen dioxide) Biosafe Systems **(B, F)**

Penbotec– (pyrimethanil) Janssen **(F)**
Penncozeb – (mancozeb) UniPhos **(F)**
*****Perm-Up – (permethrin) UniPhos **(I)**
Phostrol – (sodium, potassium, and ammonium phosphates) NuFarm (**F, B**)
Poast – (sethoxydim) BASF **(H)**
Polyram – (metiram) BASF **(F)**
Portal – (fenpyroximate) Nichino America **(A, I)**
*Pounce – (permethrin) FMC **(I)**
*Prentox Diazinon – (*Diazinon) Prentiss **(I)**
*Prentox Malathion – (malathion) Prentiss **(I)**
Princep – (simazine) Syngenta **(H)**
Pristine – (pyraclostrobin + boscolid) BASF **(F)**
*Proaxis – (gamma cyhalothrin) Dow AgroSciences **(I)**
*Proclaim – (emamectin benzoate) Syngenta **(I)**
ProPhyt – (potassium phosphite) Luxembourg-Pamol (**F)**
Procure – (triflumizole) Chemtura **(F)**
*Provado – (imidacloprid) Bayer **(I)**
Prowl – (pendimethalin) BASF **(H)**
PyGanic, Pyrenone – (pyrethrins) McLaughlin Gormley King, Bayer **(I)**
Quash – (metconazole) Valent **(F)**
Quintec – (quinoxyfen) Dow AgroSciences **(F)**

Rally – (myclobutanil) Dow AgroSciences **(F)**
Recoil (glyphosate and 2,4-D) NuFarm
Rely – (glufosinate-ammonium) Bayer **(H)**
Ridomil Gold – (mefanoxam) Syngenta **(F)**
Rimon – (novaluron) Chemtura **(I)**
Roundup Original – (glyphosate) Monsanto **(H)**
Roundup Original Max – (glyphosate) Monsanto **(H)**
Roundup Ultradry – (glyphosate) Monsanto **(H)**
Roundup Weathermax – (glyphosate) Monsanto **(H)**
Rovral – (iprodione) Bayer **(F)**
Rubigan – (fenarimol) Gowan **(F)**

Savey – (hexythiazox) Gowan **(A)**
Scala – (pyrimethanil) Bayer **(F)**
Scholar – (fludioxonil) Syngenta **(F)**
Select Max (clethodim) Valent USA **(H)**
Serenade – (Bacillus subtilis) AgraQuest **(B, F)**
Sevin – (carbaryl) Bayer **(I)**
Sherpa – (imidacloprid) Loveland **(I)**
Shield-Brite TBZ – (thiabendazole) Pace International **(F)**
Simazine – (simazine) Agriliance, Drexel **(H)**
Sim-Trol – (simazine) Sipcam Agro **(H)**
Sinbar – (terbacil) DuPont **(H)**
Solicam – (norflurazon) Syngenta **(H)**
Sovran – (kresoxim-methyl) BASF **(F)**
SpinTor – (spinosad) Dow AgroSciences **(I)**
*Stinger – (clopyralid) Dow AgroSciences **(H)**
StorOx – (hydrogen dioxide) Biosafe Systems **(B, F)**
Streptrol – (streptomycin) Nufarm **(B)**
*Supracide – (methidathion) Gowan **(I)**
Suregard Lime Sulfur – (liquid lime-sulfur) Value Garden Supply (**A, F, I**)
Surflan – (oryzalin) UniPhos **(H)**
Sulforix Lime Sulfur – (liquid lime-sulfur) Miller Chemical (**A, F, I)**
Surround – (kaolin) BASF **(A,F,I)**
Syllit – (dodine) Agriphar **(F)**

T-Methyl – (thiophanate-methyl) Micro Flo **(F)**
*Temprano – (abamectin) Chemtura **(I)**
Tenn-Cop – (copper salts of fatty and rosin acids (Griffin) **(B, F)**
*Thionex – (endosulfan) Makhteshim **(I)**
Thiophanate-methyl – (thiophanate-methyl) FarmSaver, Makhteshim Agan **(F)**
Thiram Granuflo – (thiram) Tamico **(F)**
Topaz Fungicide – (phosphorous acid) Agriliance (**F)**
Topsin M – (thiophanate-methyl) UniPhos **(F)**
Touchdown, HiTech, Total – (glyphosate) Syngenta **(H)**
Triadimefon – (triadimefon) Taminco **(F)**
§Trilogy – (neem oil extract) Certis **(A,I,F)**

*Unison – (2,4-D) Helena **(H)**

Vangard – (cyprodinil) Syngenta **(F)**
*Vendex – (hexakis, fenbutatin-oxide) UniPhos **(A)**
Voliam Flexi – (thiamethoxam/chlorantraniliprole) Syngenta **(I)**
*Vydate – (oxamyl) DuPont **(I)**

*Warrior – (lambda-cyhalothrin) Syngenta **(I)**
*Weedar 64 – (2,4-D) Nufarm **(H)**

Zeal – (etoxazole) Valent **(A)**
Ziram – (ziram) UniPhos **(F)**
Ziram Granuflo – (ziram) Taminco **(F)**

5.2 Fungicides

(For meaning of symbols preceding product names, see abbreviation list at the end of this publication)

Azoxystrobin (Abound) is a locally systemic, strobilurin fungicide labeled on stone fruit for control of brown rot, powdery mildew (rusty spot), and peach scab. It is labeled on apricots, sweet and tart cherry, nectarines, peaches, plums and prunes. Abound is a protectant fungicide and should therefore be applied before infection occurs. Abound, like other strobilurin fungicides, is prone to resistance development. Follow label restrictions for resistance management. Abound can be applied up to the day of harvest.

Caution: Abound is extremely phytotoxic to certain apple varieties. Therefore, **DO NOT** spray Abound where spray drift may reach apple trees; do not spray when conditions favor drift beyond the intended

area of application; do not use equipment to spray apple trees that previously has been used to spray Abound.

§Bordeaux Mixture is a mixture in water of copper sulfate (bluestone) and hydrated spray lime and is used as a spray on pears and apples for fire blight, on peaches for leaf curl, and on cherries in postharvest sprays for leaf spot. The recommended amount of each ingredient varies from one crop to another and is designated by 3 figures (e.g., Bordeaux 2-6-100). The 1st figure of the Bordeaux formula is the copper sulfate in lb, the 2nd is the spray lime in lb, and the 3rd is the water in gal. The mixture is prepared by dissolving copper sulfate snow (not fixed copper) in about 1/2 tank of water. Once the copper sulfate is completely dissolved, the spray lime is added slowly with constant agitation, and the tank is filled with water. Bordeaux mixture must be agitated vigorously to prevent settling.

Bordeaux mixture is generally unsafe to use on fruit crops after the 1/4-inch green stage. However, pears tolerate copper, and it can be used during bloom for fire blight control provided that the disease pressure is only moderate to light. Bordeaux mixture has long residual action and gives good control of leaf spot when applied to sour cherries in a postharvest spray.

Due to the large volume of spray lime, Bordeaux mixture has many compatibility problems. When used in combination with other pesticides, the labels of the pesticides involved should be read thoroughly.

Captan is formulated and sold as a 50% or 80% dry wettable powder, as an 80% wettable dry granular, as a liquid (4 lb AI/gal), and as dust formulations. Re-entry intervals vary depending on formulation and protective clothing, so check labels.

On apples, captan controls apple scab, black rot, white rot, Brooks fruit spot, Botryosphaeria rot, bitter rot, and blossom-end rot. In the control of apple scab, captan used at the rate of 1 lb AI/100 gal of spray gives adequate protection when applied on a 6- to 10-day schedule. Shorter intervals should be used if excessive washing of the spray residue or rapid growth of tissue occurs during a critical period for spore discharge. Captan has limited postinfection activity. Captan is not effective for control of rust diseases and powdery mildew. In wet years or orchards where sooty blotch and fly speck are consistent problems, captan should be tank mixed with Topsin M to improve control of these diseases. Captan used alone is relatively weak against fly speck.

Captan may cause spotting, yellowing, and dropping of leaves when used at full strength early in the season on Delicious, Baldwin, and Stayman, especially when used in combination with sulfur. Captan can be combined with sulfur to control mildew on most other varieties. Combining captan with dodine or malathion may increase the injury. Captan should not be used with lime, or be applied to alkaline residues. Captan should not be applied within 7-10 days of an oil application. Tank-mixing Captan with foliar nutrients or spray adjuvants that enhance penetration may result in phytotoxicity.

Captan also controls brown rot on stone fruits and cherry leaf spot. Leaf injury occurs on certain sweet cherry varieties such as Emperor Francis, Schmidt, and Giant. Leaf and fruit injury is likely to occur on soft-fleshed plums if captan is used in several continuous sprays before July. On Stanley prune, a “shot-hole” type of injury to the leaves and roughening of the fruit surface may occur with the use of captan in sprays around bloom and shuck split stages. It has caused leaf injury on some varieties of peaches when sprayed on young developing leaves if the spray is preceded by extended periods of cloudy wet weather.

Captan is also registered for use as a postharvest dip or drench of apples, pears, cherries, and peaches for the control of postharvest rots. If fruit is likely to be exported, review the acceptability and tolerance limits of captan for countries of export destination before postharvest treatments. Check maximum residues allowed at <http://www.mrldatabase.com>

Chlorothalonil (Bravo, Echo, Applause, Equus) is available in a number of different formulations. Chlorothalonil shows good activity against cherry leaf spot, peach leaf curl, brown rot blossom blight, and black knot. However, some of the generic products are not labeled for all of these diseases. Users should pay strict attention to the timing of applications because improper use of this material (after shuck split on some crops) may result in phytotoxicity and unacceptable residue levels. Chlorothalonil is a broad-spectrum fungicide that is not at risk for development of fungicide-resistance in pathogens that it controls.

Cyprodinil (Vangard) is an anilinopyrimidine or AP fungicide registered for the control of apple scab and blossom blight on stone fruits (except for sweet cherries). Because it works best at lower temperatures and does not control fruit scab, Vangard is not recommended for use beyond tight cluster. Vangard can provide 48 to 72 hr of postinfection activity against apple scab on leaves. In efficacy trials conducted in Cornell orchards, Vangard was rarely more effective against scab than mancozeb fungicides except in situations where postinfection activity played a role. However, activity may be reduced in orchards with apple scab that is resistant to the SI fungicide group.

Dicloran (Botran) is formulated as a 75% WP or WSB for use on stone fruit. It is labeled for control of brown rot blossom blight on peaches, nectarines, sweet (but not tart) cherry, plums and prunes. It is labeled for control of brown rot fruit rot and Rhizopus rot on apricots, peaches, nectarines, and sweet cherry. Two applications at 18 and 10 days prior to harvest are permitted for control of fruit rot; Botran has a 10-day preharvest

interval (PHI). Botran is not compatible with EC formulations.

Difenconazole + cyprodinil (Inspire Super MP) is a pre-packaged combination of SI and anilinopyrimidine fungicides for management of apple diseases. The difenconazole partner is more effective against apple scab than older SI fungicides (Rally, Rubigan, Procure). The two fungicides are sold separately in the same package, but must be mixed. It is recommended that Inspire Super be combined with a mancozeb fungicide.

Dodine (Syllit) is formulated and sold as a 65% wettable powder and as a flowable containing 3.4 lb dodine per gallon. Due to resistance concerns, we recommend that growers limit use of dodine, and test apple scab isolates where resistance is suspected. Dodine has given excellent control of cherry leaf spot on both sweet and sour cherry.

Fenarimol (Rubigan), a sterol-inhibitor or SI fungicide, is formulated as a 1-lb/gal emulsifiable concentrate. It is especially useful in an apple scab control program because of its long (72-96 hr) kickback activity and prolonged presymptom activity. However, it is important to remember that kickback and presymptom activities are strongly dependent on rate; thus, the longer one waits to spray after the start of an infection period, the higher the rate needed for control. It has also been shown that a single postinfection spray of Rubigan is more effective if followed by a second application 7-10 days later. Because the material has limited protectant capabilities against apple scab, especially on fruit, it should always be used in combination with a contact fungicide (e.g., captan, mancozeb). Fenarimol is also very active against cedar apple rust and powdery mildew.

On pears, Rubigan is labeled for control of scab, powdery mildew, and rusts. It is more effective against leaf scab infections than it is against fruit scab, so tank-mixing with a protectant fungicide is recommended. Rubigan cannot be used on pears until petal fall (it may effect fruit shape if used earlier).

Rubigan is also registered for control of powdery mildew and leaf spot on cherries, against which it is very effective. However, it has little activity against brown rot.

Warning: Rubigan is no longer effective against apple scab in a number of orchards because the pathogen has developed resistance to the SI fungicide group. Rubigan may also fail to control leaf spot on cherries where that pathogen has become resistant to SI fungicides.

Fenbuconazole (Indar) is a sterol-inhibitor or SI fungicide labeled for use on most stone fruits and apples. Indar is labeled for control of scab, powdery mildew, rust and sooty blotch/flyspeck on apples. Indar provides outstanding control of brown rot with good residual activity following the last application. Follow label directions for including a spray adjuvant when using Indar to control brown rot on smooth-skinned stone fruits. Indar is also labeled for control of cherry leaf spot and peach scab, and provides moderate control of powdery mildew on sour cherries. No more than four applications should be applied per season.There is a 0-day PHI with respect to residue tolerance, and a 12-hour restricted-entry interval for worker protection.

Warning: Indar may fail to control apple scab where the pathogen has become resistant to SI fungicides

Fenhexamid (Elevate) is labeled for control of brown rot blossom blight and fruit rot on all stone fruits. University trials have shown that Elevate provides good control of blossom blight but is less effective than SI fungicides for controlling the fruit rot phase of brown rot.

Ferbam (Ferbam Granuflo) is a contact carbamate fungicide in the same chemical family as thiram and ziram, but it is not an EBDC fungicide. It is very effective against rust diseases of apple and moderately effective as a protectant against apple scab. It also is effective against Brooks fruit spot, frog-eye (black rot) leaf spot, sooty blotch, fly speck, pear scab, and pear leaf and fruit spots. It is recommended for use in combination with sulfur for control of brown rot and leaf spot on sour cherries under light to moderate disease pressure conditions. Ferbam also is very effective as a dormant spray on peaches for control of peach leaf curl.

Although ferbam is safe on apple foliage, it may cause enlargement of fruit lenticels in certain seasons and causes severe russeting on Golden Delicious. It is undesirable in late-season sprays because of its unsightly residues.

Ferbam is compatible with most commonly used pesticides. It should not be used with lime.

§Fixed Copper is a term that refers to several relatively insoluble forms of copper that are safer for fruit crops than basic copper sulfate and more convenient to use than Bordeaux mixture. The fixed copper compounds are sold under many trade names but fall into 3 basic types: copper oxychloride and copper sulfate (e.g., C-O-C-S WDG); copper hydroxide (e.g., Kocide 2000, Champ Formula 2); and complexed forms of basic copper sulfate (e.g., Cuprofix Ultra 40 Disperss. Dust preparations (e.g., C-O-C-S Copodust) are also available. All copper fungicides work by releasing free copper ions, so activity (and potential phytotoxicity) is usually related to the amount of actual metallic copper that is applied to the crop.

Fludioxonil (Scholar) is a new non-systemic fungicide registered for postharvest uses on stone fruits and pome fruits. Scholar is the only fruit fungicide in the new phenylypyrrole class of chemistry and it therefore is effective against fungi that have developed resistance to benzimidazole and other fungicide groups. Scholar applied after harvest is effective against brown rot (*Monilinia* species), *Botrytis cinerea*, *Rhizopus stolonifer*, and *Gilbertella persicaria*, and *Penicillium* species. Scholar can be applied as a dip or drench, as line spray, or mixed in fruit waxes. For fruit destined for export, check with importers to be certain that the importing country has an established tolerance (MRL) for fludioxonil before treating fruit (see http://mrldatabase.com).

Fosetyl-Al (Aliette) is registered for control of Phytophthora collar rot on bearing and non-bearing apples and for control of the bacterial disease, blister spot, on bearing apples. It is also labeled for control of fire blight but this use is not recommended. Aliette should not be tank mixed with copper compounds. If applied prior to or after the application of copper, the pH of Aliette should be raised to 6.0 or above with an alkaline buffer such as potassium carbonate (3 lbs of potassium carbonate to 5 lbs of Aliette WDG) or diammonium phosphate (1:1 ratio). Mixing of Aliette WDG with surfactants, foliar fertilizers or adjuvants that enhance pesticide penetration may cause phytotoxicity.

Iprodione (Rovral, Iprodione) is formulated as a 50% wettable powder and a 4 lb/gal flowable. Iprodione is highly effective for control of brown rot blossom blight on stone fruits. It is especially effective at inhibiting spore production by the brown rot fungus, and therefore is particularly recommended in wet years conducive to rapid disease buildup. This material has 24- to 48-hr post-infection activity against blossom blight infections. Iprodione cannot be applied after petal fall.

Kresoxim-Methyl (Sovran) is a strobilurin fungicide. Like the other strobilurin fungicides (e.g., Abound, Flint), Sovran is an excellent protectant, and will be most reliable when used in this manner. Sovran has some kickback activity against apple scab, but it is not as effective in this mode as the sterol inhibitors once were. However, Sovran reduces spore production from the lesions that are present when the fungicide is applied. Sovran provides good control of powdery mildew, but it is only moderately effective against cedar apple rust and weak against quince rust. Sovran provides excellent control of sooty blotch and flyspeck. Sovran provides good to very good control of black rot and fair control of bitter rot.

Caution: Sovran causes moderate to severe phytotoxicity (leaf burning) on several sweet cherry varieties. The most sensitive varieties are: Somerset, Sweetheart, Valera, Van, and Vandalay; these varieties might also be injured by spray drift containing Sovran. Minor to moderate injury occurs on Cavalier, Coral Champagne, Emperor Francis, Royalton, Schmidt, Summit, and Viva; there is less danger of injury due to spray drift on these varieties. Many other sweet and sour cherry varieties (including Bing, Brooks, Cashmere, Gold, Hardy Giant, Hart-land, Hedelfingen, Hudson, Kristin, Lapins, Lambert, Montmorency, Napoleon, Nelson Black Sweet, Rainier, Royal Ann, Sam, Stark Crimson, Stella, Sue, Tehranivee, Tulare, Ulster, Vega, Vic, Viscount, and Windsor) showed no injury when sprayed directly with high labeled rates. The Sovran manufacturer recommends: (i) Do not apply Sovran near or allow drift onto cherries in the highly sensitive group (Somerset, etc.); and (ii) thoroughly rinse spray equipment (tanks, hoses, nozzles) after spraying Sovran and before using this equipment on sensitive cherry varieties.

Mancozeb (Dithane, Manzate, Penncozeb) is formulated for use on apples and pears as a 4 lb/gal liquid, a 75% active dry flowable and as an 80% active wettable powder. It is a broad spectrum protectant fungicide with good residual properties, providing excellent control of apple and pear scab, rust diseases, summer diseases (sooty blotch, fly speck, and bitter rot), and Fabraea leaf spot. Label changes allow low-rate uses up to 77 days before harvest, whereas high rate applications are not allowed after bloom.

Maneb (Maneb) is a broad-spectrum protectant with activity against apple scab, rusts, flyspeck and sooty blotch. The registrant has requested EPA to remove apple uses beginning in 2008. Unless apples are on the label of a specific container of the fungicide, that container should not be used on apples. The label recommends two treatment schedules and they are not to be combined or integrated. The pre-bloom schedule allows applications to begin at green tip and continue through bloom. The extended application or tank-mix schedule allows applications to begin at green tip and continue through the second cover spray or until 77 days before harvest.

Mefanoxam (Ridomil Gold) is a systemic fungicide highly specific in its activity against a particular group of fungi. Important tree-fruit crop diseases caused by these fungi are limited to root and crown rots caused by species of *Pythium* and *Phytophthora*.

The 4EC formulation of Ridomil Gold is labeled for use on bearing apple and stone fruit trees for the control of Phytophthora root and crown rots (collar rot). Although Ridomil is highly effective for preventing crown rot infections, it is usually ineffective for curing trees that are declining from this disease.

Metaconazole (Quash) is a sterol-inhibiting fungicide formulated as an 50% water dispersable granule labeled

for use on stone fruit, primarily for brown rot and peach scab. There are limits on the number of applications and the amount of material that may be used in a year. It has a 14-day preharvest interval.

Metiram (Polyram) is formulated as an 80% active dry flowable labeled for use on apples but not pears. It is an ethylenebisdithiocarbamate (EBDC) fungicide similar to mancozeb in chemistry and activity. Use limits are similar to those for mancozeb.

Myclobutanil (Rally; previously sold as Nova) is a member of the triazole group of sterol inhibitor (SI) fungicides. It is very active against powdery mildew, cedar apple rust, and scab on apples. Like the other sterol inhibitors, Rally is particularly active against apple scab in the kickback and presymptom modes. Fruit scab control is usually improved by tank-mixing with a contact fungicide (captan, mancozeb). It is also registered and very effective for control of brown rot blossom blight and powdery mildew on some stone fruits (cherries, peaches, and nectarines), and for control of cherry leaf spot. It is neither registered nor effective for control of fruit brown rot.

Warning: Rally is no longer effective against apple scab in a number of orchards where the pathogen has developed resistance to the SI fungicide group. Rally may also fail to control leaf spot on cherries where that pathogen has become resistant to SI fungicides.

Propiconazole (Orbit) is a sterol inhibitor fungicide labeled for control of brown rot on apricots, cherries, nectarines, peaches, and plums. (See label warning about late-season use on Stanley plums.) It is also labeled for cherry leaf spot. Orbit has a 0-day PHI and a 24-hour restricted-entry interval for worker protection.

Warning: Orbit may fail to control disease where the pathogen populations have become resistant to SI fungicides.

Pyraclostrobin + Boscolid (Pristine) is a new fungicide that is registered for use on both pome fruits and stone fruits. Pyraclostrobin is in the strobilurin fungicide group with activity similar to that of Flint and Sovran, whereas boscolid is a carboximide fungicide with good activity against *Botrytis* diseases and brown rot. Pristine controls a broad range of diseases including brown rot, peach scab, powdery mildew, cherry leaf spot, black rot, white rot, bitter rot, fly speck, sooty blotch, and fruit decays caused by *Botrytis* and *Penicillium.* It may be applied up to 5 times per season on stone fruits and 4 times per season on pome fruits. It has a 0-day PHI. Pristine may prove useful for managing SI fungicide resistance in brown rot and cherry leaf spot if used in alternations with SI fungicides. Pristine provides excellent control of summer diseases on apples. Note that the label prohibits rates of less than 14.5 oz/A on pome fruits.

Pyrimethanil (Penbotec, Scala) is a new anilinopyrimidine fungicide (same class as Vangard) that is registered as Penbotec for postharvest use on pome fruits and as Scala for control of scab on pome fruits and brown rot blossom blight, scab, and shot hole on all stone fruits except cherries. Penbotec is very effective for controlling postharvest decays caused by *Penicillium expansum* and *Botrytis cinerea*. It can be applied as a dip or drench, as line spray, or mixed in fruit waxes. Scala has activity similar to that of Vangard (cyprodinil): it is most effective under cool conditions and has up to 48 to 72 hr of postinfection activity against apple scab. In trials it has provided scab control similar to mancozeb when used in a protectant timing, but it was superior to mancozeb in a trial where short-term postinfection activity (<72 hr) was crucial. However, activity may be reduced in orchards with apple scab that is resistant to the SI fungicide group.

Quinoxyfen (Quintec) is a fungicide which is limited to cherries for control of powdery mildew. It is a unique class of fungicide, a quinoline.

§Sulfur. The most commonly used and acceptable form of sulfur is the wettable form. Wettable sulfurs are finely divided elemental sulfur particles with a wetting agent added so that the sulfur can be mixed with water and remain in suspension while being applied. The wettable sulfurs are most readily available as dry, wettable powder containing 95% sulfur, and as fused bentonite sulfur containing 30% or 81% sulfur, depending on the brand used. Against apple scab, the sulfur products are effective in a protective schedule only.

Dry wettable sulfur is used at a rate of 5 lb AI/100 gal in early-season sprays in a protective program. It can be used through bloom without substantially reducing set. Fruit russeting and reduction in yield may result if it is used under high-temperature conditions such as those that occur during postbloom sprays.

Sulfur is effective against powdery mildew of apple when used at 2 to 3 lb AI/100 gal. It is also somewhat effective against cherry mildew. Sulfur is used on stone fruits to control brown rot, but is not as effective as captan or the newer brown rot fungicides. It is moderately effective against cherry leaf spot, but not effective against Rhizopus rot.

Flowable sulfur products are also available. They have the advantage over wettable sulfur in that they are effective at lower rates and have better retention capabilities.

Tebuconazole (Elite, Tebuzol) is a sterol-inhibitor fungicide that is registered for and provides excellent control of brown rot on cherry, peach, and nectarine, especially when used at the higher label rates. It also provides control of leaf spot and powdery mildew of

cherry. It has a 0-day preharvest interval on these crops and a 12-hour reentry interval.

Warning: Elite may fail to control disease where the pathogen populations have become resistant to SI fungicides.

Tebuconazole + Trifloxystrobin (Adament) is a fungicide mix of a sterol-inhibitor and a strobilurin for management of stone fruit diseases, primarily brown rot and peach scab. Adament has a 1-day preharvest interval, and a 24-hour reentry interval. See the label for limits on annual use.

Thiabendazole (Mertect 340-F, Shield-Brite TBZ) is registered as a flowable formulation for control of storage rots of apples and pears. Thiabendazole (TBZ) is active against *Penicillium* and *Botrytis* (blue mold and gray mold), but will not control rots caused by Alternaria and Rhizopus. Dip, drench, or spray the harvested fruit with a suspension of 16 fl oz of the flowable formulation in 100 gal of water. TBZ is compatible with DPA, but not with ethoxyquin. Strains of fungi resistant to TBZ are present in most apple storages and may compromise the performance of this fungicide. Combinations with captan can improve activity against TBZ-resistant strains of *Penicillium*.

Thiophanate-Methyl (Topsin M, Thiophanate-Methyl, T-methyl) is formulated as a 70% or 85% wettable and a 4.5-lb/gal flowable and is registered for control of diseases of stone fruits, apples, and pears. The 4.5F formulation is not registered on pears. Thiophanate-methyl is a benzimidazole fungicide in the same chemical group as benomyl and thiabendazole. Many fruit pathogens have developed resistance to benzimidazole fungicides, but Topsin M is still effective for controlling flyspeck, sooty blotch, black rot, and white rot on apples in most orchards. Do not tank mix thiophanate-methyl with copper-containing materials or with highly alkaline pesticides such as Bordeaux mixture or lime sulfur. The maximum annual use-rates listed on the labels limit the number of applications that can be used to control summer diseases on apples.

Thiram (Thiram Granuflo) is a contact carbamate fungicide in the same chemical family as ferbam and ziram, but it is not an EBDC fungicide. Thiram Granuflo is no longer labeled for use on apples. It is a moderately effective fungicide for brown rot, peach leaf curl, and peach scab, but is weaker than captan. Thiram is sometimes used for its activity as a deer and rabbit repellent.

Triadimefon (Bayleton, Triadimefon) is formulated as a 50% dry flowable. This material is effective against apple (but not cherry) powdery mildew and apple rust diseases. It has little activity against scab or other apple diseases.

Trifloxystrobin (Flint, Gem) is a strobilurin fungicide. Gem is registered on stone fruit, but not apples. Like Sovran, Flint is an excellent protectant against apple scab and should be used in this manner. Flint provides good control of apple scab and powdery mildew but is only moderately effective against cedar apple rust and is weak against quince rust. Flint also provides excellent control of sooty blotch and flyspeck, good to very good to control of black rot, and fair control of bitter rot. Flint and Gem are registered for control of cherry leaf spot, scab, and mildew on stone fruits.

Triflumizole (Procure) is a sterol inhibitor fungicide with activities, strengths, and weaknesses similar to those of Rubigan and Nova/Rally. Procure provides very good to excellent control of apple scab, powdery mildew and cedar apple rust. It is labeled for control of scab and mildew on pears and for brown rot, mildew, and leaf spot control on sweet and tart cherries.

Warning: Procure is no longer effective against apple scab in a number of orchards because the pathogen has developed resistance to the SI fungicide group. Procure may not control other diseases where the pathogen has become resistant to SIs.

Ziram (Ziram, Ziram Granuflo) is a contact carbamate fungicide in the same chemical family as ferbam and thiram, but it is not an EBDC fungicide. It is used most effectively as a summer cover spray for apples, where it provides good control of sooty blotch and fly speck, but only marginal control of rots (black, white, and bitter). It is not as effective against scab as either captan or the EBDC fungicides, but will provide acceptable control of secondary scab under low to moderate pressure. It is compatible with oil. Ziram is also labeled for control of scab and Fabraea leaf spot on pears. It has a 14-day PHI on both crops, and a 48-hour restricted-entry interval.

5.3 Bactericides

§Streptomycin (Agrimycin, Firewall, Streptrol, Streptomycin) is a bactericide used for control of blister spot on 'Crispin' apples and fire blight of apples and pears. It is formulated as streptomycin sulfate in a 17% wettable powder. Streptomycin is commonly used during bloom at the rate of 1/2 lb/100 gal for fire blight control, but can be used at 1/4 lb/100 gal in combination with 1 pt of Regulaid/100 gal dilute spray. It can be applied to pears until 30 days before harvest and to apples until 50 days before harvest. However, summer sprays of streptomycin are NOT recommended, except following a hailstorm.

Tests of streptomycin applied during bloom at a constant amount in different volumes of water indicated that control of fire blight was reduced at concentrations in excess of 6X. Thus, concentration of streptomycin sprays greater than 6X is specifically not recommended.

Resistance to streptomycin is widespread among populations of the blister spot bacterium. Resistance is also widespread among populations of the fire blight bacterium in Pacific Coast and Midwest production districts, and has recently been detected in NY. Indiscriminate use of this material (e.g., summer sprays) will hasten the development of resistance.

§Oxytetracycline (Mycoshield, Flameout), another antibiotic, is registered for use on peaches and nectarines to control bacterial spot and is the best material available for this use. It is also registered for control of fire blight on apple (Mycoshield only) and pear, but is not as effective as streptomycin.

5.4 Other Materials

Apogee (Prohexadione calcium) is a plant growth regulator that reduces shoot growth. It acts by inhibiting the biosynthesis of gibberellin, the plant hormone that regulates cell elongation. Apogee will reduce the severity of fire blight shoot infection if applied 10–14 days in advance of infections. It is not active against blossom blight and does not provide protection against rootstock infection. Apogee does not have direct antibiotic activity against the fire blight bacteria, rather it decreases host susceptibility. For maximum reduction in fire blight susceptibility, Apogee should be applied early in the growing season (when shoots are 1 to 3 inches long) and reapplied 14–21 days later to prevent vigorous shoot growth. Do not tank mix Apogee with calcium sprays because calcium will reduce the effectiveness of Apogee. One pound of ammonium sulfate may be added for each pound of Apogee if the water source for spray applications contains high levels of calcium carbonate (hard water). Use a standard adjuvant/non-ionic surfactant.

Hydrogen Dioxide (StorOx, OxiDate) works like hydrogen peroxide and kills fungi and bacteria via surface contact with the organism. OxiDate is labeled for control of diseases in the field whereas StorOx is labeled for use as a surface disinfectant and as an antimicrobial for hydro coolers and water flumes. Hydrogen dioxide does not have residual activity, nor will it control fungi or bacteria that have already penetrated host tissue. Thus, it must be applied after pathogens have been deposited on plant surfaces but before they can initiate infections. Field applications to apples are not recommended because OxiDate can cause severe fruit russetting under certain conditions. Controlled inoculation trials indicate no significant effect of OxiDate on fire blight infection of apple.

Phosphorous Acid (Fosphite, Topaz Fungicide, Agri-Fos, Fungi-Phite) and Phosphites (Phostrol, ProPhyte) can be viewed as generic forms of Aliette and are labeled on tree fruits primarily for control of root and crown rot diseases caused by *Phytophthora* species. However, some products are also labeled for suppression of fire blight and/or blister spot. Trials suggests they do not provide reliable suppression of fire blight when applied during bloom, but they can be very useful as part of a program for controlling blister spot. Although these products are being tested for controlling other diseases of tree fruits, there is not yet sufficient data to support labels for other diseases. As with Aliette, using these products with or soon after copper fungicides can cause copper phytotoxicity.

§Serenade (*Bacillus subtilis*) is a biofungicide labeled for control of fire blight, apple scab and powdery mildew. Serenade is a wettable powder formulation of the bacterium *Bacillus subtilis*, a common soil resident. The bacterium acts by releasing cell contents during growth in order to eliminate or reduce competitors in its immediate environment. Serenade is relatively ineffective for controlling fungal diseases under the climatic conditions that exist in the Northeast. When used alone, Serenade provides only partial control of fire blight. In alternation with streptomycin, it sometimes provides control approaching that of a full streptomycin program. Serenade should be applied as a preventive and can be applied up to and including the day of harvest.

5.5 Insecticides

The insecticides and acaricides used to control fruit pests can be divided into several categories according to their chemical composition, mode of action, persistence, and other properties. To plan and carry out an effective spray program, it is important to understand these characteristics. A simplified classification of most of the insecticides and acaricides recommended in this bulletin is given, along with some of their general properties and uses.

Notes on Materials

The hazard of a material poisoning honey bees is given as follows: High = hazardous to bees at any time; 1 day to 2 wk residual toxicity. Moderate = not hazardous if applied in either evening or early morning when bees are not foraging, except during periods of high temperature; 3 hr to 1 day residual toxicity. Low = not hazardous to bees at any time; 1 hr to 1 day residual toxicity.

5.5.1 Organophosphates

Most organophosphate insecticides are highly toxic to warm-blooded animals when inhaled, swallowed, or absorbed through the skin. Persons handling or applying these materials should take every precaution for their own safety and for that of others. Although the organophosphates in general are less persistent than the chlorinated hydrocarbons, their toxicity often prohibits their use close to harvest (see following materials). Organophosphates are contact insecticides as well as stomach poisons. Therefore,

they are useful for a quick kill of all insect forms present at the time of application, as well as for reasonable residual protection. When used alone or in combination with other materials, some organophosphates cause phytotoxicity on fruit varieties. Check this bulletin under the pest, the crop, and the product for more details about this situation.

*Azinphos-Methyl (*Guthion) Labeled for apples, pears and cherries until September 30, 2012. Use rates vary depending on the year and crop so read label carefully. Pick-Your_Own harvesting is prohibited on pears and cherries. The reentry interval for Pick-Your-Own customers (and others not covered by the Worker Protection Standard) in apple blocks depends on the rate used (33-44 days, see label). There are also instructions regarding drift to occupied buildings and establishing buffer zones for water bodies. No phytotoxicity or fruit finish problems have been noted to date; it gives reasonably good finish on Golden Delicious. This material should not be used with lime. It provides broad-spectrum control with good residual effectiveness against major pests. Several minor pests have become resistant to this material, including rosy and green apple aphids,white apple leafhopper, obliquebanded leafroller, and spotted tentiform leafminer. The material has a high bee-poisoning hazard. **[Note: In 2009, the total amount of formulated product allowed per acre is 6 lbs for apples, 4 lbs for pears, and 3 lbs for cherries.]**

Formulation available and EPA registration number: *Guthion (Makhteshim Agan) 50WS: 66222-162.

Chlorpyrifos (*Lorsban) 4E formulation is registered for control of San Jose scale during the prebloom period on apples, pears, peaches, and plums. Application during this period will also control rosy apple aphid. This material can be used alone or in combination with oil. It is also registered for use on peaches and cherries to control peachtree borers and in apples as a postbloom trunk spray to control a variety of borers. The 50WS formulation is similarly restricted to prebloom use in apples plus postbloom trunk sprays against borers, so its potential targets correspond to those of the 4E formulation. A 75 WG (water dispersible granule) formulation is available for all tree fruits except apricots, and exhibits better efficacy, rainfastness, and fewer phytotoxicity problems than the 50W or 4E formulations. An amended registration extends the period of its use on apple through petal fall, which means that it can now be used as an alternative to other commonly used petal fall materials against such pests as plum curculio, European apple sawfly, codling moth, and oriental fruit moth, as well as some additional pests that might not be controlled by other OPs, including obliquebanded leafroller and rosy apple aphid. This label also lists trunk sprays for many borer species in apple. All three formulations can also be used in tart cherries to control borers, as well as other pests including leafrollers, plant bugs, and scales. The material has a high bee-poisoning hazard.

Formulations available and EPA registration numbers: *Lorsban (Dow AgroSciences) 4EC: 62719-220; Lorsban (Gowan) 50WS: 62719-221; Lorsban (Gowan) 75WG: 62719-301-10163.

*Diazinon has caused russeting or related finish problems on R.I. Greening, Golden Delicious, and Baldwin. No injury has been reported on McIntosh or closely related varieties. Observations on other varieties are limited. The material should not be used in combination with copper. It is used for control of San Jose scale and woolly apple aphid. It is generally less persistent than other standard phosphates and has a high bee-poisoning hazard.

Formulations available and EPA registration numbers: *Diazinon 50W (Makhteshim Agan): 66222-10; *Diazinon AG500 (Makhteshim Agan) 66222-9; *Diazinon AG600 WBC (Loveland) 66222-103-34704; *Diazinon Insecticide (Drexel) 4EC: 19713-91; *Prentox Diazinon (Prentiss) AG500: 655-459; *Prentox Diazinon (Prentiss) 50WP: 655-456.

Dimethoate is a broad-spectrum systemic material registered on pears that is still effective against certain organophosphate-resistant aphids and leafhoppers. It will also suppress tarnished plant bug when used prebloom. It has a high bee-poisoning hazard.

Formulations available and EPA registration numbers: Dimethoate 400 (Loveland): 34704-207; Dimate (Agriliance) 4EC: 51036-110-9779; Dimethoate (Drexel) 4EC: 19713-231; Dimethoate (Micro Flo) 4EC: 51036-110. **[Note: These products have been voluntarily withdrawn from use on apples. Pears are still a registered use.]**

Malathion is registered for use on apricots, peaches, nectarines and cherries for control of aphids.

Formulations available and EPA registration numbers: Malathion (Loveland) 57EC: 34704-108; Malathion (Drexel) 5EC: 19713-217; Prentox 5 lb. *Malathion Spray (Prentiss) 5EC: 655-777.

*Methidathion (*Supracide) is registered for dormant or delayed dormant use on apples, peaches, plums, apricots, and cherries for the control of San Jose scale and rosy apple aphid. It may be mixed with oil in these sprays. It has a high bee-poisoning hazard.

Formulations available and EPA registration numbers: *Supracide (Gowan) 25WP: 10163-244; *Supracide (Gowan) 2EC: 10163-236.

*Phosmet (*Imidan) is a broad-spectrum material with a lower toxicity to mammals than many other commonly used organophosphates. It is compatible with most commonly used insecticides and fungicides, but is incompatible with alkaline materials such as Bordeaux

mixture and lime. It may cause severe leaf injury to sweet cherries, particularly those of Emperor Francis parentage. It can be used in summer sprays in integrated mite-control programs because of its low toxicity to predator mites. In some seasons in which rainfall has been negligible during the late summer, the fruit occasionally shows a buildup of the carrier used in the wettable powder. Imidan is effective in controlling codling moth, apple maggot, redbanded leafroller, plum curculio, peach twig borer, and oriental fruit moth on apple, pear, peach, apricot, nectarine, and plums to be used for prunes. It has been ineffective against phosphate-resistant populations of pear psylla. It has a high bee-poisoning hazard. The user shall not authorize any person who is not covered by the Worker Protection Standard (WPS), such as members of the general public involved in "pick-your-own" or similar operations, to enter a treated area for 14 days after application.

Formulations available and EPA registration numbers: *Imidan (Gowan) 70WP, 70WS: 10163-169.

5.5.2 Carbamates

Carbamates are presently represented by 3 insecticides widely used on fruit trees.

*Carbaryl (Sevin) applications made within 30 days after petal fall have a pronounced thinning effect on most apple varieties. Sevin does not thin pears. It is a broad-spectrum material that acts as a stomach as well as contact poison and controls various fruit insects, including organophosphate-resistant pests such as white apple leafhopper. It is one of the low-hazard insecticides and can be used until 1 day before harvest on most fruit crops, as well as in home orchards. Sevin is very toxic to bees and, therefore, should not be used just before bloom; it is also toxic to certain predator mite species.

Formulations available and EPA registration numbers: Sevin (Bayer) 4F: 264-349; Sevin (Bayer) XLR Plus 4EC: 264-333; Sevin (Bayer) 80S: 264-316; *Sevin (Bayer) 80WS: 264-526; Carbaryl (Drexel) 4L: 19713-49.

*Methomyl (*Lannate) spray injury to foliage and fruit resulting in fruit drop has been observed on Early McIntosh-type varieties. This material is highly toxic to predator mites and, when used in a seasonal program, has promoted the buildup of woolly apple aphid. It has been registered for controlling organophosphate-resistant apple aphid, rosy apple aphid, leafrollers, tufted apple bud moth, lesser appleworm, white apple leafhopper, and tentiform leafminer, as well as codling moth. Although *methomyl has broad-spectrum activity, its short residual activity (5-7 days) makes it less effective against fruit feeders (such as plum curculio, apple maggot, or codling moth) than are organophosphate materials. *Lannate has a 96 hour reentry period for peaches, 72 hours for apples, and 48hours for pears. Not for use during any period after a commercial crop site is opened for public entry as a "U-Pick", "Pick Your Own" or similar operation; in no case shall preharvest applications be made after first public entry. It has a high bee-poisoning hazard.

Formulations available and EPA registration numbers: *Lannate (DuPont) 90SP: 352-342, *Lannate LV (2.4L): 352-384.

*Oxamyl (*Vydate) is a combination insecticide, nematicide, and acaricide with systemic properties, which translocates throughout the leaves and into the roots of fruit trees. It is formulated as a methanol-based liquid for foliar or drench treatment of newly planted trees, primarily for nematode control. It is recommended on bearing apple trees as a foliar spray for control of spotted tentiform leafminer, aphids, leafhoppers, and mites. It is a mite suppressant requiring back-to-back applications for effective control. When applied between petal fall and 30 days thereafter, thinning may occur. *Vydate is not a broad-spectrum insecticide, but is hard on mite predators. Not for use during any period after a commercial crop site is opened for public entry as a "U-Pick", "Pick Your Own" or similar operation; in no case shall preharvest applications be made after first public entry. It has a moderate bee-poisoning hazard.

Formulation available and EPA registration number: *Vydate (DuPont) 2L:352-372.

5.5.3 Pyrethroids

This group of insecticides has broad-spectrum activity and considerable efficacy at low dosage. These compounds are similar in terms of biological activity, residual effectiveness, toxicity, and effects on nontarget organisms. In addition to being directly toxic to insects, pyrethroids are also repellent. They are generally very persistent, and some are reportedly more effective at cooler temperatures. Although mammalian toxicity of most pyrethroids is relatively low, direct exposure can cause allergic reactions such as skin irritations and difficulty in breathing. Fish are highly sensitive to pyrethroid insecticides. Therefore, drift or runoff to bodies of water should be avoided when spraying. Pyrethroids can have undesirable effects on nontarget organisms in the orchard. Most pyrethroids, when used postbloom, have a temporary suppressive effect on spider mites, but populations often recover quickly, resulting in outbreaks. Predator mites are very sensitive to pyrethroid insecticides and are repelled for many weeks by the residue. Postbloom use of these compounds on apple or pear can also result in outbreaks of the woolly apple aphid on apple and Comstock mealybug on apple or pear. Currently, Cornell does not recommend multiple applications of pyrethroids in regular cover-spray programs on any fruit crop because of secondary pest problems and the increased likelihood of resistance development. However, pyrethroids are valuable for the control of special pest problems on fruit that are difficult to control with organophosphate or carbamate insecticides. To extend the field life of these compounds and delay development of

resistance, they should not be applied more than once or twice/season in an orchard.

*Bifenthrin (*Bifenture, *Brigade, *Fanfare) is labeled for use on pears. This is a relatively established pyrethroid in other crops, and was one of the first that demonstrated mite control in addition to the efficacy profile common to other members of this family. Besides European and twospotted spider mites, the label also includes aphids, codling moth, green fruitworm and leafrollers, leafhoppers, plant and stink bugs, and plum curculio. Pear psylla is not on the label. This material has a high bee poisoning hazard.

Formulations available and EPA registration numbers: *Bifenture (UniPhos) 2EC: 70506-57; *Brigade (FMC) 10WS: 279-3108; *Fanfare (Makhteshim Agan) 2EC: 66222-99.

*Cyfluthrin (*Baythroid) is a synthetic pyrethroid has activity on a broad range of the major insect pest species in tree fruit crops, including leafhoppers, internal Lepidoptera, leafrollers, plum curculio, apple maggot, sawflies, true bugs, San Jose scale crawlers, American plum borer, black cherry aphid, and cherry fruit fly. There are actually two formulations, one (*Baythroid XL) whose a.i. is the beta-isomer, which is twice as effective and therefore has (a.i.) use rates half those of the "regular" cyfluthrin. It has a high bee poisoning hazard.

Fomulations available and EPA registration numbers: *Baythroid 2 (Bayer) 2EC: 264-745; *Baythroid XL (Bayer) 1L: 264-840.

*Cyfluthrin/Imidacloprid (*Leverage) is labeled against a wide range of pests of pome fruit and stone fruit. It is a combined formulation of imidacloprid, the a.i. found in Provado, plus the pyrethroid cyfluthrin, the a.i. in Baythroid. The pome fruit label includes internal worms and leafrollers, aphids (except wooly appe aphid), apple maggot (combined with a sticker), sawfly, plum curculio, San Jose scale crawlers and plant bugs. The stone fruit label adds Japanese beetle, American plum borer, and cherry fruit fly, among others. This product may not be applied prebloom. It has a high bee poisoning hazard.

Formulation available and EPA registration number: Leverage 2.7 (Bayer): 264-770.

*Deltamethrin (*Battalion, *Decis) is a pyrethroid registered for use on pome fruits for a broad spectrum of insect pests. It is likely to be harsh on mite predators as are other pyrethroid insecticides.

Formulations available and EPA registration numbers: *Battalion (Arysta) 0.2EC: 264-1007-66330; *Decis (Bayer) 0.2EC:264-1007; *Decis (Bayer) 1.5EC:34147-12-264.

*Esfenvalerate (*Asana XL). *Asana XL is a purified ester of fenvalerate with generally better activity, which is reflected in its low labeled usage rates. *Asana XL is registered for control of apple, pear, and stone fruit pests. It is particularly useful for prebloom insect control on apple and against pear psylla; however, tolerance or resistance to *fenvalerate has been documented in some pear psylla populations. It has a high bee-poisoning hazard.

Formulation available and EPA registration number: *Asana XL (DuPont) 0.66EC: 352-515.

*Fenpropathrin (*Danitol) is labeled for control of insect pests of apples and pears, including leafminers, leafhoppers, leafrollers, tarnished plant bug, aphids, plum curculio, internal leps, and apple maggot, with activity also against European red mite. It has a high bee poisoining hazard.

Formulation available and EPA registration number: *Danitol (Valent) 2.4EC: 59639-35.

*Gamma-Cyhalothrin (*Proaxis) is identical to *lambda-cyhalothrin, below, in that they both contain the same a.i., but, whereas *Warrior is a mixture of both the active and inactive isomer, *Proaxis contains only the active (“resolved”) isomer. It is formulated as a 0.5 lb a.i./gal capsule suspension, but because 1 gal of *Warrior contains the same amount of active isomer as 1 gal of *Proaxis, the labeled uses, rates, and restrictions of the two products are identical. It has a high bee-poisoning hazard.

Formulation available and EPA registration number: *Proaxis (Loveland) 0.5CS: 74921-3-34704.

*Lambda-Cyhalothrin (*Lambda-Cy, *Warrior) is labeled for control of insect pests of all tree fruits, including leafrollers, codling moth, oriental fruit moth, lesser appleworm, green fruitworm, leafminers, apple maggot, cherry fruit flies, plum curculio, plant bugs, leafhoppers, aphids, pear psylla, peachtree borers, American plum borer, Japanese beetle and San Jose scale. It has a high bee poisoning hazard.

Formulation available and EPA registration number: *Lambda-Cy (UniPhos) 1EC: 70506-121; *Warrior (Syngenta) 1CS: 100-1112; 2.08CS:100-1295.

*Permethrin (*Ambush, *Perm-Up, *Pounce) is labeled for control of insect pests of cherries, pears, and peaches. On apples, use is restricted to prebloom and petal fall applications. Its recommended use is similar to that of *esfenvalerate. It has a high bee-poisoning hazard.

Formulations available and EPA registration numbers: *Ambush (Amvac) 25WP: 5481-502; Ambush (Amvac) 2E 5481-549; *Perm-Up (UniPhos) 3.2EC: 70506-9; *Pounce (FMC) 3.2EC: 279-3014; *Pounce 25WP: 279-3051; *Pounce WS: 279-3083.

Zeta-cypermethrin (Mustang Max) is registered for the control of numerous insect species on pome and stone fruits. It is likely to be harsh on mite predators as are other pyrethroid insecticides.

Formulation available and EPA registration number: Mustang Max (FMC) 0.8EC: 279-3249.

5.5.4 Other Materials

*Abamectin (*Agri-Mek) is a natural fermentation product containing a macrocyclic glycoside, used on apples and pears as an acaricide/insecticide. When used as currently recommended, it controls European red mite and pear psylla, and aids in the control of spotted tentiform leafminer. Abamectin is toxic to bees and predator mites on contact, but the foliar residue dissipates quickly, making it essentially non-toxic to these species after a few hours (low bee-poisoning hazard).

Formulation available and EPA registration number: *Agri-Mek (Syngenta) 0.15EC: 100-898; *Abba (Makhteshim Agan) 0.15EC:66222-139; *Temprano (Chemtura) 0.15EC:67760-71-400.

Acetamiprid (Assail) belongs to the neonicotinoid group of insecticides (along with *Provado and Actara). It was registered by the US EPA under the reduced risk pesticide policy and is considered a replacement for older OP insecticides. Assail has a spectrum of effectiveness across several insect groups, and is active against pests such as plum curculio, apple maggot, internal leps, aphids, leafhoppers, leafminers, San Jose scale, European apple sawfly and mullein plant bug, plus pear pests such as pear psylla and Comstock mealybug. It has low toxicity to honey bees and most beneficial insects, although some flaring of mites has been reported by researchers.

Formulation available and EPA registration number: Assail (UniPhos) 30SG:8033-36-4581.

§Azadirachtin (Aza-Direct, Azatin XL) is derived from the seeds of the neem tree, Azadirachta indica, which is widely distributed throughout Asia and Africa. Azadirachtin has been shown to have repellent, antifeedent, or growth regulating insecticidal activity against a large number of insect species and some mites. It has also been reported to act as a repellent to nematodes. Neem extracts have also been used in medicines, soap, toothpaste and cosmetics. It shows some activity against leafminers, leafhoppers, mealybugs, aphids, caterpillars, tarnished plant bug and pear psylla, but repeated applications at short intervals are probably necessary for acceptable control of most pests. Azadirachtin is relatively short-lived and mammalian toxicity is low (rat oral LD50 >10,000). It can be used up to and including the day of harvest and reentry is permitted without protective clothing after the spray has dried. It is relatively nontoxic to beneficials, but toxic to fish, aquatic invertebrates, and bees exposed to direct treatment, although relatively non-toxic when dried. It is therefore categorized as having a moderate bee poisoning hazard.

Formulations available and EPA registration numbers: Aza-Direct (Gowan) 1.2L: 71908-1-10163; Azatin XL (Certis,OHP) 3L: 70051-27-59807

§Bacillus Thuringiensis (Bt, Dipel, Deliver, Biobit, Javelin, Agree) is a microbial insecticide specific for the control of caterpillars. It contains spores and crystalline endotoxin that must be ingested by larvae with high gut pH to provide control. It is effective against many fruit pests, including leafrollers and fruitworms. Although this material will control codling moth and other internal lepidopteran apple pests, it does not provide as effective control as do most conventional insecticides. One exception is the obliquebanded leafroller, which has become so difficult to control with conventional toxicants that the Bt products work at least as well as any material available. This material is exempt from requirements for a tolerance on all raw agricultural commodities, thus it can be sprayed up until harvest. It is harmless to humans, animals, and beneficial insects, including the honey bee.

Formulations available and EPA registration numbers: §Agree WG (Certis) 3.8WS: 70051-47; Biobit HP (Valent BioSciences) 2.1FC: 73049-54; Deliver (Certis) 18WG: 70051 - 69; DiPel (Valent BioSciences) 10.3DF73049-39; Javelin (Certis) 7.5WDG:70051-66.

Buprofezin (Centaur) is an Insect Growth Regulator (IGR) labeled for use on apples, pears, and peaches for control of scale insects, mealybugs, leafhoppers and pear psylla. It is effective against the nymph stages by inhibiting chitin biosynthesis. It also suppresses oviposition of adults and reduces viability of eggs. Centaur is restricted to one application per year on apples; two applications per year on pears and peaches.

Formulations available and EPA registration numbers: Centaur (Nichino America) WDG:71711-21; Cerntaur (Nichino America) WSB:71711-15.

Clothianidin (Clutch) is in the neonicotinoid class of insecticides and is registered for use on apples and pears. The target pests include aphids, leafhoppers, plum curculio, apple maggot, leafminers, codling moth, oriental fruit moth and pear psylla. Do not apply more than 6.4 oz. of Clutch 50 WDG (0.2 lb. active ingredient) per acre per season.

Formulations available and EPA registration numbers: Clutch (Arysta) 50WDG:66330-40; Clutch (Valent) 50WDG: 59639-152.

§Codling Moth Granulosis Virus (Carpovirusine, Cyd-X) These products contain an insecticidal baculovirus, *Cydia pomonella* granulovirus, which is specific to the larval form of the codling moth, and is

registered for use in apples, pears, and (Cyd-X only) plums. This biological insecticide must be ingested in order to be effective, after which the viral occlusion bodies dissolve in the larval midgut and release infectious virions. These enter the cells lining the digestive tract, where they replicate; eventually, the other tissues are infected and the larva stops feeding and eventually (within 3–7 days) dies. After death, the larva disintegrates, releasing billions of new occlusion bodies, which may infect other codling moth larvae upon ingestion. No adverse effect to fish, wildlife or beneficial organisms has been observed; it has a low bee-poisoning hazard.

Formulations available and EPA registration numbers: Carpovirusine (Arysta LifeScience) 0.99SC: 66330-55; Cyd-X (Certis) 0.06SC: 70051-44.

*Emamectin benzoate (*Proclaim) is registered for use on pome fruits. This restricted-use material is a soluble granule formulation of emamectin benzoate, which is a second-generation avermectin insecticide related to *Agri-Mek. The primary target pests are leafrollers, leafminers, and fruitworms; however, the label also lists suppression of codling moth, oriental fruit moth, lesser appleworm, pear psylla, and spider mites (European red mite and twospotted spider mite). *Proclaim is translaminar, being absorbed quickly into the leaf tissue, and forming a reservoir of a.i. against plant-feeding pests. Although it is most effective when ingested, limited contact activity does exist for a short period after application. Addition of a penetrating adjuvant such as horticultural mineral oil or a nonionic surfactant is recommended. It has a high bee poisoning hazard.

Fomulation available and EPA registration number: *Proclaim (Syngenta) 5SG: 100-904.

*Endosulfan (Thionex) is a long-residual period chlorinated hydrocarbon registered for use on peaches, pears, apples, plums, cherries, and other fruit crops. Used as a preplant as well as seasonal treatment on stone fruits for control of peachtree borers, it is also effective against aphids, white apple leafhopper, adult leafminers, green fruitworms, cutworms, and, in some areas, tarnished plant bug. This material is useful in integrated mite control programs because of its low toxicity to predator mites. It is highly toxic to fish and should not be used near any body of water. Because of its long residual effectiveness, the days-to-harvest intervals are longer and the number of applications/ season more restricted than for other materials. No phytotoxic or fruit finish problems have been observed with either the EC or WP formulations. *Thiodan has a moderate bee-poisoning hazard.

Formulations available and EPA registration numbers: Endosulfan (Drexel) 50WP: 51036-91; *Thionex (Makhteshim-Agan) 3EC: 66222-63; *Thionex (Makhteshim-Agan) 50WP: 66222-62.

§Extract of Neem Oil (§Trilogy) is a product derived as a clarified extract of Neem oil. Trilogy is labeled for a wide range of pest control or suppression uses, including use as a fungicide, insecticide, and miticide. Specific uses have not been well-studied for every labeled pest; rates suggested on the label also vary widely. Neem oils have been found to suppress European apple sawfly and may deter feeding or egglaying of other insect pests. Research on its use as a scab fungicide have shown that it is ineffective as a stand-alone material. Because Trilogy is an oil-based material cautions against mixing with other pesticides incompatible with oil, such as sulfur and captan, should be followed. Trilogy applications have been found to form a persistent film on fruit and foliage that may make removal of residues such as kaolin difficult at harvest or packout. This product is toxic to bees if exposed to direct treatment and is hazardous to fish and aquatic invertebrates.

Formulation available and EPA registration number: §Trilogy (Certis) 70051-2).

Flonicamid (Beleaf) is labeled for aphids and plant bugs for pome fruit and stone fruit. The label classifies it as a member of the pyridinecarboxamide family, an IRAC section 9C material, which is defined as "Unknown or non-specific mode of action- selective feeding blockers". Researchers have reported good efficacy against green peach aphid and tarnished plant bug in peaches. The label also lists apple aphid, black cherry aphid, rosy apple aphid, spirea aphid, and woolly apple aphid. It has a low bee poisoning hazard.

Formulation available and EPA registration number: Beleaf (FMC) 50SG:71512-10-279.

*Imidacloprid (*Provado) is a broad spectrum contact and locally systemic chloronicotinyl insecticide with low mammalian toxicity. It is primarily effective against aphids, whiteflies, thrips, scales (crawlers), pyslla, leafhoppers, mealybugs, some beetle and weevil species, and leafminers. The flowable formulation is labeled on apples for aphids (except woolly apple aphid), leaf-miners, leafhoppers and San Jose scale and on pears for aphids, pear psylla, mealybug, and San Jose scale. It has also shown activity against pear midge when applied at petal fall. This material has no effect on any mites, beneficial or phytophagous, but is hard on Stethorus. High bee-poisoning hazard, exhibiting toxicity on contact plus repellency and hive disorientation. Compatibility note: may be mixed with other pesticides, although a preliminary test of compatibility with candidate materials is recommended. When preparing tank mixtures, add wettable powders first, then *Provado and other flowables, and emulsifiable concentrates last.

Formulation available and EPA registration number: *Provado (Bayer) 1.6F: 264-763.

Indoxacarb (Avaunt) is a broad-spectrum oxadiazene labeled in apples and pears against plum curculio, apple maggot, and European apple sawfly, with some activity also on Lepidoptera such as codling moth, oriental fruit moth and leafminers, as well as leafhoppers. It is also labeled in stone fruit for plum curculio and Oriental fruit moth (suppression only). The active ingredient is activated by the insect to an insecticidal form only upon ingestion or absorption through the cuticle, after which it causes paralysis by interference with the sodium flow into nerve cells. It has generally slight to no effects on beneficial insects and mites, but is highly toxic to bees exposed to direct treatment and relatively non-toxic when dried. It is therefore categorized as having a moderate bee poisoning hazard.

Formulation available and EPA registration number: Avaunt (DuPont) 30WDG: 352-597.

§Insecticidal soaps (M-Pede) are concentrates made from biodegradable fatty acids and are contact insecticides that can be effective against such soft-bodied arthropods as aphids, mealybugs, and psyllids. They can provide suppression of pear psylla when used in a seasonal spray program, but the residual period is short, and uniform drying conditions are required to prevent droplet residues on the fruit surface. They have a low bee-poisoning hazard.

Formulation available and EPA registration number: M-Pede (Dow) 49L: 62719-515.

§Kaolin (Surround) is a naturally occurring clay mineral that has many uses as a direct and indirect food additive, in food contact items, cosmetics and toiletries, and as an inert ingredient in many pesticide formulations. When applied, the 95WP crop protectant forms a white, mineral-based particle film intended to reduce the damage to plants caused by certain arthropod and disease pests, as well as environmental stress caused by solar effects. In research trials in apples, it has shown some preventive efficacy against plum curculio, internal Lepidoptera such as codling moth and oriental fruit moth, leafrollers, phytophagous mites, leafhoppers, and apple maggot. In pears, it can additionally suppress pear psylla, and in stone fruits it reduces feeding damage from Japanese beetle. Frequent applications (7–10-day intervals) and maximal coverage are advised while there is active foliar growth. Surround has a low bee-poisioning hazard.

Formulation available and EPA registration number: Surround (BASF) 95WP: 70060-14.

*Methoxyfenozide (*Intrepid) is the more-active successor to Confirm (tebufenozide); it imitates the natural insect molting hormone, and works by initiating the molting process within a few hours of ingestion. The premature molt makes it impossible for the larva to complete the shedding of the original exoskeleton. The larva is trapped within the old cuticle and death occurs, usually within 2–5 days, due to starvation and dehydration. *Intrepid is labeled for use in apples. pears, and stone fruit against leafrollers, fruitworms, oriental fruit moth, codling moth and lesser appleworm. *Intrepid is essentially safe to birds, fish, and most beneficials; however, it is toxic to aquatic invertebrates. It has a low bee-poisoning hazard.

Formulation available and EPA registration number: *Intrepid (Dow AgroSciences) 2F: 62719-442.

Novaluron (Rimon) is registered for use on apples. It is an insect growth regulator that interferes with the insect's ability to form chitin, thus disrupting the molting process. Therefore, it is effective only against the immature stages of insects and will not kill adults. Route of insect entry is primarily through ingestion, with some contact activity. See label for the best timing of application for codling moth, Oriental fruit moth and leafrollers.

Formulation available and EPA registration number: Rimon (Chemtura) 0.83EC:66222-35-400.

§Pheromones for mating disruption. Synthetic pheromones are available for disrupting the chemical communication of certain insect pests, thereby preventing them from mating and producing larvae that injure the crop. Pest-specific pheromones are released from dispensers or microcapsules placed or sprayed in the orchard before the initiation of flight, and can reduce or in some cases eliminate the need for supplementary insecticidal sprays. This approach works best in large (5-10A or more), rectangular plantings, where the pheromone concentration in the air is more uniform and can be maintained at a high level. Border insecticide sprays may be needed in orchards adjacent to sources of adult immigration or in other high pressure situations.

Formulations available and EPA registration numbers: For oriental fruit moth - Checkmate OFMF (Suterra): 56336-24; Isomate-M 100 (CBC): 53575-19. For peachtree borers - Isomate-LPTB (CBC): 53575-23. For obliquebanded leafroller – Isomate OBLR/PLR Plus (CBC): 53575-24. For codling moth – Isomate-C TT (CBC): 53575-25; Checkmate CM-F (Suterra):56336-37. For codling moth *plus* oriental fruit moth – Checkmate CM-OFM Duel (Suterra):56336-49; Isomate CM/OFM TT (CBC):53575-30.

§Pyrethrin or Pyrethrum (PyGanic, Pyrenone) is produced in the flowers of *Chrysanthemum cinerariaefolium* and is the forerunner of the synthetic pyrethroid insecticides. It is available as an emulsifiable concentrate, (PyGanic), or synergized by piperonyl butoxide (Pyrenone). Pyrethrin is labelled against a large number of pests. It may be moderately to highly effective against leafhoppers, aphids, pear psylla, apple maggot, codling moth, true bugs, caterpillars, mealy-bugs, plum curculio, and thrips. It is quickly broken down in the environment and may be used up to and

including the day of harvest. Pyrethrin is relatively non-toxic to humans and other mammals, although the dust produces allergy attacks in people who are allergic to ragweed pollen. The acute oral LD50 is 1200 to 1500 mg/kg. It is toxic to fish, and has a low bee-poisoning hazard.

Formulations available and EPA registration numbers: PyGanic (McLaughlin Gormley King) 1.4EC: 1021-1771; Pyrenone (Bayer) 6L: 432-1033.

Pyriproxyfen (Esteem), which is registered for use in apples and pears, is a juvenile hormone analog (a type of insect growth regulator) that interferes with the insect's normal metamorphosis and kills by retarding its growth and causing sterility; ovicidal activity is also exhibited. It shows translaminar properties, so applications on the top surface of the leaf will affect insects on the bottom surface. Although leafrollers and codling moth appear on the label, results from preliminary field trials in the region suggest that it has greatest efficacy on San Jose scale, pear psylla, leafminers and aphids. It has low toxicity or is non-toxic to most beneficial species, and has a low bee poisoning hazard.

Formulation available and EPA registration number: Esteem (Valent BioSciences) 35WP:59639-115.

Spinetoram (Delegate) is a new spinosyn insecticide related to spinosad (below), but which has been chemically modified to be more active and effective against a broader range of insects. It has efficacy against internal feeding Lepidoptera such as codling moth and oriental fruit moth, plus leafrollers and leafminers. It is also labeled for control of pear psylla, thrips, and cherry fruit fly, and shows suppression of apple maggot and plum curculio. Like spinosad, it acts by disrupting insect nerve function. It is nontoxic to birds, fish, aquatic invertebrates, and most beneficial arthropods. It has a low bee-poisoning hazard.

Formulation available and EPA registration number: Delegate (Dow AgroSciences) 25WG:62719-541.

§Spinosad (SpinTor, §Entrust, §GF-120) is a mixture of spinosyn A and spinosyn D molecules, a naturally derived group of toxicants from a species of Actinomycete bacteria. Spinosad, which acts as both a contact and a stomach poison, is available for use in apples, pears and stone fruits, primarily against lepidopteran species such as obliquebanded leafroller,codling moth, oriental fruit moth, and light apple and brown tufted budmoths although suppression of apple maggot is also exhibited. GF-120 is a specially formulated spinosad product mixed with a feeding attractant targeted specifically against apple maggot. GF-120 is applied differently than most pesticides as a low volume coarse spray at total spray volumes of 25-120 fluid ounces of spray mix per acre; applicators should refer to manufacturer labeling for specific information. Spinosad is essentially nontoxic to birdsand fish, but exhibits toxicity to aquatic invertebrates and some beneficials. This product is toxic to bees exposed within three hours of application.

Formulations available and EPA registration numbers: §Entrust (Dow AgroSciences) 80WP: 62719-282;GF-120 (Dow AgroSciences) NF: 62719-498 SpinTor (Dow AgroSciences) 2SC: 62719-294.

Thiacloprid (*Calypso) is a neo-nicotinoid registered for use on apple, pear and quince, exhibiting both systemic activity and crop safety. Its mode of action is through interference with the nicotinergic acetylchloline receptor, and it controls pests by both contact and stomach activities. *Calypso has activity on apples against aphids (except woolly apple aphid), leafminers, leafhoppers, mirid bugs, codling moth, oriental fruit moth, plum curculio, apple maggot, and European apple sawfly. It will also suppress scale insects (crawler stage). On pears, it is active against pear psylla, aphids, codling moth, mealybugs, leafminers, and the pear midge. It will also suppress scale insects on pears. *Calypso has a low acute toxicity to warm-blooded animals and a low bee poisoning hazard; however, it is highly toxic to marine/estuarine invertebrates.

Fomulation available and EPA registration number: *Calypso (Bayer) 4F: 264-806.

Thiamethoxam (Actara) is a broad-spectrum neonicotinoid material labeled for use in apples and pears against a number of chewing and sucking pests. It moves rapidly into plant mesophyll tissues, where it is locally systemic and protected from rapid degradation. It shows activity against plum curculio, aphids, European apple sawfly, leafhoppers, mealybugs, and pear psylla. Although it has little effect on predatory mites or beneficial insects, it is toxic to fish and aquatic invertebrates, and highly toxic to bees exposed to direct treatment, although relatively non-toxic when dried. It is therefore categorized as having a moderate bee poisoning hazard.

Formulation available and EPA registration number: Actara (Syngenta) 25WDG: 100-938.

5.6 Acaricides

Of the 5 species of mites found on fruit trees in New England, only the European red mite and the twospotted spider mite are abundant and widely enough distributed to be major problems.

Mites are not insects, and because they are not affected by most insecticides, special chemicals, known as acaricides, have been developed for their control. With few exceptions, acaricides are not effective against insects. Therefore, growers who want to control mites in their orchards should **(A)** use oil during the half-inch green to tight cluster period, or an acaricide at the tight cluster to pink bud stage, and

then **(B)** regularly monitor mite populations on the foliage from petal fall until harvest, applying an acaricide and/or an insecticide that will provide some suppression when mite numbers exceed the threshold for that period (refer to Figs. 4–6). For further information on the use of these materials, their limitations, and the precautions to be observed, refer to the Comments sections in the spray recommendations.

Abamectin (*Agri-Mek). Refer to "Other Materials" section.

Acequinocyl (Kanemite) is a new miticide now registered for control of European red mite and twospotted spider mite in apples and pears. This material, which is a member of the quinoline family, represents new chemistry and a novel mode of action, against which no resistance has yet been demonstrated in mite populations. It has activity against all life stages and is recommended for use against threshold populations, normally those occurring in summer. Two applications per season are allowed; it is nominally safe to predatory mites and has a low bee poisoning hazard.

Fomulation available and EPA registration number: Kanemite (Arysta LifeScience) 15SC: 66330-38.

Bifenazate (Acramite) is a carbazate that acts as a contact acaricide against both the motile stages of mites and the larvae and nymphs that hatch from treated eggs. Because this represents a new class of chemistry, there is no cross-resistance of this material demonstrated with other currently used acaricides. It is effective against both European red mite and twospotted spider mite, exhibiting a rapid knockdown of contacted motile forms and a relatively long residual efficacy period. It is labeled for use on apples, pears, peaches, nectarines, plums and prunes. Only one application per year is permitted. It is moderately toxic to honeybees upon direct contact, but low in toxicity by foliar residue: it therefore has a moderate bee poisoning hazard.

Formulation available and EPA registration number: Acramite (Chemtura) 50WS: 400-503.

Clofentezine (Apollo) is a tetrazine compound used as a contact acaricide that acts primarily as an ovicide/larvicide; it is particularly effective against winter eggs of European red mite. Following early season applications, it gives excellent residual control. Its use in apples is restricted to no later than 45 days before harvest, but in pears, cherries, peaches and apricots it may be used up until 21 days before harvest. It is safe to bees (low bee-poisoning hazard), beneficial insects, and predatory mites. It is not an effective adulticide.

Formulation available and EPA registration number: Apollo (Makhteshim-Agan) 4SC: 66222-47.

Dicofol (Kelthane) is a chlorinated hydrocarbon that acts as a contact acaricide with no other insecticidal properties. Dicofol is registered for mite control on apples, pears, crabapples and quinces. Occasional control failures of dicofol have been reported, and it is clear that resistance has developed in mite populations. Dicofol is compatible with most commonly used insecticides and fungicides except for lime or other highly alkaline materials; it can be applied in dilute as well as concentrate sprays. However, as with other miticides, coverage and control are usually better when applied dilute at high volume. Predatory mites and other mite predators are able to survive applications of Dicofol. It has a low bee-poisoning hazard. This product has been discontinued but may be used until supplies are exhausted.

Formulations available and EPA registration numbers: Dicofol (Griffin) 4E: 1812-423; Kelthane (DowAgroSciences) 50 WSP: 62719-414.

Etoxazole (Zeal) acts like an insect growth regulator by inhibiting molting, and has very good activity against all life stages of European red mite and twospotted spider mite when applied preventatively or at threshold. It stops egg, larva and nymph development on contact and sterilizes adults; its translaminar movement into the leaf tissue ensures longer residual activity and action against mites feeding on plant surfaces not directly contacted by the spray application. It is labeled for use on apples and pears; only one application per year is permitted. It has a low bee-poisoning hazard.

Formulation available and EPA registration number: Zeal Miticide1 (Valent) 72WS: 59639-138.

Fenpyroximate (Portal) is a contact acaricide/insecticide registered on apple, pear and other pome fruits for the control of various mite species (including twospotted spider mites, European red mites), white apple leafhopper, mealybugs, and pear psylla. Two applications are allowed per season; however, to avoid resistance, do not make more than one application per season. Portal should be rotated with products having a different mode of action where additional control is needed. Nexter (pyridaben) is in the same class as Portal.

Formulation available and EPA registration number. Portal (Nichino America) 5EC:71711-19.

*Formetanate hydrochloride (*Carzol) is a carbamate acaricide-insecticide used for control of European red mite and twospotted spider mite on pears, apples, and peaches and against phosphate-resistant white apple leafhopper, potato leafhopper, and spotted tentiform leafminer on apples. Suppression of tarnished plant bug has been achieved during some seasons with prebloom applications. *Carzol is quite susceptible to alkaline hydrolysis and should be freshly prepared before each application. This material may not be

applied past the petal fall stage. *Carzol is toxic to birds and other wildlife and highly toxic to predatory mites. It has a moderate bee-poisoning hazard.

Formulations available and EPA registration numbers: *Carzol (Aventis) 92SP: 10163-265,.

*Hexakis or Fenbutatin Oxide (*Vendex) is an organotin compound registered for the control of a wide range of plant-feeding mites on several fruit crops, including strains that are resistant to some other miticides. Where resistance to Plictran has been found, it is highly likely that resistance to this material is also present. *Vendex is nontoxic to honey bees, and is relatively nontoxic to predatory mites. It can be readily dispersed and can be used in conventional, dilute or concentrate, sprayers. Agitation is required during mixing and spraying. Thorough coverage of foliage and fruit is necessary for optimum mite control. This product is compatible with insecticides. It is not to be applied more than 4 times/season or more than 3 times between petal fall and harvest. This product is corrosive and may cause skin irritation, respiratory irritation, and eye damage. Use protective clothing and goggles as described on the label. Do not graze treated areas or contaminate food or feedstuffs. *Vendex is toxic to fish and has a low bee-poisoning hazard.

Formulation available and EPA registration number: *Vendex (UniPhos) 50WP: 70506-211.

Hexythiazox (Savey, Onager) is a carboxamide compound used as a contact and stomach-poison acaricide. It is effective against eggs and larvae of European red mite; it will not kill adults. It is registered for a single application in all pome and stone fruits, and may be used up to 28 days before harvest. It provides excellent residual control, and is safe to bees (low bee-poisoning hazard), beneficial insects, and predatory mites.

Formulations available and EPA registration numbers: Savey (Gowan) 50DF: 10163-250; Onager (Gowan) 1EC:10163-277.

§Petroleum Oil Emulsions have been applied in the dormant and/or prebloom period for many years to control certain scales and other insects, as well as the European red mite. Although oil was once largely supplemented or replaced by new pesticides, it is still strongly recommended for red mite control, and has been used with increasing frequency during the past few years. Newer acaricides often prove unreliable as the mite populations develop resistance to them; mites are generally unable to develop resistance to oil. The type of oil, as well as its viscosity and other characteristics, has an important influence on its effectiveness in pest control and its phytotoxicity. Oils in the 60- to 70-second viscosity range have historically been recommended as the preferred products for effective mite control with minimum phytotoxicity to fruit trees. However, because of blending processes used by petroleum refiners, it now appears that the viscosity of a given product is a less reliable indicator of suitability than is the 50% distillation temperature, with a value of 412 +/- 8° F being preferred for prebloom use. Table 5.7.1 gives the specifications for narrow range plant-spray oils currently available that permit relatively safe use on apple foliage during the summer months. An oil is a physical pesticide, effective only when the film deposited covers every egg or young mite. Therefore, thorough spraying and complete coverage of the entire tree are essential. A prebloom oil is recommended at 2 gal/100 from the 1/2-inch green to the tight cluster stage. A concentration of 1 gal/100 is advised from the tight cluster to the pink stage because mite eggs become more susceptible as the season advances. In apple orchards that have received an early season oil spray, a summer oil can effectively suppress mite populations when applied at petal fall and in subsequent cover sprays at rates of 1 to 2 gal/100 gal of finish spray solution. Although generally compatible with most crop protection chemicals, oil should never be mixed with fungicides containing sulfur, such as Captan or Bravo. Refer to Table 18.1.5 for guidelines in determining potential compatibility. Apple variety, moisture stress, and spray drying conditions should be taken into account to minimize any possible effects on foliage quality and fruit finish. Summer oils can increase the incidence of scarf skin in varieties such as Red Rome, Jonathan, and Stayman. Fruit spotting and enlarged lenticels have been caused by applying summer oil (Sun Spray Ultrafine) with Kelthane 50WSP under poor drying conditions. Oil has a low bee-poisoning hazard.

Formulations available and EPA registration numbers: Sunspray (Sun) 6E: 862-11; Stylet-Oil (JMS Flower Farms): 65564-1; Damoil (Drexel): 19713-123; OMNI Oil 6E (Helena): 5905-368-ZA; Saf-T-Side (Brandt Consolidated): 48813-1; BioCover UL (Petro-Canada): 69526-5-34704; PureSpray Spray Oil 10E (Petro-Canada): 69526-5; PureSpray Green (Petro-Canada): 69526-9; Prescription Treatment Ultra-Fine (Whitmire Micro-Gen): 862-23-499; Synergy Super Fine Spray Oil Emulsion (Griffin): 48813-1-75339; Mite-E-Oil (Helena): 5905-302.

Use this procedure for mixing a fungicide-insecticide-oil combination:

1. Fill the spray tank 1/4 full with water and add the liquid or wettable powder pesticide.
2. Resume filling the tank and add the self-emulsifying oil. Continue agitation.
3. Do not allow mixture to stand without agitation.
4. When using the tank-mix oils, first combine the wettable powder or liquid pesticides with 100 gal of water containing the emulsifying agent. Then add the oil to the mixture. Agitate vigorously while spraying.

Table 5.6.1. Optimum properties of representative narrow-range oils available in the US[1]

Specification	Sunspray Ultra-Fine	Orchex 796 (Omni Supreme)	NR 415	NR 440	Volck Supreme	Gavicide Super 90
Distillation temperature (°F at 0.2 psi) ASTM D-1160						
50%	414	440	415	440	476	440
10%–90% range	65	68	60	80	85	55
Unsulfonated Residue (% min.) ASTM D-483	92	92	92	92	99	93
API gravity ASTM D-4052	32	35.1	32	31	34.8	33
Viscosity SUS (sec at 100° F) ASTM D-446	68	74	70	100	105	86
Pour point (°F) ASTM D-97	10	6	20	20	10	5

[1] Davidson et al. (Davidson NA, Dibble JE, Flint ML, Marer PJ, Guye A. 1991. Managing insects and mites with spray oils. University of California Publication 3347. 47 p.) used the term 'narrow-range' to refer to paraffinic oils with ≥ 92% UR and ASTM D 1160-based 10%-90% distillation ranges of <111° F at 0.2 psi. and the then-recently formulated 'supreme oils' alike, and regarded the latter to be as safe as 'narrow-range' products for use on plants, but stated that they may pose more of a phytotoxicity problem on water-stressed plants because of their greater persistence. The term 'supreme oil' is now widely recognized as meaning a paraffinic product that would now be classified as an Agricultural Mineral Oil (AMO). Some of these products, and some Horticultural Mineral Oils (HMO's), have very high UR values (99.9%) that meet criteria required for US Food and Drug Administration classification as food grade medicinal (pharmaceutical) paraffins.

Pyridaben (Nexter) is a pyridazinone compound used as a selective contact acaricide-insecticide in apples and pears, plus all stone fruits, with effectiveness against motile forms of mites and pear psylla; it does not kill eggs. It is recommended for use to control postbloom mite and psylla populations, and is an effective late season rescue material. Nexter is toxic to fish and aquatic invertebrates, and has a high bee-poisoning hazard. Only one application per season is allowed on apples and pears; 2 applications per season on stone fruits. Allow a minimum of 30 days between sequential applications of Nexter in crops that allow more than one application per season. It is in the same class as Portal (fenpyroximate).

Formulation available and EPA registration number: Nexter (Gowan) 75WS:81880-4-10163.

Spirodiclofen (Envidor) is registered for use on pome and stone fruits for the control of several mite species including European red mites, twospotted spider mites, pear rust mite, apple rust mite, and peach silver mite. It has contact activity against mite eggs, immature stages and adult females. Adult males are not affected. Only one application is allowed per crop season.

Formulation available and EPA registration number: Envidor (Bayer) 2SC: 264-831.

5.7 Fumigants and Nematicides for Tree Fruits

Whenever a new orchard is being planted in an old orchard site, preplant soil fumigation should be considered. Nematodes, particularly *Pratylenchus penetrans* (the lesion nematode), can seriously injure the roots of a newly planted tree, restricting its growth and future productivity. This type of injury is most common on cherries, but all fruit trees are susceptible to some extent. Nematodes are more likely to build up to damaging levels in sandy and loamy soils than in heavier soil types. The dagger nematode, *Xiphenema americanum*, can also cause serious losses at population levels too low to cause serious root injury by its transmission of the virus that causes stem pitting of stone fruits, the constriction disease on Stanley prune trees, and apple union necrosis on trees grown on MM.106 rootstock.

Where apples are being replanted following apples, soilborne microorganisms can damage young tree roots and severely reduce the growth of the new trees. This effect can occur in all soil types, regardless of nematode levels. Trees in such situations frequently show a significant growth increase following preplant treatment with a broad-spectrum fumigant that kills fungi and other microorganisms as well as nematodes.

Although fumigants are frequently cost-effective, their potential benefits are often lost when they are applied to soils that are cold and wet or are otherwise poorly prepared. For best results, the site should be plowed as deeply as possible (at least 12 in.) after the old orchard is removed, and all old roots that turn up should be discarded. The land should then be limed, fertilized, fitted, and planted with a cover crop such as creeping red fescue, perennial ryegrass, or sudangrass. The land should be cover cropped for at least 1 yr, preferably 2 or 3. Near the end of July during the year before new trees are to be planted, the cover crop should be plowed under and nitrogen added to improve its decomposition. Poor decomposition of the cover crop or other weeds will reduce the effectiveness of the fumigant. The site should then be disked repeatedly to keep down weeds and

work the soil into seedbed condition. The soil should be loose to a depth of at least 10 in. and free of any large, hard clods that the fumigant can't penetrate. Fumigants are generally most effective if applied while the soil is relatively warm and dry. The best time for fumigation is mid-August to early September, although materials may still be effective is applied until mid-October under some conditions. Best results have been obtained with broad-spectrum soil fumigants (Table 5.7.1).

For cost effectiveness, fumigants should be applied in bands 8 ft wide centered over the row. The material should be injected to a depth of 12 in. with shank applicators 6 to 8 in. apart for VapamHL and 10 to 12 in. apart for *Telone C-17 or *Telone C-35. Rolling or cultipacking after treatment will help seal the surface and improve the activity of the fumigant. Before the trees are planted in the spring, the soil should be disked, care being taken not to throw unfumigated soil onto the treated band.

Postplant Nematicides. Where soil analysis shows high populations of parasitic nematodes in a young orchard, a postplant application of a nematicide may be justified. Currently, 2 chemicals are registered on nonbearing trees for such a purpose (Table 5.7.2): (1) *Oxamyl (*Vydate 2L) - mix 2 qt *Vydate 2L plus 4 oz of a surfactant/100 gal of water and apply as a foliar spray to the point of runoff. Make 4 applications on a 14- to 21-day schedule, beginning at first full leaf (about the time that petal fall occurs on mature trees). (2) *fenamiphos (*Nemacur), for the control of lesion nematode on apple, peach, and cherry trees. Apply to the soil surface within the drip line of the trees, at the rate of 5–6.5 gal of the 3S formulation or 100–130 lb of the 15G formulation/treated A. The treatment is made once (May until early June) each year for at least 2 successive years. Preharvest intervals for *Nemacur are 75 days for apples and 45 days for peaches and cherries.

Table 5.7.1. Preplant nematicidal and broad-spectrum soil fumigants.

Soil Fumigant	Trade Name	Rate/Treated Acre (gal)
Nematicidal Soil Fumigants		
*1-3-dichloropropene	*Telone II	10-15
Broad-Spectrum Soil Fumigants		
*chloropicrin plus *1,3-dichloropropene	*Telone C-17	32-42
*chloropicrin plus *1,3-dichloropropene	*Telone C-35	39-50
sodium methyldithio-carbamate	Vapam HL	37.5-75

Table 5.7.2. Post-plant nematicides.

Product	Trade Name	Application Method	Rate/Treated Acre
*oxamyl	*Vydate 2L	Foliar	2 oz/100 gal
*fenamiphos	*Nemacur 3S	Soil	5-6.5 gal/ treated A

*Restricted-use pesticide; may be purchased and used only by certified applicators

5.8 Herbicides for Tree Fruits

2,4-D (2,4-dichlorophenoxyacetic acid) is marketed in various formulations. *Weedar 64 and *2,4-D Amine are registered for use in APPLE, PEAR, and STONE FRUIT orchards at least 1yr old. Unison is a newer formulation of 2,4-D acid for pome and stone fruit. 2,4-D is a selective herbicide that is effective on many annual and perennial broadleaf weeds when applied as a postemergence foliar spray. It is particularly effective in controlling dandelions on the orchard floor when applied in late fall. These materials should not be applied during the bloom period of fruit trees, i.e., from the time flower buds begin to expand until 4 weeks after bloom. Combinations of 2,4-D plus glyphosate have been effective in controlling many difficult perennial broadleaf weeds. Do not apply to bare ground or light, sandy soil. Group 4.

Carfentrazone-ethyl is registered as Aim 2EC and 1.9EW at 2 and 1.9 lb ai/gallon, respectively. It is a contact, post-emergent, desiccant herbicide for control of young broadleaf weeds only; it has no effect on grasses or sedges. Aim is most effective if used on weeds that are small (up to 4 inches high) in combination with *Gramoxone or glyphosate. Tank mix provides faster desiccation of weeds than glyphosate or *Gramoxone alone, but is not effective for long term control of perennial weeds. Aim should always be mixed with crop oil concentrate or nonionic surfactant. Do not allow spray to contact green bark, fruit or foliage. Aim can be used for sucker control when tissue is soft and succulent. Group 14.

Clethodim (Select Max, Valent USA) is a contact herbicide for control of annual and perennial grasses (no broadleaf) in all non-bearing (only) tree fruit. This limits it's use to newly planted orchards. Group 1.

***Clopyralid** is registered as *Stinger, at 3 lb.ai/gallon. It is a selective, postemergence herbicide for control of some broadleaf weeds if applied while weeds are generally small and actively growing. Some of the weeds controlled include clover species, dandelion, nightshade, burdock, common groundsel, jimsonweed, horseweed, and many thistle species including Canada. Can be used in STONE FRUIT orchards. (Section 24-C

pending in apples in Massachusetts.) Stinger is highly leachable in light soils.

Dichlobenil (2,6-dichlorobenzonitrile) is a white crystalline solid available in 4% granular and 50% wettable powder formulations. The granular formulation (Casoron 4G) is preferred because of its greater effectiveness. Dichlobenil volatizes rapidly under warm, moist soil conditions and must be applied in late fall or very early spring before the soil temperature exceeds 45°F to minimize such loss. It is absorbed principally by the roots of established and germinating weeds and rapidly translocated to growing points. This material is effective against a wide range of annual and established perennial grasses and weeds including nutsedge and quack-grass. Applications of 100 lb of 4% granules/A are effective on many annual grasses and broadleaf weeds, whereas 150 lb/A are usually required for control of most established perennials. Dichlobenil is labeled for use on APPLE, PEAR, and CHERRIES.

Diuron (3-[3,4-dichlorophenyl]-1,1-dimethyl-urea) is marketed in an 80% dry flowable formulation as Karmex or Diuron 80DF as well as Diuron 4L (4lb AI per gallon). Diuron is effective against germinating annual broadleaf weeds and some annual grasses. It is absorbed by roots and translocated to the leaves where it interferes with photosynthesis. For best results it must be present in the soil before weed seeds germinate. Diuron is best used in combination with materials that are more effective on grasses. It is not effective on established perennial grasses or broadleaf weeds. Diuron has been effective against triazine-resistant pigweeds. Rates must be determined in relation to soil texture and organic matter content. Use is limited to APPLES, PEARS, and PEACHES. Labels do not recommend treatment of trees on full dwarf rootstocks. Group 7.

Fluazifop-p-butyl (butyl 2-[4-[5-[trifluoro-meth-yl]-2-pyridinyl]oxy]phenoxy]propanoate) is available in a 2 lb AI/gallon formulation as Fusilade DX. Fluazifop is a selective postemergence herbicide effective on both annual and perennial grasses. Its best use is for control of grasses in newly planted orchards. Two applications are usually necessary with perennial grasses such as quackgrass. Spot treatments are suggested unless a severe grass problem exists. Inclusion of a nonionic surfactant enhances uptake by grass leaves. Can be used in STONE FRUIT ORCHARDS of any age and in NON-BEARING APPLE and PEAR ORCHARDS.

Flumioxazin is registered as Chateau WDG (Valent), 51% A.I. It is primarily a residual herbicide for control of annual grass and broadleaf weeds, however, it will provide additional burn-down when tank-mixed with another contact herbicide. Chateau initially had a label for only non-bearing uses on tree fruit, however, a supplemental label (continued in 2008) now allows use on all apples and stone fruit. It is an excellent material to use in rotation with other residual herbicides during spring or fall applications. It may be used the year of planting, however, shielding the tree trunks from spray is recommended.

Glufosinate-ammonium (ammonium-DL-homoalanin-4-yl-(methyl) phosphinate) is currently registered as Rely formulated as a liquid with 1 lb. AI per gallon. Rely is a non-selective herbicide for application as a directed spray labeled for control of a broad spectrum of annual and perennial grass and broadleaf weeds, some woody species, and rootsucker control in APPLES. It has no residual activity. Avoid all contact with foliage and green bark tissue since injury to the trees can result, especially in young trees.

Glyphosate (N-[phosphono[methyl] glycine). The isopropylamine salt is distributed as an aqueous solution under [various generic formulations and under] the name Roundup Original or Roundup WeatherMax. Glyphosate is a nonselective broad-spectrum herbicide for controlling established annual and perennial grasses and weeds plus woody brush, vines, and trees. No residual soil activity is to be expected from this material. The best timing of applications varies with weed type but is usually after weeds have developed full foliage and/or have begun to flower. Greatest effectiveness against nutsedge is obtained after tuber formation begins. Inclusion of 2,4-D and/or a nonionic surfactant is suggested to increase effectiveness. Glyphosate is absorbed through foliage and bark and translocated throughout the plant. Glyphosate may be applied as a directed spray or by wiper in APPLE, PEAR, and CHERRY orchards. Do not allow contact with foliage or bark on trunks of young fruit trees. Root-suckers or low branches that might be contacted by glyphosate should be removed at least 10 days before the glyphosate application. In APRICOT, PEACH, NECTARINE, PLUM, or PRUNE plantings, use wiper applications only. PEACHES and PLUMS are EXTREMELY SENSITIVE to glyphosate, and ANY contact with leaves or small branches or trunks of young trees may result in severe damage or tree death. Do not apply after mid-summer as the risk of long-term injury is greater.

Isoxaben (Gallery, DuPont) is a pre-emergent broadleaf herbicide that can only be used on (all) non-bearing tree fruit. This limits it's use to the year of planting.

Napropamide (2-[a-napthoxy]-N,N-diethyl propionamide) is formulated as a 50% dry flowable in the form of Devrinol 50DF. Napropamide is effective in controlling most annual grasses and many annual broadleaf weeds. It has been only partially effective against ragweed and Pennsylvania smartweed under orchard conditions and does not control established weeds or grasses. Napropamide inhibits development

and growth of roots. It must be present in the soil before weed-seed germination. Napropamide can be applied in newly planted orchards as soon as the soil settles around the roots and no open cracks are present. Contact herbicides are required to help control established weeds and those that are not effectively controlled by napropamide. It can be applied to all tree-fruit crops. Must be incorporated by rainfall to a soil depth of 2–4 inches within 24 hours of application.

Norflurazon (4-chloro-5-[methylamino]-2-[a, a,a-trifluoro-m-tolyl]-3[2H]-pyridazinone) is formulated as a dry flowable in Solicam DF. Norflurazon at rates recommended provides control of most annual grasses and many annual broadleaf weeds plus suppression of quackgrass and nutsedge. It is absorbed by roots and translocated to growing points where it inhibits pigment formation. The material must be applied and moved into the soil by rainfall or irrigation before seed germination. Rates of application depend on organic matter and clay contents of the soil and crop. Norflurazon is most frequently used in tank-mix combinations that will increase effectiveness of broadleaf weed control. Established perennial weeds are not effectively controlled by norflurazon. Registered for use in APPLE, PEAR, APRICOT, CHERRY, NECTARINE, PEACH, PLUM, and PRUNE, depending on tree age.

Oryzalin (3,5-dinitro-N4,N4-dipropylsulfanil-amide) is available as an aqueous suspension (Surflan A.S. or Oryzalin 4A.S.) containing 4 lb AI per gallon. It provides effective control of most annual grasses and some annual broadleaf weeds.

Oryzalin has controlled triazine-resistant pigweed, but has not been sufficiently effective on ragweed or Pennsylvania smartweed. It is not effective against established weeds or grasses. Oryzalin is absorbed by roots of germinating seedlings and interferes with cell division. To be effective, it must be applied and moved into the soil by 1/2 - 1 inch of rainfall-before seed germination. Oryzalin can be used in newly planted orchards as soon as the soil settles around the roots and no open cracks are present. It can be used in all tree-fruit crops.

Oxyfluorfen (2-chloro-1-[3-ethoxy-4-nitro-phe-noxy]4-[trifluoromethyl]benzene) is available as a 2 lb AI per gallon formulation in Goal 2XL or Galigan 2E. Oxyfluorfen has preemergence and post-emergence activity as a contact herbicide. Uptake can be through leaves, stems, or roots, but very little translocation occurs in the plant. Destruction of membranes occurs when treated plant parts are exposed to light. Oxyfluorfen is primarily effective against seedling broadleaf weeds. It does not control established perennial weeds or grasses and is best used in tank-mix combinations with other appropriate herbicides. Applications of oxyfluorfen must be made while trees are dormant, before buds begin to swell, to avoid possible damage from vapors. Registered for use on all tree-fruit crops of any age.

*Paraquat (l-1-dimethyl-4,4-bipyridinium ion), as the dichloride salt, is currently marketed as *Gramoxone Max or Inteon. *Paraquat is a nonselective contact herbicide that is effective in killing emerged annual broadleaf weeds and grasses and top-killing and suppression of perennials. It is rapidly absorbed into foliage and green bark where it is effective in destroying cell membranes. *Paraquat is strongly adsorbed onto soil colloids where it is degraded by microbial activity. Contact with foliage, branches, and green bark on trunks of young trees can result in damage to the trees. Observe all worker safety cautions specified on labels when mixing, handling, or applying *paraquat. It is registered for use on all tree-fruit crops. Group 22.

Pendimethalin (N-[1-ethylpropyl]-3,4 dimethyl-2,6 dinitrobenzenamine), formulated as an emulsifiable concentrate containing 3.3 lb AI/gal, is sold as Prowl. Pendimethalin is effective in controlling most annual grasses and some annual broadleaf weeds when used in preemergence applications. Primary mode of action is through root uptake and subsequent inhibition of cell division. Pendimethalin can be used in newly planted orchards. Combination with a contact herbicide is necessary to control emerged or established weeds. Use is limited to NONBEARING TREES, for all tree-fruit crops, except for Prowl H2O which has a supplemental label for bearing trees. Group 3.

*Pronamide (3,5-dichloro[N-1,1-dimethyl-2-propynl]benzamide), available in water-soluble pouches as *Kerb 50WP, is effective in controlling winter annual and perennial grasses and chickweed. It is absorbed by roots and translocated throughout the plant. *Pronamide must be applied in late fall, before soil freeze-up, and moved into the soil by water to be effective. The range of activity on broadleaf weeds is limited, requiring additional measures for their control. Rates of application are determined by the type of grass being controlled and by soil texture. Registered for use on APPLE, CHERRIES, NECTARINE, PEACH, PEAR, PLUM, APRICOT and PRUNE.

Rimsulfuron (Matrix FNV, DuPont) has both pre- and post-emergent activity on many (mostly annual) grasses and broadleaf weeds. Trees must be established at least one year in the orchard.

Sethoxydim (2-[1-[ethoxyimino]butyl]-5-[2-[ethythio]propyl]-3-hydroxy-2-cyclohexen-1-one) is marketed as Poast, which contains 1.5 lb AI/gal. Sethoxydim is a selective grass herbicide for use in controlling established annual and perennial grasses. It does not control broadleaf weeds or sedges. A crop-oil

concentrate must be used with sethoxydim. Suggested rates depend on height of grasses being treated. Sethoxydim can be used in APPLE, PEAR, APRICOT, CHERRY, NECTARINE and PEACH orchards of any age and in NONBEARING PLUM and PRUNE ORCHARDS.

Simazine (2-chloro-4, 6 bis[ethylamino]-s-triazine) is available in several formulations including Princep 4L, Simazine 4L and 90DF, and Princep Caliber 90 for use in orchards. Simazine is effective in controlling a wide range of annual broadleaf weeds and grasses. It does not control established perennial weeds or grasses. Simazine is taken up by roots and translocated to the leaves where it interferes with photosynthesis. It must be applied and moved into the soil before weeds germinate to be most effective; therefore, late fall or very early spring applications are suggested. Activity is reduced in soils of low pH.

Resistant weeds such as pigweeds and lambsquarters have been found where simazine has been the principal herbicide used. Control of these weeds has been achieved by using tank-mix combinations with diuron, oryzalin, or pendimethalin. Rates of simazine application and crop tolerance depend on soil texture and organic-matter content as well as crop and tree age. Registered for use in APPLE, PEAR, TART CHERRY, SWEET CHERRY, PEACH, and PLUM.

Terbacil (3-tert-butyl-5-chloro-6-methyluracil) is formulated as an 80% wettable powder under the name Sinbar. It is effective in controlling most annual grasses and broadleaf weeds and in providing partial control or suppression of such perennials as quackgrass, horsenettle, and nutsedge. Terbacil is absorbed by plant roots and is translocated to the leaves where it interferes with photosynthesis. Residual activity of terbacil in the soil is relatively long-lived. This material is frequently used in tank-mix combinations with diuron or simazine. Application rates and crop tolerance depend on soil texture and organic-matter content as well as crop and tree age. Use is limited to APPLES and PEACHES. Terbacil is newly registered for just-planted young and non-bearing apple, peach, plum, apricot and cherry trees at very low rates, but these uses have not yet been fully tested.

**Restricted-use pesticide; may be purchased and used only by certified applicators, or used by someone under the supervision of a certified applicator.*

6 Disease Management

6.1 Apple Scab Fungicides

Apple scab fungicides can control disease through four different types of activity: protection, after-infection activity, presymptom activity, and postsymptom activity. Understanding these activities and knowing which fungicides exhibit them can help a grower determine the materials that are likely to give the best results under a certain set of conditions.

Protection. Protection refers to the ability of fungicide residues to kill or inactivate scab spores (and thereby prevent infection) when the residue is already on or in the leaf or fruit before the infection takes place. A good protective fungicide must exhibit satisfactory retention, that is, the fungicide residue must stick to the leaf surface or be retained within to resist excessive washing away of the deposits by rain. On the other hand, a good protective fungicide should also have good redistribution properties, that is, fungicide residues should have a tendency to be washed by rain and redeposited on previously unprotected tissue. Ideally, a fungicide should stick well enough not to be washed off the tree, but should be redistributed well enough during rains to protect new growth.

After-infection activity. After-infection activity refers to the ability of a fungicide to kill or stop the growth of the fungus and thereby prevent the establishment of scab lesions, if applied within a given period after the start of a wetting period. It is expressed as the period of time from the beginning of a wetting period within which the fungicide must be applied to stop infection. The data given in Table 6.1.2 are accurate at average temperatures of 50–60° F. At lower temperatures, the periods of after-infection activity for contact fungicides are longer than those listed.

Presymptom activity. Presymptom activity can be thought of as an extension of after-infection activity. When applied following an infection period, but beyond the time limits of its after-infection activity listed in Table 6.1.2, a fungicide with significant presymptom activity will allow small chlorotic lesions to develop; however, it will inhibit or greatly reduce the production of secondary spores from those lesions. Thus, if applied too late to completely stop infection, it will still greatly reduce the amount of inoculum available for secondary spread.

Postsymptom activity. Postsymptom activity refers to the ability of a fungicide, when applied to an actively sporulating scab lesion, to prevent or greatly inhibit the further production of secondary scab spores from that lesion. Because such applications do not kill the fungus, but merely arrest its development, they must be repeated to maintain this suppression. As with presymptom activity, this has the obvious benefit of reducing the pressure for the spread of secondary scab.

Table 6.1.1. Activity spectrum of apple fungicides.

		Ratings for the Control of							*Relative Toxicity to Beneficials*				
Fungicide	**Fungicide Family/ FRAC code‡**	**Scab**	**Powdery Mildew**	**Cedar Apple Rust**	**Black/ white rot**	**Sooty Blotch/ Fly speck**	**Bitter Rot**	**Mite Suppres-sion (a)**	**Bees**	**Af**	**Tp**	**Sp**	**Aa**
captan[j]	Phthalimide/ M4	4	0		1	3	2[e]	3[e]	L	L	L	—	L
cyprodinil (Vangard)	Anilinopyrimidine/9	2[g]	1		0	0	0	0	L	-–	—	—	—
dodine (Syllit)	Guanidine/M7	2[b,c]	0	1	1	1	0	0	L	L[f]	L[f]	—	L
Fenarimol (Rubigan)[g]	DMI (SI)/3	4[c]	4	4	0	0	0		L	L	L	—	—
fenbuconazole (Indar)	DMI (SI)/3	4[c]	4	4	0	0	0		L	L	L	—	—
ferbam (Ferbam)	Dithiocarbamate/ M3	2	0	2	1	2	1	0	L	—	—	—	—
kresoxim-methyl (Sovran)	Strobilurin (QoI)/11	4	3	2	3	4	2	0	L	L	L	—	—
mancozeb (Dithane, Manzate, Penncozeb,)	Dithiocarbamate/ M3	3[d]	0	4	3	4	4	0	L	M-H[h]	M-H[h]	—	—
maneb (Manex, Maneb)	Dithiocarbamate/ M3	3[d]	0	4	3	4	4	0	L	M-H[h]	M-H[h]	—	—
metiram (Polyram)	Dithiocarbamate/M3	3[d]	0	4	3	4	4	0	L	—	—	—	—
myclobutanil (Rally)[g]	DMI (SI)/3	4[c]	4	4	0	0	0	—	L	L[I]	L[I]	—	—
pyraclostrobin + boscalid (Pristine)	Strobilurin (QoI)/11 + carboxamide	4	3	2	3	4	3	—	L	—	—	—	—
pyrimethanil (Scala)[g]	Anilinopyrimidine/9	2[g]	—	0	0	0	0	—	—	—	—	—	—
§sulfur	Inorganic/M2	2	2	0	1	1	–	0	L	L[f]	L[f]	—	—
thiophanate-methyl (Topsin M)	Benzimidazole/M1	2[b,c]	2[c]	0	4	4	1	2	L	L[I]	L[I]	—	—
trifloxystrobin (Flint)	Strobilurin (QoI)/ 11	4[c]	3	2	3	4	2	0	L	L	L	—	—
triflumizole (*Procure)[g]	DMI (SI)/3	4	4	4	0	0	0	—	L	—	—	—	—
Ziram	Dithiocarbamate/M3	2	0	2	1	3	1	—	L	M-H[h]	M-H[h]	—	—

Key to control ratings: **—** = Unknown or does not apply **0** = none, **1** = slight, **2** = fair, **3** = good, **4** = excellent

(a) These indicate the degree of mite suppression of the product when used on a full-season schedule.
(b) Activity downgraded because of resistance concerns.
(c) Resistance is documented or suspected in many orchards
(d) Indicates efficacy at the 1 lb/100 gal rate; efficacy increases to 4 with the 2 lb/100 gal rate.
(e) Limited residual activity. Efficacy rating of "good" assumes regular reapplication during periods of heavy disease pressure. More effective against sooty blotch, less effective against fly speck.
(f) Information derived from 24-hr slide dip tests conducted at the New York State Agricultural Experiment Station.
(g) Activity of these materials is highly rate-dependent. Stated efficacies assume a rate of 9 fl oz/A for Rubigan 1E, 5 oz/A for Rally 40WP, 6 oz/A Rally 40WSP, 9 oz/A for Procure 50WS, 5oz/A for Vangard, and 10 oz/A for Scala. Rally is the new trade name for myclobutanil, previously known as Nova.
(h) Low to moderate impact from several early season (through 1C) applications; moderate to high impact from summer applications.
(i) This information is derived from application field tests conducted at the New York State Agricultural Experiment Station.
(j) 24hr REI for some formulations
(k) Apples are no longer included on the most recent labels.
§ potentially acceptable in certified organic programs.
‡ The Fungicide Resistance Action Committee (FRAC: http://www.frac.info/frac/index.htm) is an organization committed to prolonging the effectiveness of fungicides at risk for resistant development and to minimizing crop loss due to resistance development. With the exception of lettered codes, fungicides with the same FRAC code have a similar chemistry (modes of action) and the propensity for cross-resistance development.

Key to beneficials:
Bees = honeybees
Af = *Amblyseius fallacis*, a predatory mite found throughout New York State
Tp = *Typhlodromus pyri*, a predatory mite found mostly in Western New York
Sp = *Stethorus punctum*, a ladybird beetle predator of mites
Aa = *Aphidoletes aphidimyza*, a cecidomyiid predator of aphids

Key to toxicity ratings:
L = (bees) not hazardous to honey bees at any time. 1 hr to 1 day residual toxicity (all others) low impact on population (less than 30% mortality after 48 hr).
M = moderate impact on population (between 30% and 70% mortality after 48 hr).
H = high impact on population (more than 70% mortality after 48 hr).
— = no data.

(Information compiled from 48-hr residue tests conducted at the New York State Agricultural Experiment Station, except where noted. Pesticides with a long residual period, like pyrethroids, will have a more negative impact than pesticides with short-lived residue, like some organophosphates.)

Table 6.1.2. Characteristics of apple scab fungicides.

Fungicide and Rate/100 Gal (assuming 300 gpa for standard trees)	Protection	Retention	Redistribution	After-Infection Activity (hr)	Pre-symptom	Post-symptom
captan 50WP, 2 lb	VG	VG	G	18-24	none	none
cyprodinil (Vangard) 75WG, 1.67 oz	G	G	?	48-72	none	none
dodine (Syllit) [1] 3.4 FL, 12 oz	VG	VG	G	18-24	E	VG
fenarimol (Rubigan) 1EC, 3-4 fl oz [1]	F	VG	P	72-96	E	G-VG
fenbuconazole (Indar) 2F, 2-2.7 fl oz	F	VG	P	72-96	E	G-VG
ferbam, 2 lb	G	G	G	15-20	none	none
§liquid lime sulfur, 1.5-2 gal	F	F-G	F-G	72-96	none	F
kresoxim-methyl (Sovran) 50WP, 1.33 oz	VG	E	G	48-72[2]	none	G
mancozeb 75DF, 80WP, 2 lb	VG	VG	G	18-24	none	none
metiram (Polyram) 80WP, 2 lb	VG	VG	G	18-24	none	none
myclobutanil (Rally) [1] 40WP, 40 WSP 2 oz	F	VG	P	72-96	E	G-VG
pyrimethanil (Scala) 600SC, 3.3 oz	G	G	?	48-72	none	none
§sulfur, 5 lb actual	F	F-G	F-G	none	none	none
thiophanate-methyl [1] (Topsin M) 70WP, 6 oz	F	G	P-F	18-24	E	VG
trifloxystrobin (Flint) 50WP, 0.67 oz	VG	E	G	48-72[2]	none	G
triflumizole (Procure) [1] 50WS, 2.5 oz	F	VG	P	72-96	E	G-VG
Ziram 76WDG, 76DF, 1 1/2 lb	F-G	P-F	F-G	15-20	none	none

[1] Not effective against resistant strains of the fungus.
[2] The after-infection activity of Sovran and Flint may be only 48 hr in orchards with DMI-resistant populations of apple scab.
[3] Apples are not included on the most recent label.
§ potentially acceptable in certified organic programs.

Key: **P** = poor, **F** = fair, **G** = good, **VG** = very good, **E** = excellent.

6.2 Notes on Apple Scab Management

Implications of inoculum dose. Economic losses to apple scab in commercial orchards usually appear following convergence of three factors:

i. High levels of carry-over inoculum are present in leaf litter in the orchard.
ii. Weather conditions favor ascospore infections between green tip and bloom.
iii. Fungicide protection is inadequate to prevent infections at some point between green tip and bloom.

The importance of high inoculum levels as a contributor to scab epidemics cannot be over-emphasized. No one can control the weather, and bad weather may interfere with fungicide applications. However, several methods are available for reducing inoculum in orchards. Any one of these methods can reduce inoculum by at least 70%, thereby converting high-inoculum orchards into moderate or low-inoculum orchards. Using one of these inoculum reduction strategies does not eliminate the need for fungicide protection beginning at green tip, but it reduces risks of control failures in bad scab years.

Orchard sanitation for high-inoculum orchards. The inoculum dose in overwintering leaves can be reduced by using any one of the following methods:

a) Apply 40 lb/A of urea fertilizer (mixed in 100 gal of water/A) sometime after winter but before bud break. Urea softens senescent and fallen leaves and stimulates their microbial breakdown, promoting faster removal by earthworms that feed on them. It may also directly suppress ascospore formation. Treat the entire orchard, including the ground cover in the row middles. Apply the spray using either an air blast sprayer with the upper nozzles turned off or a boom sprayer set up to spray both under the trees and the row middles. Reduce subsequent nitrogen fertilizer rates by the amount of N applied under the drip line of the tree rows. Ignore the amount of N applied to the row middles, as the ground cover will use this.
b) Shred overwintering leaves using a flail mower set low enough to contact the fallen leaves. Leaves must be raked or blown from under trees, or the mower must be offset to reach them. Shredded leaves decay more quickly, and flail-mowing leaves in spring disorients many of the leaf pieces so they eject ascospores toward the soil instead of up into the air. Prunings can be chopped at the same time. However, the low mower settings required to effectively shred leaves may leave row middles so denuded as to be slippery or muddy at the time when early fungicide sprays are needed.
c) Apply 2.5 ton/A of lime in early winter after leaves have fallen from trees. Lime raises the pH of fallen leaves enough to increase the rate of microbial breakdown of the fallen leaves.

Determining inoculum levels in orchards: In research trials, the first fungicide spray for apple scab has been safely delayed until as late as tight cluster in orchards where scab was very well controlled throughout the previous season and the predicted ascospore dose (PAD) was therefore very low. To apply this option, an assessment of foliar scab must be made as close as possible to the time of leaf fall in autumn since late leaf infections can be an important source of inoculum for the following season. It is not safe to assume that there were few or no infections in an orchard based on casual observations during harvest or late sprays. Even packout evaluations of scab do not adequately estimate the scab present in an orchard. If a grower is going to take advantage of low-inoculum and delay the first fungicide, it is critical that the amount of scab be measured using the method that has been shown to measure the amount of inoculum that is in the block the next spring.

Sampling Directions

STEP 1: Assess the orchard for leaf scab after harvest but before leaf-fall:

- **Examine 10 trees** selected randomly from the entire orchard (usually every nth tree; e.g., in an orchard with 1000 trees, examine every 100th tree).
- On trees that are **9 to 12 ft. tall, examine 10 extension shoots on 10 trees selected throughout the block.** For example, in a 1000 tree block, examine every 100th tree; in a 500 tree block, examine every 50th tree.
- Shoot extensions should be selected randomly from high, low, exterior, and interior parts of the tree canopy. If sucker shoots are present, randomly select one sucker shoot.
- On trees approximately **6 ft. tall, examine 5 extension shoots/tree on 20 trees** if the tree size and shape provide an adequate sampling of the canopy.
- For very high density plantings with trees **3 to 6 ft. tall and sparse canopy, examine 2 extension shoots/tree on 50 trees**.
- On each extension shoot, examine the upper and lower surface of each leaf. Record the **number of scabbed leaves**. If a lesion or spot is doubtful, it should be considered a scab lesion and the leaf should be counted as a scabbed leaf.
- Total the **number** of scabbed leaves you have recorded and use Figure 6.1.1 or Figure 6.1.2 to determine if further sampling is necessary, or whether the sample size is sufficient to predict the "scab-risk" of the orchard.

STEP 2: If sanitation practices will **NOT** be considered, refer to Figure 6.2.1. If sanitation practices will be considered, refer to Figure 6.2.2.

Limit this strategy to small or moderately-tall trees on semi-dwarfing rootstock. ***Old blocks of standard trees should not be candidates for this delayed-spray approach.*** In

addition, ***this strategy is risky for orchards where apple scab is resistant to dodine and SI fungicides*** because no fungicides with pre-symptom activity will be available to compensate for any errors. The green tip spray should never be omitted in orchards where PAD assessments were not completed the previous autumn.

Determining scab infection periods. The Revised Mills Table (Table 6.2.1) shows the minimum duration of wetting required at various temperatures for initiation of apple scab infections. Both ascospores and conidia infect at similar rates when tested at equivalent temperatures and inoculum doses. Therefore, a single set of conditions can be used for determining minimum wetting requirements for both primary and secondary infections.

Longer wetting at any given temperature often causes more disease, and a 2- to 6-fold increase in severity generally results when wetting is extended beyond the minimum times specified in the table. Also, inoculum doses are generally much lower for ascospores than for conidia, so the severity of infection at any given combination of temperature and wetting duration is usually greater when secondary inoculum is present, as compared with early in the season, when only ascospores are present.

Day vs. night release of ascospores. Extensive research has shown that under most circumstances, over 95% of the available ascospores are not released until after sunrise when rain begins after sunset. Thus, it is often safe to assume that in low inoculum orchards (as defined above) primary infection periods begin at dawn when rain begins at night. This assumes that the low percentage of night-released ascospores, coupled with the already low seasonal "crop" of ascospores at low-inoculum sites, is insignificant. However, secondary spores (conidia) are not affected by light or darkness. Therefore, DO NOT ignore wetting hours during darkness if scab infections have already been observed in the orchard or if you are not certain of excellent control for all previous infection periods.

Seasonal ascospore maturity and discharge. Ascospore maturity can be estimated from degree-day accumulations. Degree-days should be recorded from the date when 50% of the fruit buds on McIntosh trees are between silver tip and green tip. The base temperature for degree-day accumulation is 32° F; thus, if the average temperature (high plus low divided by two) for a given day is 50° F, ascospore maturity advances in response to 18 degree-days over that period. The cumulative percentage of matured ascospores at various degree-day accumulations is given in Table 6.2.2. The table also lists the "90% confidence interval" for the estimated maturity.

To determine when the ascospore supply is exhausted according to the model, use the following rule: After the cumulative percentage of matured ascospores reaches 95% (740 accumulated degree-days), the season's supply of ascospores will be depleted after "favorable" rain (daytime rain of more than 0.10 inches with temperatures greater than 50° F).

The model is useful for describing the beginning, peak, and end of ascospore maturation in general terms, but unusual weather conditions may contribute to significant ascospore discharges earlier than or later than the model predicts. Note that the model uses 90% confidence limits to bracket ascospore maturity estimates. For example, at 740 DD, there is a 90% chance that the proportion of matured ascospores is somewhere between 79-99%. For any model prediction, there is also a 10% chance that actual ascospore maturity will be outside of the confidence limits due to unusually advanced or retarded spore maturity.

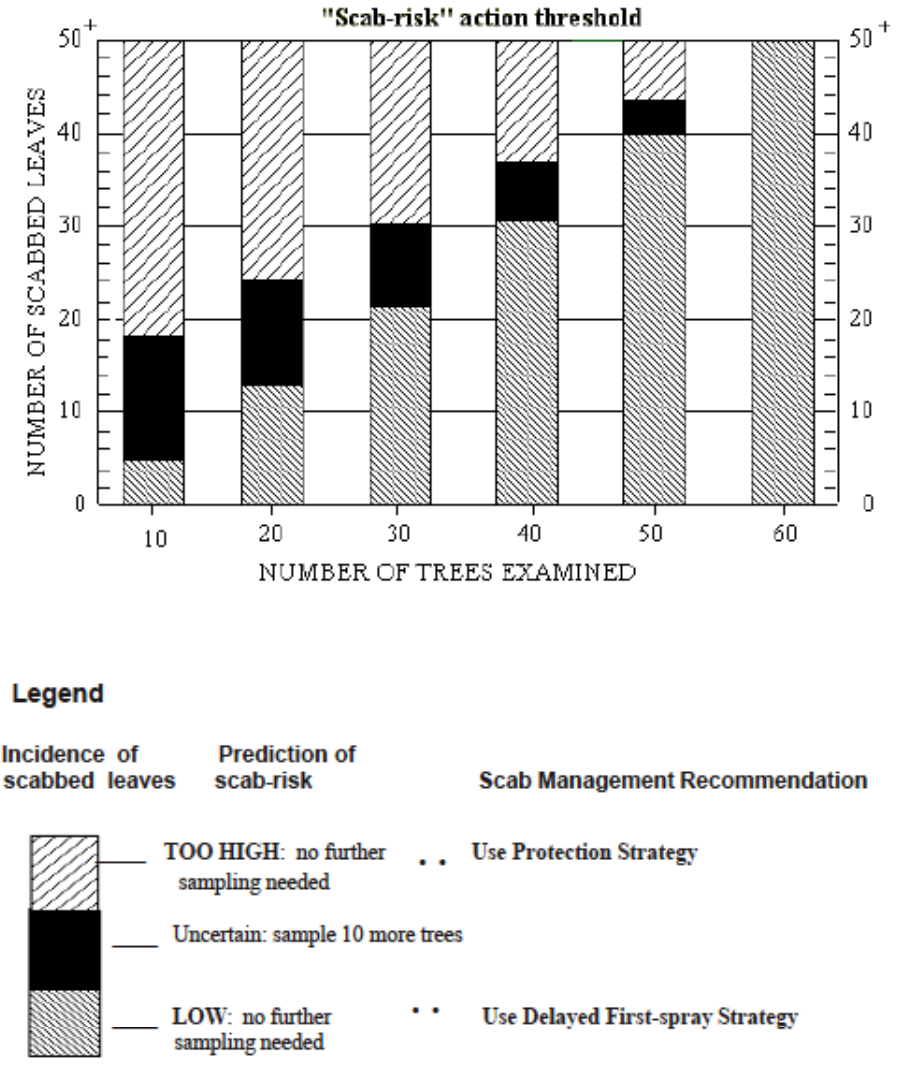


Figure 6.2.1. Sequential sampling chart for determining level of scab risk in an orchard block. Use this chart if sanitation practices will NOT be considered.

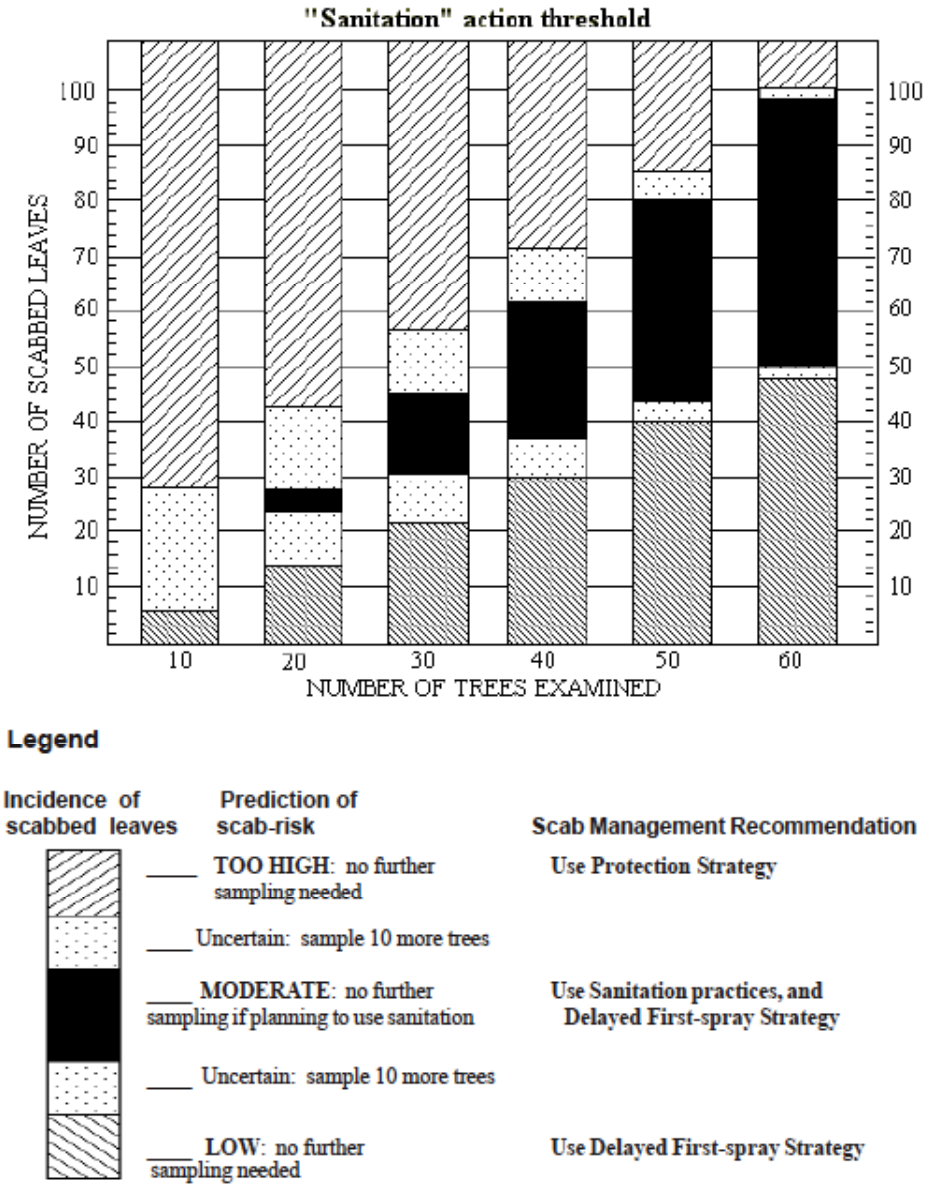


Figure 6.2.2. Sequential sampling chart for determining level of scab risk in an orchard block when sanitation practices will be considered.

Table 6.2.1. Revised Mills Table. Approx. hours of wetting necessary to produce primary apple scab infections, and approx. number of days required for lesions to appear, at different average temperatures.

Temperature (˚F)	Hours [1]	Lesions Appearance (days) [2]
34	41	–
36	35	–
37	30	–
39	28	–
41	21	–
43	18	17
45	15	17
46	13	17
48	12	17
50	11	16
52	9	15
54–56	8	14
57–59	7	12–13
61–75	6	9–10
77	8	–
79	11	–

[1] Refer to Notes on Apple Scab Management for computing wetting intervals for primary infection when rain begins at night in low-inoculum orchards. Data of MacHardy & Gadoury (1989); and Stensvand, Gadoury, & Seem (1997).

[2] Number of days required for lesions to appear after infection has been initiated. No further wetting is required. Additional days may be required if conditions are unfavorable for lesion development (prolonged periods above 80° F or very dry weather).

Table 6.2.2. Cumulative percentage of ascospores matured at various degree-day (base 32° F) accumulations.

Degree-days [3]	Cumulative ascospores matured (%)	90% Confidence interval for estimate [4]
35	1	0–7
110	3	0–14
145	5	1–19
215	10	2–32
325	25	7–55
450	50	21–80
575	75	46–94
685	90	69–98
740	95	79–99
790	97	86–100
865	99	93-100

[3] Degree-days should be recorded from the date when 50% of McIntosh fruit buds are between silver tip and green tip. The base temperature for degree-day accumulation is 32° F. Data of Gadoury & MacHardy, 1982.

[4] The width of the 90% confidence interval is a statistical measure of the precision of estimated maturity. It is the range within which the estimate should fall 90% of the time.

Table 6.2.3. Activity spectrum of stone fruit fungicides.

		Registered for use on:				*Control of* Brown Rot		Cherry			Peach	
Fungicide	**Fungicide Family/FRAC code‡**	**Apricot**	**Cherry**	**Peach**	**Plum**	**Blossom Blight**	**Fruit Rot**	**Leaf Spot**	**Powdery Mildew**	**Black Knot**	**Leaf Curl**	**Peach Scab**
Abound [a]	Strobilurin(QoI)/11	+	+	+	+	3	3	3	4	—	—	3
Adament	DMI (SI)/3 plus Strobilurine (QoI)/11	—	+	+	—	4[i]	4[i]		4[i]	—	—	—
Applause 720 [f]	Chloronitrile/M5	+	+	+	+	—	—	4[g]	0	4[g]	4[g]	4[g]
Botran [c]	Chlorophenyl/14	+	+	+	+	2[g]	2	—	—	—	—	
Bravo [f]	Chloronitrile/M5	+	+	+	+	3	—	4[g]	0	4[g]	4[g]	4[g]
Concorde [f]	Chloronitrile/M5	+	+	+	+	3	—	4[g]	0	—	4[g]	4[g]
Captan[d]	Phthalimides/M4	+	+	+	+	3	2-3	3	0	3	—	3
§Copper [e]	Inorganic/M2	+	+	+	+	—	—	3	2	1	3	—
Echo [f]	Chloronitrile/M5	+	+	+	+	3	—	4[g]	0	—	4[g]	4[g]
Elevate	Hydroxyanilide/ 17	+	+	+	+	3	2	—	—	—	—	—
Elite	DMI (SI)/3	—	+	+	—	4[h]	4[h]	3[h]	3	0	—	—
Equus 720 [f]	Chloronitrile/M5	+	+	+	+	3	—	4[g]	0	4[g]	4[g]	4[g]
Ferbam	Dithiocarbamate/ M3	—	+	+	—	—	2	2	0	—	4	1
Gem	Strobilurin(QoI)/11	+	+	+	+	—	—	3	4	—	—	3
Indar	DMI (SI)/3	+	+	+	—	4[h]	4[h]	3[h]	3	—	—	3
Nova	DMI (SI)/3	+	+	+	+	2[h]	1[h]	4[h]	4	—	—	—
Orbit	DMI (SI)/3	+	+	+	+	4[h]	4[g] [h]	3[h]	3	—	—	—
Pristine	Strobilurin(QoI)/11	+	+	+	+	4	4	4	4	—	—	—
Procure	DMI (SI)/3	—	+	—	—	1	—	3[h]	4	—	—	—
Quash	DMI (SI)/3	+	+	+	+	4	4	—	3	—	—	—
Rovral, Iprodione	Dicarboximide/2	+	+	+	+	4	—	2	0	—	—	—
Rubigan	DMI (SI)/3	—	+	—	—	—	—	3[h]	3	—	—	—
Scala	Anilino-pyrimidines/9	+	—	+	+	3	1	—	—	—	—	—
§Sulfur	Inorganic/M2	+	+	+	+	2	1	1	2	0	—	3
Syllit	Guanidine/M7	—	+	+	—	—	1[g]	2	0	—	—	—
Thiram	Dithiocarbamate/ M3	—	—	+	—	1	1	—	—	—	3	3
Topsin M, Thiophanate-methyl, T-methyl	Benzimidazole/1	+	+	+	+	—[b]	—[b]	—[b]	2	2	—	3[b]
Vangard	Anilino-pyrimidines/9	+	+/—	+	+	3	—	—	—	—	—	—
Ziram	Dithiocarbamate/ M3	+	+	+	—	2	1	2	—	—	3	2

Key to Control Ratings: — = does not apply , ?=unknown, **0** = none, **1** = slight; **2** = fair; **3** = good; **4** = excellent.

[a] Abound extremely phytotoxic to certain apple varieties. DO NOT spray Abound where spray drift may reach apple trees; do not spray when conditions favor drift beyond intended area of application; do not use spray equipment to spray apple trees that previously had been used to spray Abound.

[b] Because of widespread resistance to thiophanate-methyl in NY, these fungicides are NOT recommended for brown rot control..

[c] Do not use on tart cherry.

[d] Do not use on sweet cherry. Some captan products (more recent labels) have a 24-hr REI.

[e] Leaf injury may occur on Schmidt, Emperor Francis, and Giant sweet cherry varieties from sprays applied between petal fall and harvest. Injury may occur on 'Stanley' or Japanese-type plums if applied repeatedly early season.

[f] See special requirements for eye protection for 7 days after application.

[g] Significant timing or crop restrictions; check label.

[h] May fail to provide brown rot and/or leaf spot control in orchards where pathogens have developed resistance.

[i] Efficacy estimated based on individual performance of component active ingredients, Elite and Flint

§ Potentially acceptable in certified organic programs.

‡ The Fungicide Resistance Action Committee (FRAC: http://www.frac.info/frac/index.htm) is an organization committed to prolonging the effectiveness of fungicides at risk for resistant development and to minimizing crop loss due to resistance development. With the exception of lettered codes, fungicides with the same FRAC code have a similar chemistry (modes of action) and the propensity for cross-resistance development.

Table 6.2.4. Approximate number of hours of leaf wetness required for cedar apple rust infections to occur on leaves of susceptible cultivars.

Average Temp (˚F)	Degree of Infection [1]	
	Light	Severe
36	24	—
40	12	24
43	8	10
46	6	7
50	5	6
54	4	5
58	3	5
61	3	4
64	3	4
68-76	2	4
79+	—	–

[1] Based on the data of Aldwinckle, Pearson, & Seem, Cornell University assumes that cedar apple rust inoculum (orange, swollen galls) is available at the start of the rain. If inoculum is not already present (dry period prior to the rain), add 4 hr at temps above 50˚ F and 6 hr at temps of 46-50˚ F. Infection is unlikely at temps below 46˚ F if inoculum is not already present.

Table 6.2.5. Approximate hours of continuous leaf wetness necessary to produce cherry leafspot infection [a].

Average Temp (˚F)	Degree of Infection		
	Light (hours)[b]	Moderate (hours)[b]	Heavy (hours) [b]
50	18	27	36
55	11	19	26
60	6	14	20
65	5	12	19
70	6	14	22
75	10	20	31

[a] Determined by S. Eisensmith and A. Jones, Michigan State University.

[b] Hours of wetness from the beginning of a rain. Assumes significant level of inoculum present.

7 Insect and Mite Management

Table 7.1.1. Activity spectrum of pome fruit insecticides and acaricides

		Ratings for the Control of													Relative Toxicity to Beneficials				
Insecticide	**IRAC‡**	**AM**	**Aph**	**Int**	**GFW**	**LH**	**OBLR**	**PC**	**PPs**	**RAA**	**RBLR**	**SJS**	**STLM**	**TPB**	**Bees**	**Af**	**Tp**	**Sp**	**Aa**
Actara (thiamethoxam)	4A	—	1	1	–	3	0	3	3	3	0	0	2	2	M	L[d]	L[d]	L	L
*Agri-Mek, *Abacus, *Abamectin, *Abba, *Epi-Mek,, *Temprano (abamectin)	6	—	—	—	—	3	—	—	3	—	—	—	3	—	L	M	M[d]	M	L
Altacor (chlorantraniliprole)	28	1	—	3	3	1	3	1	—	—	3	—	2	—	L	L	L	L	L
*Ambush, *Pounce (permethrin)	3	—	2	—	3	—	2-3	3	2	2	3	1	3	3	H	H	H	H	L
*Asana XL (esfenvalerate)	3	3	2	3	3	3	2-3	3	2	2	3	1	3	3	H	H	H	H	M
Assail (acetamiprid)	4A	3	3	3	—	3	0	2	2	3	0	2	3	2	L	M	L	M	M
Avaunt (indoxacarb)	22	2	1	2	—	3	0	3	—	0	—	0	2	2	M	L[d]	L[d]	L	L
§Aza-Direct, §Neemix (azadirachtin)	18B	—	2	2	—	2	—	0	—	2	—	—	3	--	M	L[d]	L	L	L
§B.t, (§Biobit, §Dipel, §Javelin, MVP)	11B2	0	0	2	3	0	3	0	0	0	3	--	0	0	L	L[d]	L[d]	L	L
Beleaf (flonicamid)	9C	—	3	—	—	—	—	—	—	—	—	—	—	3	L	—	—	—	—
*Baythroid (cyfluthrin)	3	3	2	3	3	3	2-3	3	—	—	3	—	3	3	H	H	H	H	H
Belt (flubdiamide)	28	—	—	3	3	—	3	—	—	—	3	—	—	—	L	L	L	L	L
*Calypso (thiacloprid)	4A	3	3	3	—	3	1	3	3	1	1	2	3	1	L	L	L	M	L
*Danitol (fenpropathrin)	3	3	2	3	3	3	2-3	3	2	2	3	1	3	3	H	H	H	H	H
Delegate (spinetoram)	5	2	0	3	3	—	3	2	3	—	3	—	3	—	L	M	M	L	L
*diazinon	1B	—	1	2	2	1	0	2	0	3	0	2	1	1	H	M	M	M	H
dimethoate – pears only	1B	—	2	3	2	3	0	2	0	2	0	2	1	2	H	H	H	M	H
Esteem (pyriproxyfen)	7C	0	0	2	0	0	0	0	3	3	0	3	2	0	L	L	L	M	L
*Guthion (azinphos-methyl)	1B	3	1	3	1	1	1	3	0	1	3	2	1	1	H	L	L	L	H
*Imidan (phosmet)	1B	3	1	3	1	1	1	3	0	1	3	2	1	1	H	L	L	L	M
*Intrepid (methoxyfenozide)	18A	0	0	2	—	0	3	0	—	0	3	0	2	0	L	L	L	L	L
*Lannate (methomyl)	1A	2	2	3	3	3	2-3	2	0	1	3	2	3	1	H	H	H	M	H
*Leverage (cyfluthrin/imidacloprid)	3/4A	3	3	3	3	3	2-3	3	2	3	3	2	3	3	H	H	H	H	H
Lorsban (chlorpyrifos)[a]	1B	—	—	2	3	1	3	3	0	2	2	3	1	1	H	M	M	L	--
§M-Pede (insecticidal soap)	—	0	2-3	0	0	1	0	0	2	1	0	1	0	0	L	L	L	L	L
Malathion	1B	2	2	2	1	1	1	2	0	1	2	--	1	1	H	L[d]	L[d]	L	L
Nexter (pyridaben)	21	—	0	—	—	2	—	—	3	—	—	—	—	—	H	M	L-M[D]	M	M
§oil (Stylet, Damoil, PureSpray)	—	—	—	—	1	—	—	—	—	2	—	—	3	1	—	L	L-M[b]	L-M[c]	L	L
*Proclaim (emamectin benzoate)	6	0	0	2	3	0	3	1	2	0	3	0	3	0	H	—	—	—	—
*Provado (imidacloprid)	4A	—	3	—	—	3	—	—	2	3	—	2	3	—	H	L	L	M	L
Sevin (carbaryl)	1A	2	1	2	1	3	2	2	0	1	1	2	1	1	H	M	L	H	H
SpinTor, §Entrust (spinosad)	5	2	0	2	3	0	3	0	—	0	3	—	2	0	L	L	L	L	L
*Supracide (methidathion)	1B	—	—	—	—	—	—	—	1-2	3	—	3	—	—	H	—	—	—	—
§Surround (kaolin)	—	2	1	2	2	—	—	2	2	0	—	—	2	0	L	L	L	L	L
*Thionex (endosulfan)	2A	0	2	0	3	3	2	0	0	2	2	1	1	1	M	L	L	M	M
*Vydate (oxamyl)	1A	0	2	0	—	2	0	0	0	2	—	—	3	1	M	H	H	L	M
*Warrior (lambda-cyhalothrin)	3	3	2	3	3	3	2-3	3	2	2	3	1	3	3	H	H	H	H	H

Table 7.1.1. Activity spectrum of pome fruit insecticides and acaricides *(continued)*

		Ratings for the Control of				*Relative Toxicity to Beneficials*				
Acaricide	**IRAC‡**	**ARM**	**ERM**	**PRM**	**TSSM**	**Bees**	**Af**	**Tp**	**Sp**	**Aa**
Acramite (bifenazate)	25	0	3	0	3	M	M	M	L	L
*Agri-Mek, *Abacus, *Abamectin, *Abba, *Abacus, *Abamectin, *Epi-Mek,*Temprano (abamectin)	6	3	3	3	2	L	M	M	M	L
Apollo (clofentezine)	10A	1	3	1	1	L	L	L	L	L
Kanemite (acequinocyl)	20B	—	3	—	3	L	L	L	L	—
Kelthane (dicofol)	—	3	1-2	3	1-2	L	M	L	L	L
Nexter (pyridaben)	21	2	3	2	2	H	M-H[e]	M-H[e]	M	M
§oil (Sunspray, PureSpray, Damoil, Stylet, Omni)	—	2	3	2	1	L	L-M[b]	L-M[c]	L	L
*Proclaim (emamectin benzoate)	6	—	2	—	2	H	—	—	—	—
Savey, Onager (hexythiazox)	10A	—	3	1	1	L	L	L	—	—
*Vendex (hexakis)	12B	2	1-2	2	2-3	L	L	L	L	L
Zeal (etoxazole)	10B	0	3	0	3	L	M	M	—	L

* Restricted-use pesticide; may be purchased and used only by certified applicators, or used by someone under the supervision of a certified applicator.

Key to control ratings:

— = Unknown or does not apply in this case **0** = not effective **1** = poor **2** = fair **3** = good

[a] = Lorsban 75WG allowed as foliar treatment on apple up to Petal Fall; delayed dormant only in pears. Lorsban 4E and Lorsban 50W used as trunk sprays only on apples after bloom.

‡ = IRAC (**I**nsecticide **R**esistance **A**ction **C**ommittee) Mode of Action Classification Group: Arthopod pest populations are more likely to exhibit cross-resistance to materials within the same group.

§ = Potentially acceptable in certified organic programs.

Key to toxicity ratings:

Bees:
- **L** Low; not hazardous to honey bees at any time. 1 hr to 1 day residual toxicity
- **M** Moderate; not hazardous if applied either in evening or early morning when honey bees are not foraging, except during periods of high temperature. 3 hr to 1 day residual toxicity
- **H** High; hazardous to honey bees at any time. 1 day to 2 week residual toxicity

All other Beneficials:
- **L** low impact on population (less than 30% mortality).
- **M** moderate impact on poppulati (between 30% and 70% mortality).
- **H** high impact on opulation (more than 70%mortality).
- **—** no data.
- **[b]** low impact on immatures, moderate impact on eggs.
- **[c]** low impact on adults, moderate impact on eggs and immatures. However,general population recovery occurs within 7 days.
- **[d]** This information derived from application field tests conducted at the NYS Agricultural Experiment Station.
- **[e]** Dependent on rate.

Pesticides with long residual periods (pyrethroids) will have a greater impact than those with a shorter residual (like some organophosphates).

Key to pests:

AM = apple maggot
Aph = Spirea aphid and apple aphid
ARM = apple rust mite
ERM = European red mite
GFW = green fruitworm
Int = Internal Leps (codling moth, oriental fruit moth, lesser appleworm)
LH = white apple/potato leafhoppers
OBLR = obliquebanded leafroller
PC = plum curculio
PPs = pear psylla
PRM = pear rust mite
RAA = rosy apple aphid
RBLR = redbanded leafroller
SJS = San Jose scale
STLM = spotted tentiform leafminer
TPB = tarnished plant bug
TSSM = twospotted spider mite

Key to beneficials:

Bees = honeybees
Af = *Amblyseius fallacis*, a predatory mite found throughout NYS
Aa = *Aphidoletes aphidimyza*, a cecidomyiid predator of aphids
Tp = *Typhlodromus pyri*, a predatory mite found mostly in western NYS
Sp = *Stethorus punctum*, a ladybird beetle predator of mites

Table 7.1.2. Activity spectrum of stone fruit insecticides.

Insecticide	IRAC‡	APB	Aphids	CFF	JB	OFM	PC	PTB/LPTB	TPB	WFT
Altacor (chlorantraniliprole)	28	—	—	1	—	3	—	—	—	—
*Ambush, *Pounce (permethrin); except plums	3	—	—	3	—	3	3	2	3	2
*Asana (esfenvalerate)	3	1	–	3	—	3	3	3	3	2
Assail (acetamiprid)	4A	—	3	3	3	3	2	--	2	--
§Aza-Direct, §Azatin, §Neemix (azadirachtin)	18B	—	2	—	0	2	0	2	—	—
*Baythroid (cyfluthrin)	3	—	3	3	—	3	3	3	3	—
Beleaf (flonicamid)	9C	—	3	--	—	—	—	—	3	--
Delegate (spinetoram)	5	—	--	3	—	3	2	—	—	3
*diazinon	1B	—	1	3	—	1	2	0	2	—
*Guthion (azinphos-methyl)-cherries only	1B	—	0	3	—	2-3	3	0	2	—
*Imidan (phosmet); except sweet cherries	1B	—	1	3	1	2-3	3	0	2	—
*Lannate (methomyl)	1A	—	2	—	—	2	2	1	2	3
Leverage (cyfluthrin/imidacloprid)	3/4A	0	3	3	3	3	3	3	3	--
Lorsban (chlorpyrifos)	1B	3	2	3	—	—	3	3	—	—
malathion	1B	—	2	1	1	1	2	0	1	—
§M-Pede (insecticidal soap)	—	0	2-3	0	0	0	0	0	0	—
*Provado (imidacloprid)	4A	0	3	0	2	0	1	0	—	—
Sevin (carbaryl)	1A	—	3	3	3	2	2	0	—	1
SpinTor, §Entrust (spinosad)	5	—	—	—	—	—	—	—	—	3
§Surround (kaolin)	—	—	1	2	1	2	2	—	0	—
*Thionex (endosulfan)	2A	0	1	—	—	0	0	3	2	—
*Warrior (*lambda-cyhalothrin)	3	1	3	3	1	3	3	3	3	2

Key to control ratings:
— = unknown or does not apply in this case; **0** = not effective; **1** = poor; **2** = fair; **3** = good
* Restricted-use pesticide; may be purchased and used only by certified applicators, or used by someone under the supervision of a certified applicator.
§ = Potentially acceptable in certified organic programs
‡ = IRAC (Insecticide **R**esistance **A**ction **C**ommittee) Mode of Action Classification Group: Arthopod pest populations are more likely to exhibit cross-resistance to materials within the same group.

Key to pests:
APB = American plum borer
Aphids = black cherry, green peach aphids
CFF = cherry fruit flies
JB = Japanese beetle
OFM = oriental fruit moth
PC = plum curculio
PTB/LPTB = peachtree borer/lesser peachtree borer
TPB = tarnished plant bug
WFT = western flower thrips

Table 7.1.3. Degree-day accumulations (from Jan. 1) corresponding to selected fruit phenology and arthropod pest events.

Pest/Phenology Event	DD Base 43˚F mean	DD Base 43˚F std dev	DD Base 50˚F mean	DD Base 50˚F std dev	Approx. Date mean	Approx. Date std dev
STLM Traps set out			1-April			
Pear psylla – egg laying	84	44	33	21	4-Apr	11 days
Redbanded leafroller – 1st catch	142	34	59	20	17-Apr	7 days
Rosy apple aphid – 1st egg catch	189	55	86	30	25-Apr	7 days
STLM – 1st adult catch	154	44	66	25	18-Apr	8 days
STLM - 1st egg observed	208	65	94	36	27-Apr	5 days
Tight cluster (McIntosh)	229	29	105	19	27-Apr	6 days
Tarnished plant bug – 1st observed	222	105	105	62	25-Apr	15 days
OBLR – 1st overwintered larvae observed	236	78	112	48	29-Apr	7 days
European red mite – egg hatch observed	284	53	134	34	6-May	4 days
STLM Egg Sample			Pink			
Pink (McIntosh)	294	19	141	18	4-May	6 days
Oriental fruit moth – 1st adult catch	275	52	130	36	3-May	8 days
STLM – 1st gen. Adult peak flight	327	63	160	40	7-May	7 days
OBLR Overwintered Gen. Sample			Bloom			
Full bloom (McIntosh)	385	36	196	24	11-May	6 days
San Jose scale – 1st adult catch	531	88	281	59	21-May	8 days
Cherry fruit fly traps set out			20-May			
Codling moth – 1st adult catch	489	92	257	58	19-May	7days
STLM – 1st sap-feeding mines observed	472	129	241	76	18-May	13 days
Petal fall (McIntosh)	484	39	254	26	18-May	6 days
Plum curculio – 1st oviposition scars observed	555	77	286	37	25-May	9 days
Pear psylla – hardshell stage observed	569	87	312	51	22-May	9 days
Lesser peachtree borer – 1st adult catch	589	103	319	66	25-May	8 days
ERM Sample – 2.5 mites/leaf				1-Jun		
OBLR traps set out				1-Jun		
STLM traps – change lure				1-Jun		

Abbreviations:
ERM = European red mite
OBLR = Obliquebanded leafroller
OFM = Oriental fruit moth
RBLR = Redbanded leafroller
STLM = Spotted tentiform leafminer

Note: Information in above table is based on field observations. Values and dates are given +/- one standard deviation; i.e., events should occur within the stated range approximately 7 yr out of 10. This information is provided as a scouting and sampling guide.

Table 7.1.3. Degree-day accumulations (from Jan. 1) corresponding to selected fruit phenology and arthropod pest events. *(continued)*

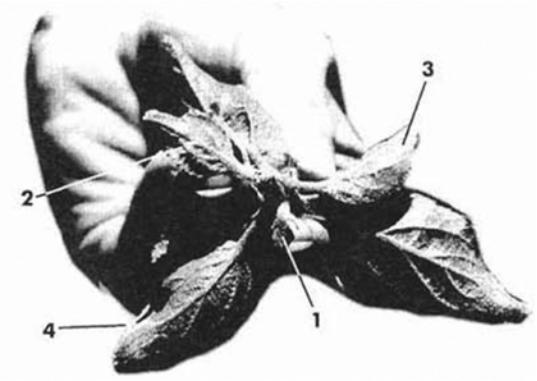
Pest/Phenology Event	DD Base 43˚F mean	DD Base 43˚F std dev	DD Base 50˚F mean	DD Base 50˚F std dev	Approx. Date mean	Approx. Date std dev
OBLR – 1st adult catch, 1st summer brood	883	56	521	46	9-Jun	6 days
Peachtree borer – 1st adult catch	1057	289	633	196	17-Jun	11 days
STLM – 2nd gen. 1st adult catch	1067	87	651	69	16-Jun	7 days
San Jose scale – 1st crawlers observed	1124	91	688	69	19-Jun	8 days
OBLR – peak catch	991	148	599	108	15-Jun	7 days
Apple maggot – 1st fly catch (non-orchard)	1424	196	909	125	2-Jul	9 days
Apple Maggot Traps Set Out (in orchard)			1-Jul			
ERM Sample – 5.0 mites/leaf			1-Jul			
Comstock mealybug tape traps set out			1 Jul (ENY), 15 (WNY)			
OFM – 2nd gen. 1st adult catch	1382	107	877	92	30-Jun	5 days
OBLR Summer Gen. 1st Sample					10-Jul	5 days
STLM Summer Gen. 1st Sample					9-Jul	7 days
RBLR – 2nd gen. 1st catch	1418	168	903	133	1-Jul	6 days
Lesser peachtree borer – peak catch	1370	469	887	331	1-Jul	17 days
STLM – 2nd gen. peak catch	1589	207	1030	164	8-Jul	9 days
RBLR – 2nd gen. Peak catch	1762	222	1160	170	14-Jul	7 days
ERM Sample – 7.5 mites/leaf			1-Aug			
OBLR traps – change lure			1-Aug			
Cherry fruit fly traps in			1-Aug			
Comstock mealybug – 2nd gen. crawlers emerging	2447	196	1651	141	9-Aug	12 days
OBLR – 1st adult catch, 2nd summer brood	2455	200	1677	161	8-Aug	9 days
STLM – 3rd gen. peak catch	2792	222	1922	169	22-Aug	9 days
All Traps In			30-Aug			

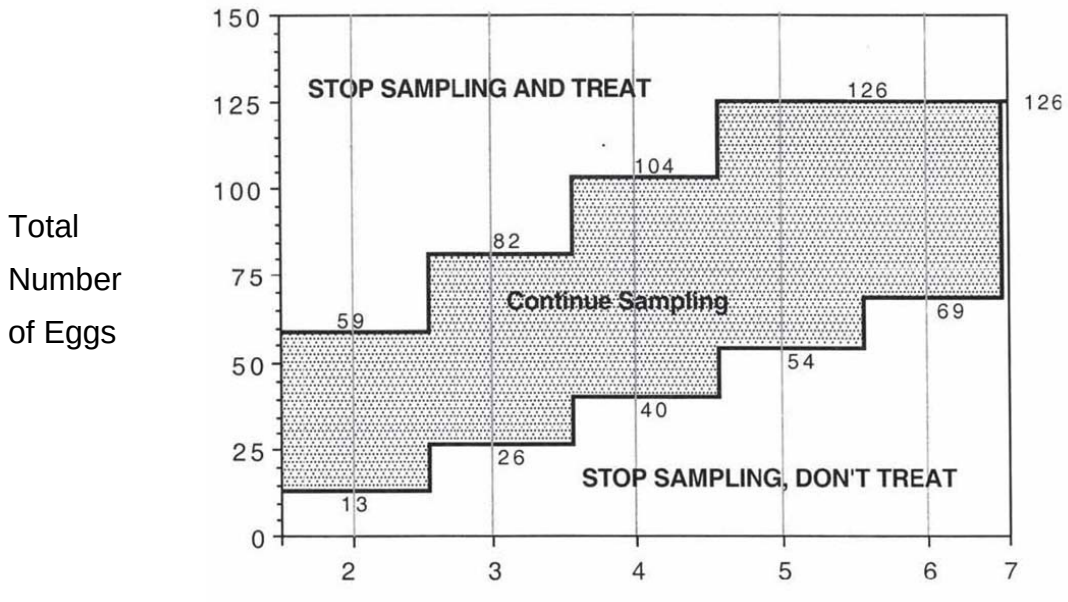
Abbreviations:
ERM = European red mite
OBLR = Obliquebanded leafroller
OFM = Oriental fruit moth
RBLR = Redbanded leafroller
STLM = Spotted tentiform leafminer

Note: Information in above table is based on field observations. Values and dates are given +/- one standard deviation; i.e., events should occur within the stated range approximately 7 yr out of 10. This information is provided as a scouting and sampling guide.

Figure 7.1.1 - STLM Pink Sampling Form

- During the pink bud or early bloom stage, start near one corner of the block, and go to every other tree until you have sampled enough trees to reach a decision, Select 3 fruit clusters from around the canopy of each tree sampled.
- Using a magnifier, count the eggs on the undersides of the 2nd, 3rd, and 4th leaves in each cluster, counting leaves in the order they unfolded (see diagram at right).
- After 2 trees have been sampled, begin comparing the accumulated total number of eggs found with the decision lines shown in the chart below for that number of trees.

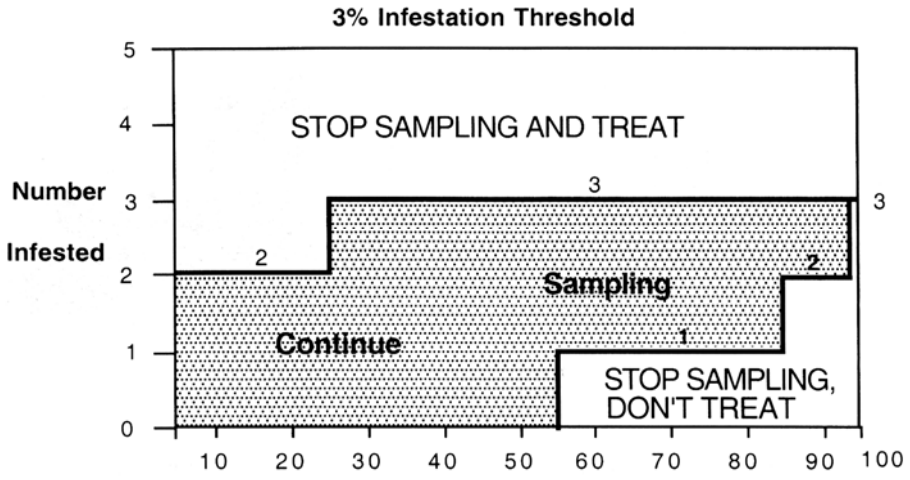




- If the number of eggs falls in the "Continue Sampling" zone, sample another tree. If the total is in the "Stop Sampling, Don't Treat" zone, sampling is stopped and no treatment is recommended. If the total is in the "Stop Sampling and Treat" zone, sampling is stopped and a treatment is recommended at either pink or petal fall. If 7 trees are sampled and the total number of eggs equals 126, the population is below threshold.

Refer to the Apple Pesticide Spray Table for a choice of pesticide materials,

Figure 7.1.2 - Obliquebanded Leafroller Sampling Form



- Examine 10 bud clusters (overwintering generation) or expanding terminals (1st summer generation) per tree for live OBLR larvae. For the 1st summer generation, sample at ~600 degree-days (43°F base) after the 1st moth flight in your area; if you do not have access to this information, use July 5 as an estimated best sample date in WNY (5-7 days earlier in ENY and Long Island).

- Sample every other tree starting with a random tree and continuing down the row. Remember that you are NOT counting OBLR larvae, but sites infested with LIVE OBLR. If trees are >10ft tall, try to include some samples from the upper canopy, or from watersprouts.

- If the total number of infested samples falls in the "Continue Sampling" zone, sample another tree. If the total falls in the "Stop Sampling, Don't Treat" zone, sampling is stopped and no treatment is recommended. If the total falls in the "Stop Sampling and Treat" zone, sampling is stopped and treatment is recommended. Refer to the Apple Pesticide Spray Table for a choice of pesticide materials.

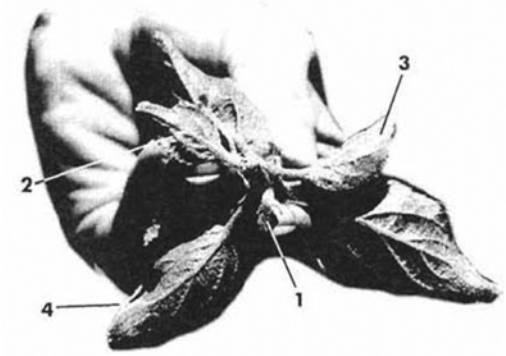
- Continue sampling until you REACH one of the boldface staircase lines in the chart above, or until you have examined a maximum of 100 clusters. If you reach the intersection of the two lines by the 100th sample, withhold treatment.

- If a no-treat decision is made for 1st summer generation larvae, resample again in 3-5 days (after approximately 100 DD more have accumulated). A second no-treat decision indicates that no treatment is recommended against this brood of OBLR.

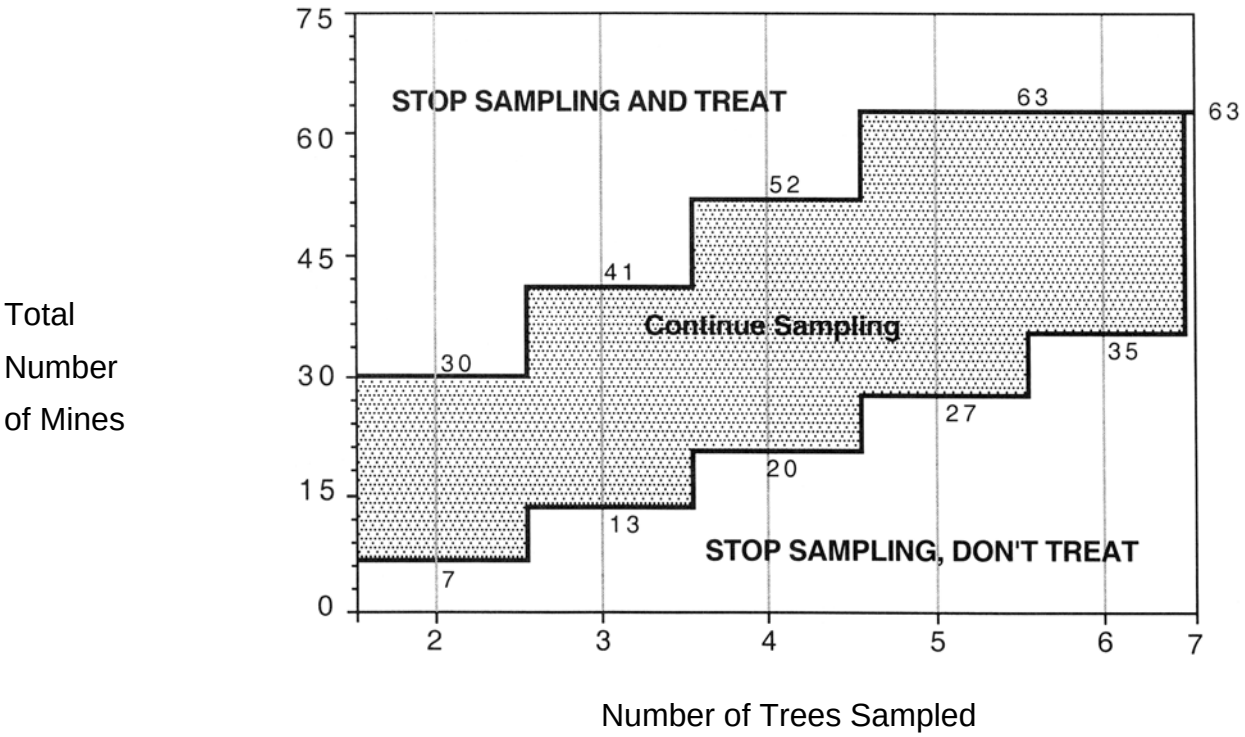
Use this table to keep track of your samples

Total Number Examined	# Infested	Total Number Examined	# Infested
10 ……..	_____	60 ……..	_____
20 ……..	_____	70 ……..	_____
30 ……..	_____	80 ……..	_____
40 ……..	_____	90 ……..	_____
50 ……..	_____	100 ……..	_____

Figure 7.1.3 - STLM Petal Fall Sampling Form



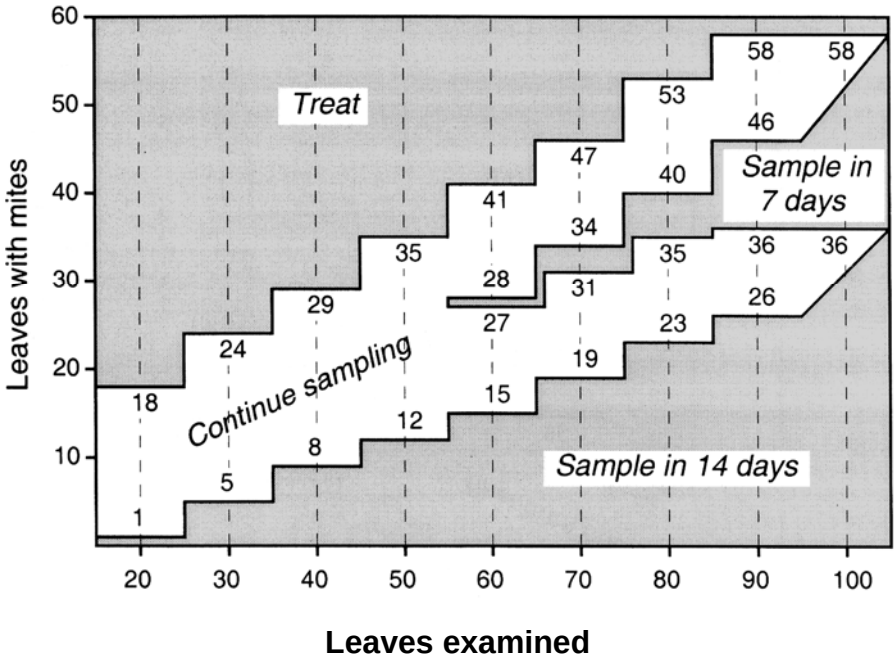
- If STLM eggs were not sampled during the pink or early bloom stage, a decision on 1st generation control can still be made by sampling sap-feeding mines at petal fall. After all the blossoms have fallen, start near one corner of the block, and go to every other tree until you have sampled enough trees to reach a decision. Select 3 fruit clusters from around the canopy of each tree sampled.
- Using a magnifier, count the mines on the undersides of the 2nd, 3rd, and 4th leaves in each cluster, counting leaves in the order they unfolded (see diagram at right).
- After 2 trees have been sampled, begin comparing the accumulated total number of mines found with the decision lines shown in the chart below for that number of trees.



- If the number of mines falls in the "Continue Sampling" zone, sample another tree. If the total is in the "Stop Sampling, Don't Treat" zone, sampling is stopped and no treatment is recommended. If the total is in the "Stop Sampling and Treat" zone, sampling is stopped and a treatment is recommended at petal fall. If 7 trees are sampled and the total number of mines equals 63, the population is below threshold.

Refer to the Apple Pesticide Spray Table for a choice of pesticide materials.

Figure 7.1.4 – Mite Sampling Chart
Threshold = 2.5 mites/leaf
(June 1 - 30)



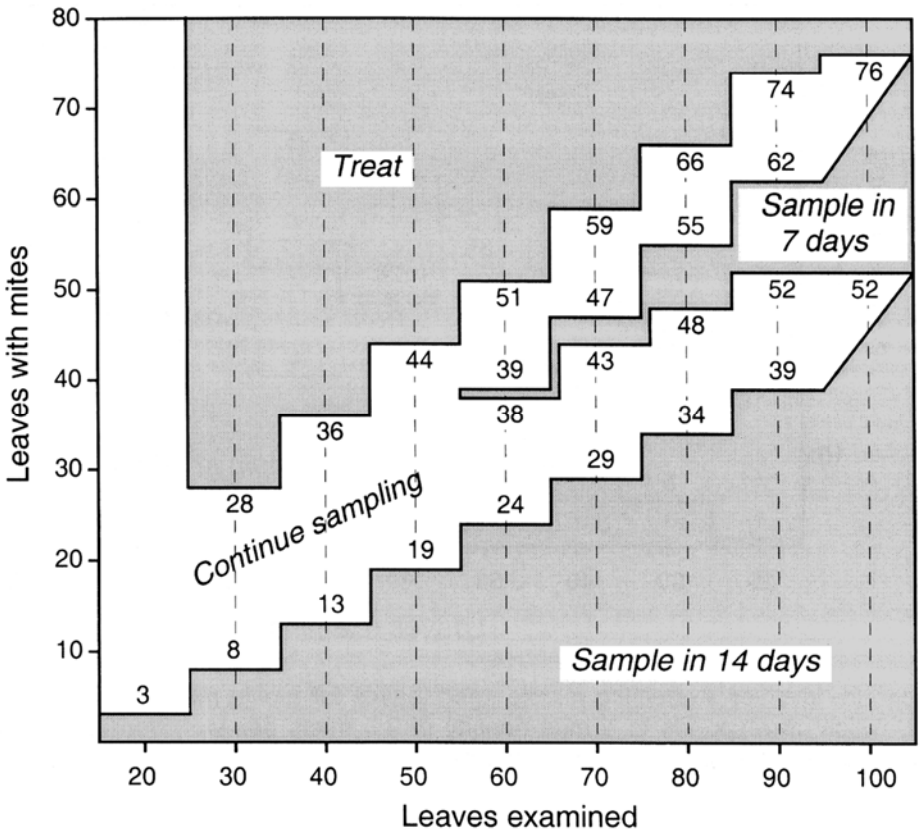
- This procedure involves examining middle aged leaves for motile mites (any stage except eggs). Use this chart, which corresponds to a mite density of 2.5 mites per leaf, from June 1 until June 30. You will not be counting mites, but will only determine whether they are present or absent on each leaf sampled.

- Starting with a random tree and sampling every other tree, collect 4 leaves in a plastic bag from each of 5 trees, choosing from each quadrant of the canopy. To make sure the leaves are of an intermediate age, pick them from the middle of the fruit cluster.

- Using a magnifier, examine the top and bottom surface of each leaf for motile mites, and keep track of the number of leaves containing motile mites. When all 20 leaves have been examined, compare this number with the numbers on the above decision guide. If the number of leaves with mites is equal to the values on the stairstep lines, the decision is the one shown in the area immediately below the value (example: For "29" after sampling 40 leaves, the decision is "Continue sampling"; for "8" the decision is to "Sample in 14 days").

- When the counts fall into any of the shaded regions, sampling is stopped and a decision is made to either treat, or else re-sample in 7 or 14 days. If the counts fall in the "Continue sampling" zone, take and examine more leaf samples in batches of 10 (5 per tree) until the counts fall into one of the shaded regions. If you reach one of the resample zones, the population is below threshold, and should remain so for at least the number of days stated. Return at the designated time and conduct another sample. If the -7 day" resample date falls during the 5.0 mites/leaf Threshold period, you can wait for a total of 14 days before resampling.

Figure 7.1.5 - Mite Sampling Chart
Threshold = 5.0 mites/leaf
(July 1 - 31)

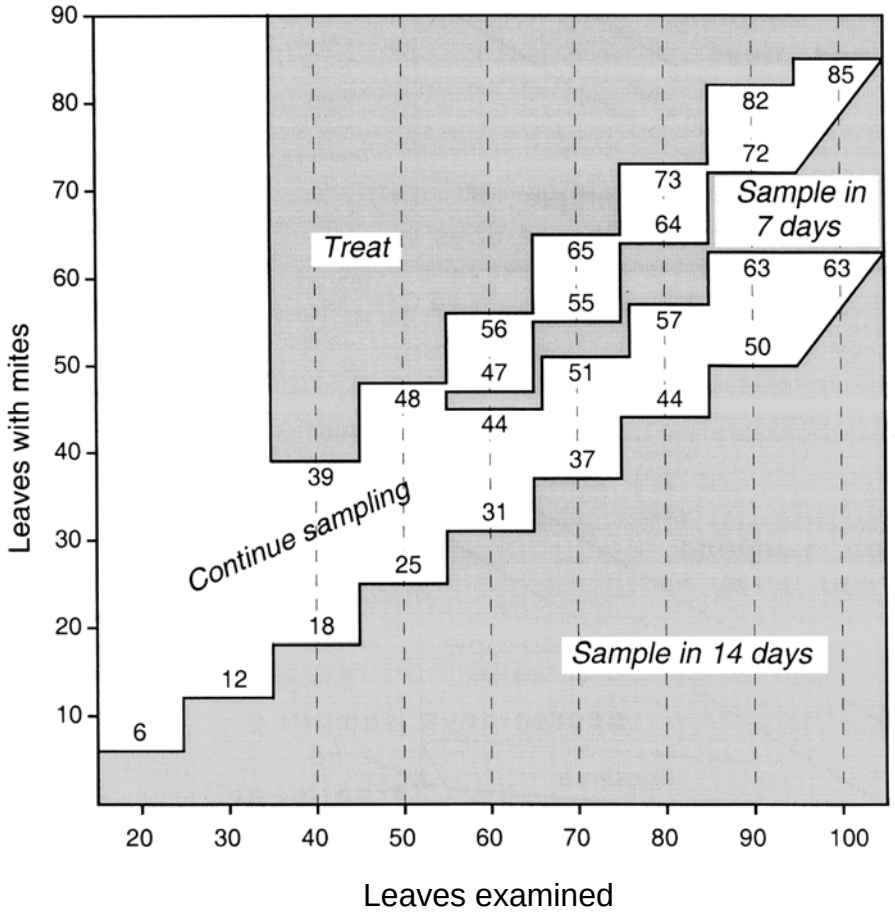


- This procedure involves examining middle aged leaves for motile mites (any stage except eggs). Use this chart, which corresponds to a mite density of 5.0 mites per leaf, from July 1 until July 31. You will not be counting mites, but will only determine whether they are present or absent on each leaf sampled.

- Starting with a random tree and sampling every other tree, collect 4 leaves in a plastic bag from each of 5 trees, choosing from each quadrant of the canopy. To make sure the leaves are of an intermediate age, pick them from the middle of the fruit cluster or foliar terminal.

- Using a magnifier, examine the top and bottom surface of each leaf for motile mites, and keep track of the number of leaves containing motile mites. When all 20 leaves have been examined, compare this number with the numbers on the above decision guide. If the number of leaves with mites is equal to the values on the stairstep lines, the decision is the one shown in the area immediately below the value (example: For "36" after sampling 40 leaves, the decision is "Continue sampling"; for "13" the decision is to "Sample in 14 days"). When the counts fall into any of the shaded regions, sampling is stopped and a decision is made to either treat, or else re-sample in 7 or 14 days. If the counts fall in the "Continue sampling" zone, take and examine more leaf samples in batches of 10 (5 per tree) until the counts fall into one of the shaded regions. If you reach one of the resample zones, the population is below threshold, and should remain so for at least the number of days stated. Return at the designated time and conduct another sample. If the "7 day" resample date falls during the 7.5 mites/leaf Threshold period, you Can wait for a total of 14 days before resampling.

Figure 7.1.6 - Mite Sampling Chart
Threshold = 7.5 Mites/Leaf
(August 1 - 15)

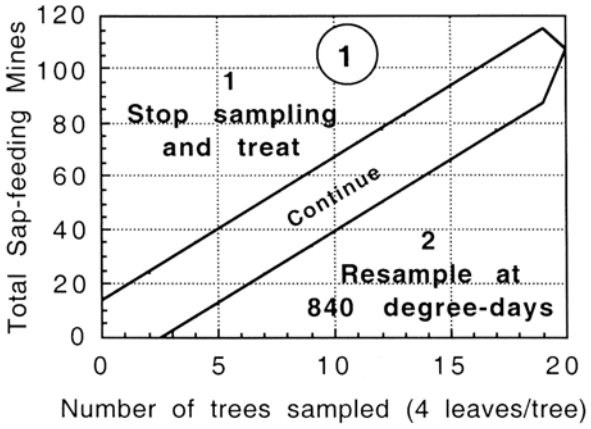


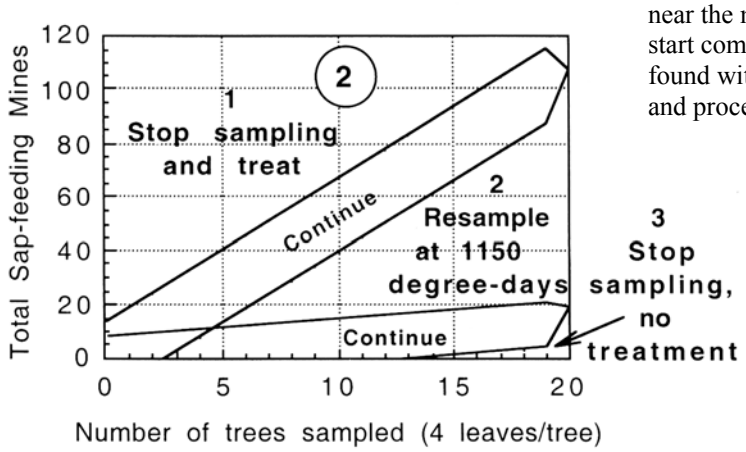
- This procedure involves examining middle aged leaves for motile mites (any stage except eggs). Use this chart, which corresponds to a mite density of 7.5 mites per leaf, from August 1-15. You will not be counting mites, but will only determine whether they are present or absent on each leaf sampled.

- Starting with a random tree and sampling every other tree, collect 4 leaves in a plastic bag from each of 5 trees, choosing from each quadrant of the canopy. To make sure the leaves are of an intermediate age, pick them from the middle of the fruit cluster or foliar terminal.

- Using a magnifier, examine the top and bottom surface of each leaf for motile mites, and keep track of the number of leaves containing motile mites. When all 20 leaves have been examined, compare this number with the numbers on the above decision guide. If the number of leaves with mites is equal to the values on the stairstep lines, the decision is the one shown in the area immediately below the value (example: For "39" after sampling 40 leaves, the decision is "Continue sampling"; for "18" the decision is to "Sample in 14 days"). When the counts fall into any of the shaded regions, sampling is stopped and a decision is made to either treat, or else re-sample in 7 or 14 days. If the counts fall in the .Continue sampling" zone, take and examine more leaf samples in batches of 10 (5 per tree) until the counts fall into one of the shaded regions. If you reach one of the resample zones, the population is below threshold, and should remain so for at least the number of days stated. Return at the designated time and conduct another sample. If the resample date falls after August 15, there should be no further need for additional samples or miticide sprays this season.

Figure 7.1.7 - STLM Summer Sampling Form





Because of variability in this pest's development from one site to the next, more than one sampling session may be needed to reach a treatment decision for 2nd generation STLM. The first sample should be taken at 690 degree-days (base 43°F) after the start of the 2nd moth flight (or approximately 25-30 days). Use July 9 as an approximate sampling date if you don't have access to pheromone trap catch data.

Start near one corner of the block and sample trees along a diagonal, moving toward the opposite corner of the block. At each tree, count all the **sap-feeding** mines on 4 mature terminal leaves randomly selected from around the outside of the canopy. Sampled leaves should be those located near the middle of the terminals. After sampling 3 trees, start comparing the accumulated total number of mines found with the appropriate chart for the sampling session and proceed as follows:

SAMPLING DONE AT 690-840 DD

If the number of mines falls in the "Continue" zone on **Chart 1**, sample another tree and check again. If the total is above this zone (area 1). sampling is stopped and a treatment is recommended. If the total is below this zone (area 2), stop sampling and sample the block again at approximately 840 DD (about 31 days) after the start of the 2nd flight.

SAMPLING DONE AT 840-1149 DD, IF NECESSARY

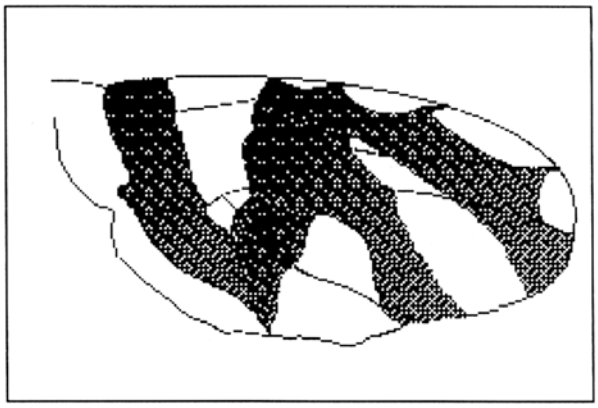
If it is necessary to sample the population a second time, refer to Chart 2 after sampling the 3rd tree. If the accumulated total falls in one of the "Continue" zones, sample another tree and check again. If the count falls in area 1, a treatment is recommended and no further sampling is necessary. If the count falls in area 2, stop sampling and sample the block again at approximately 1150 DD (about 42 days) after the start of the 2nd flight. If the count falls in area 3, treatment is not recommended and no further sampling is necessary.

SAMPLING DONE AT 1150 OR MORE DD, IF NECESSARY

If it is necessary to sample a third time, refer again to **S**, the same as in the first sampling session. This time, however, if the accumulated total number of mines falls in area 2, treatment is not recommended and no further sampling is required for this brood of STLM.

Refer to the Apple Pesticide Spray Table for a choice of pesticide materials if a treatment is elected.

Figure 7.1.8 – Apple Maggot Monitoring Form



On or before July 15, hang 3 sticky red sphere traps baited with apple volatile lures in the trees along the edge of your block closest to an abandoned orchard or a stand of woods. If no abandoned trees or woodlands are nearby, choose the southern edge of the block. Traps should be spaced at least 30 ft from each other, on the outside edge of the canopy, at least 6 ft. high. Position the traps so that they are surrounded by fruit and foliage, but are not touched by them or obstructed from view. Traps should be checked 1-2 times per week for Apple Maggot flies, which can be distinguished from similar species by the pattern of dark bands on their wings (right). If a total of 5 AM flies/trap are caught (or 15, in this case), a spray of a suitable insecticide is recommended immediately, after which the traps can be ignored for 7-14 days. (Refer to the Apple Pesticide Spray Table for a choice of pesticide materials.) Begin checking the traps again after this period of protection by the spray residue. Traps should be cleaned of non-pest flies periodically and re-coated with stickum if necessary. No treatment is recommended until a cumulative total of 5 AM flies/trap are caught. If un baited sphere traps are used, the threshold should be lowered to 1 AM fly/trap. Traps can be taken down by August 30. In New England, it may be better to leave traps up until September 10, especially in blocks with Cortland or Delicious fruit. In blocks with very early varieties ("summer apples"), July 1 is a more appropriate starting time.

Date checked	Total number of AM Flies caught since last spray	Total AM flies/3	Date of last spray	Material/Rate

Figure 7.1.9. Apple Events Calendar for the Lake Plains Area of New York

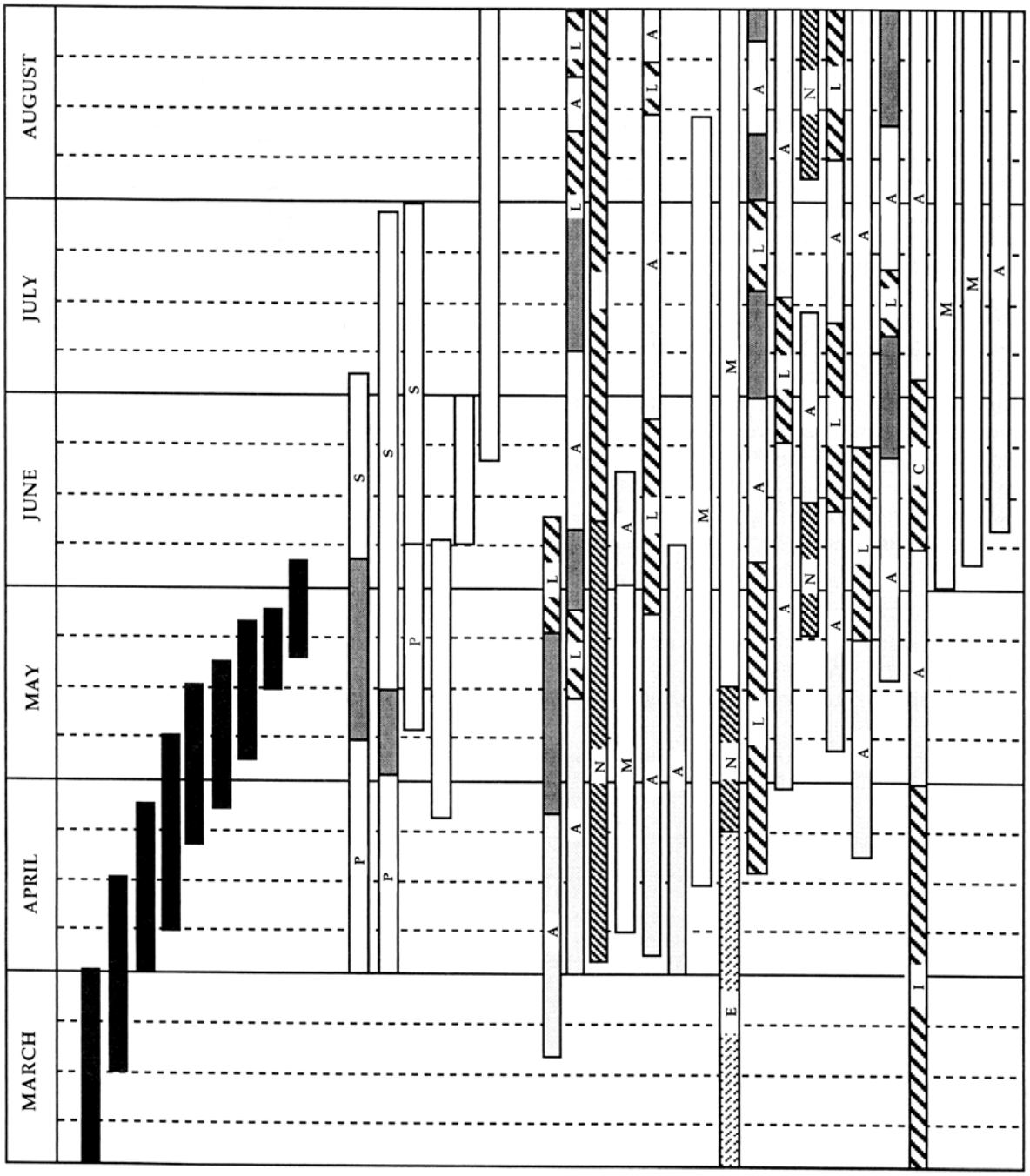
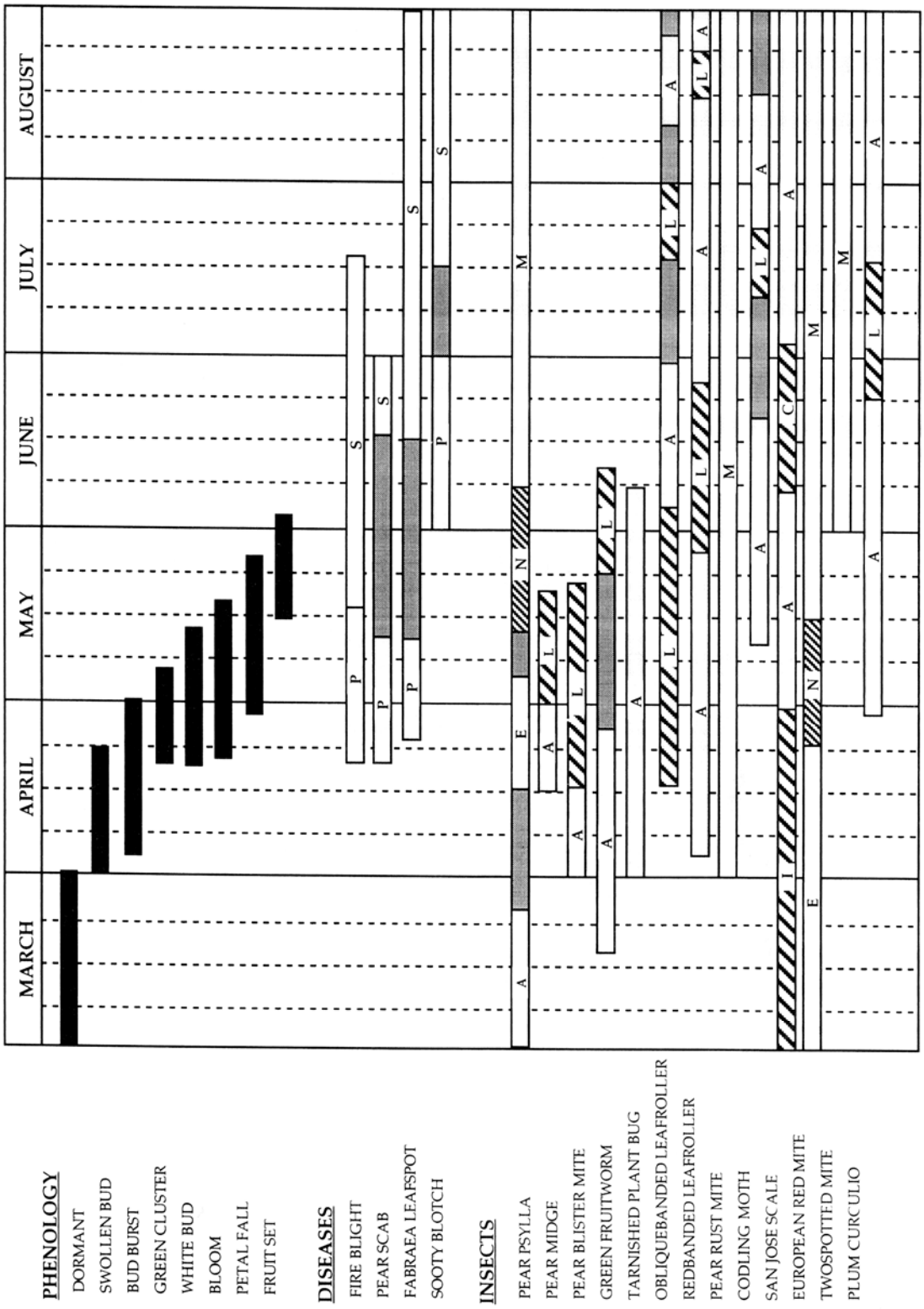


Figure 7.1.10. Pear Events Calendar for the Lake Plains Area of New York



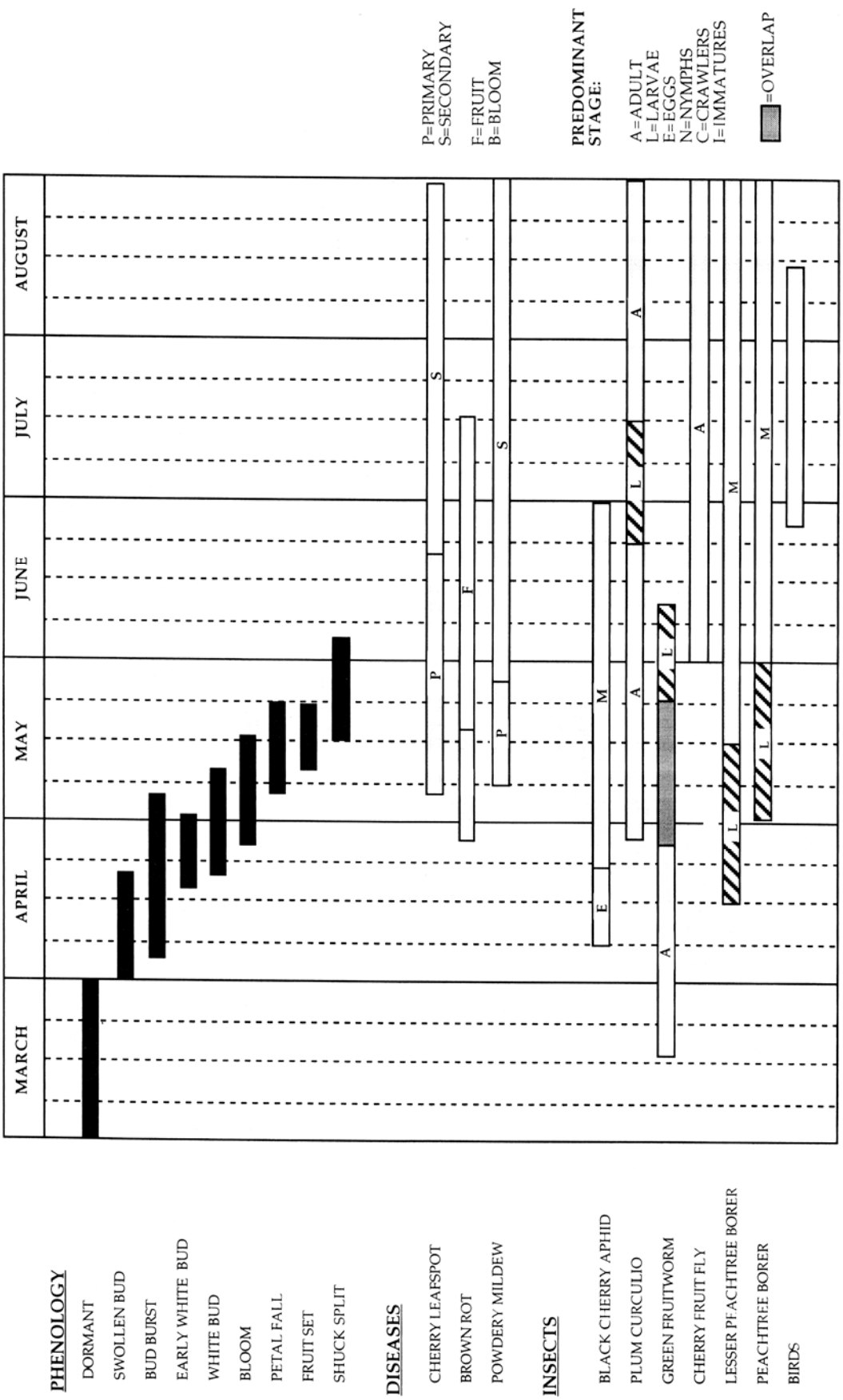


Figure 7.1.11. Cherry Events Calendar for the Lake Plains Area of New York

Figure 7.1.12. Peach Events Calendar for the Lake Plains Area of New York

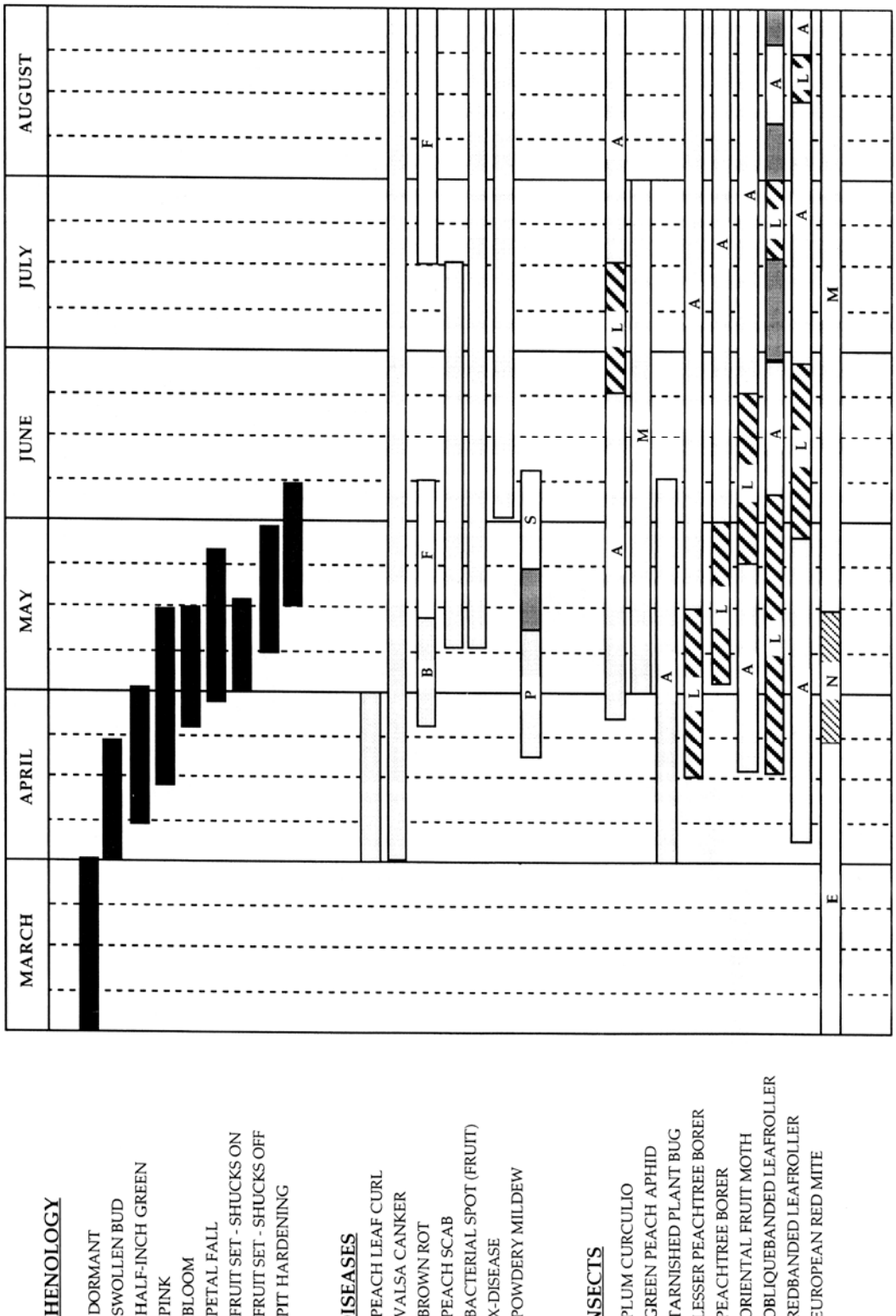
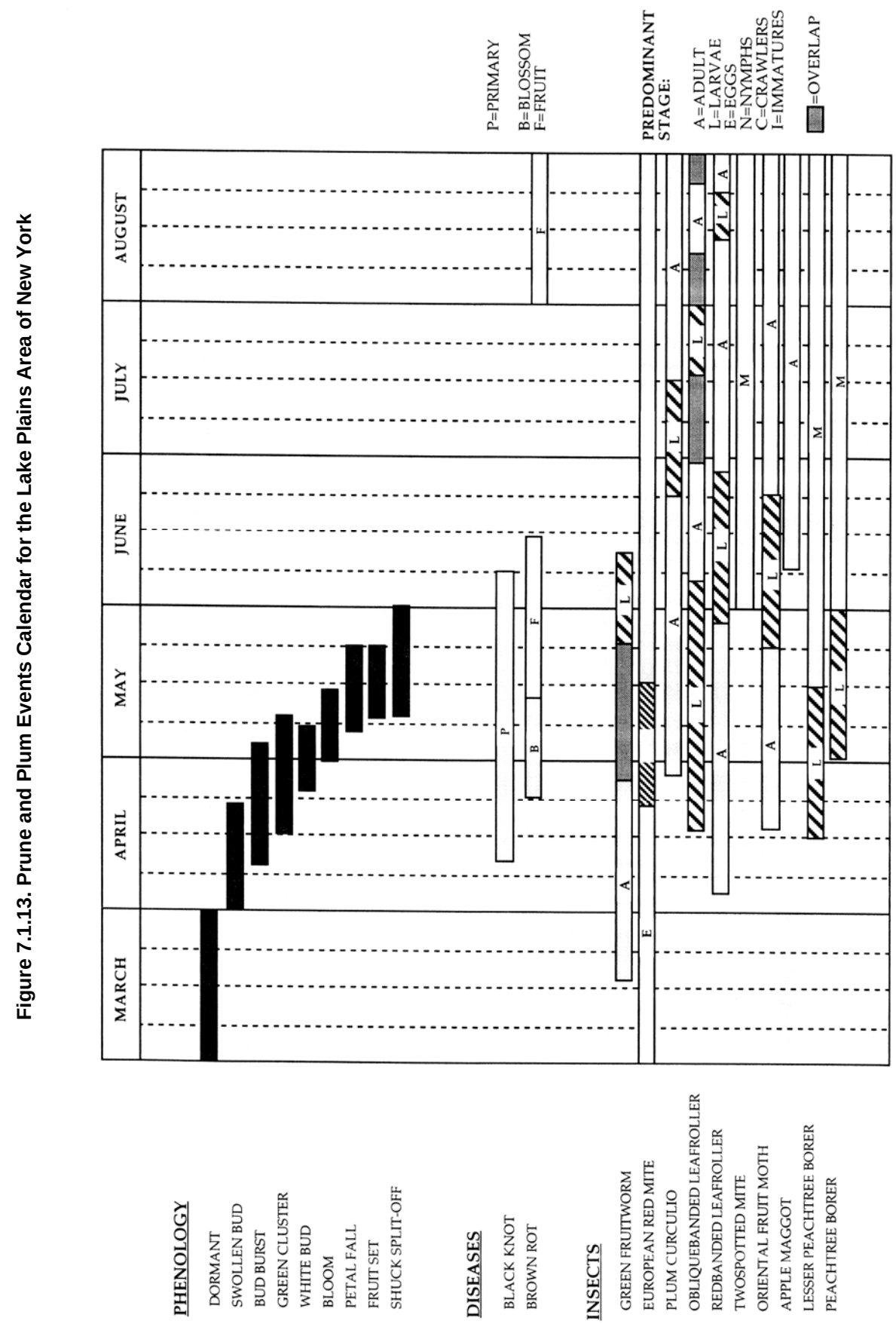


Figure 7.1.13. Prune and Plum Events Calendar for the Lake Plains Area of New York



8 Weed Management

8.1 Calibration to Ensure Correct Herbicide Rate

Herbicide labels indicate rate of application as amount of product per acre; that is, per acre actually treated. Only if you broadcast herbicide over the entire orchard floor will the treated acreage equal the orchard acreage. Follow the instructions below to assure application of the correct herbicide rate.

8.1.1 Calculating Nozzle Flow Rate

Travel Speed:
For most situations, 2–2.5 mph is best (176–220 ft./min.).

Pressure:
Use low pressure (20–35 psi) to minimize formation of small droplets, because small droplets can drift off target.

Spray Volume per Treated Acre:
Generally, low rates (20–30 gals./acre, or less) are more suitable for postemergence herbicides, where runoff from weeds would reduce effectiveness. Higher rates, 40–50 gals./acre, may provide better coverage and control when using preemergence herbicides.

Nozzles:
Avoid nozzles that produce fine mist. Generally, hollow cone nozzles produce the finest droplets, flat sprays are second, and full cone nozzles produce the coarsest spray.

A single boomless off-center flat spray nozzle, or a flooding nozzle, may be suitable for some orchards, but one or more regular flat spray nozzles on a boom may be better where branches are close to the ground.

Use the following formula to determine nozzle flow rate in gal./min., then consult a nozzle manufacturer's chart to select the proper nozzle.

8.1.2 Definition of Terms

1. **Gallons per Treated Acre (G/TA)** = Amount of herbicide spray you want to apply per treated acre.
2. **Swath (S)** = Width of the sprayed area in feet.
3. **Travel Speed (TS)** = Feet traveled per minute.
4. **Nozzle flow rate** (gallons per minute) = (Gallons per Acre x Swath x Travel Speed) divided by 43,560

Nozzle Flow Rate = (G/TA x S x TS) / 43,560

Example 1:

What nozzle flow rate do you need to apply 25 gallons of herbicide spray mix per treated acre, using a 3-foot-wide swath and a travel speed of 220 feet per minute (=2.5 miles per hour)?

Nozzle flow rate
= (25 x 3 x 220) divided by 43,560
= (16,500) divided by 43,560
= 0.38 gallons per minute.

If using 2 nozzles, select 2 that will give 0.19 gallon per minute each at the selected pressure.

8.1.3 Checking Herbicide Sprayer Output

Spray Pattern:
Check uniformity of spray pattern, using corrugated fiberglass roofing panels as a spraying surface. Spray from the same height as will be used in the orchard. Compare liquid volume collected in each trough.

Actual Spray Volume:
With proper nozzles installed, travel a measured distance at the selected speed and pump pressure. Use this formula to determine the actual spray volume in gallons per treated acre.

Gallons per Treated Acre:
= (Gallons sprayed during trial run x 43,560) divided by (Feet traveled during trial run x Swath width in feet).

Example:

You emptied a tank containing exactly 3 gallons in a distance of 1,200 feet. The treated swath was 3 feet wide. How many gallons of spray are you applying per treated acre?

Gallons per Treated Acre
= (3 x 43,560) divided by (1,200 x 3)
= (130,680) / (3,600)
= 36.3 gallons

If you want to apply 4 lbs. of herbicide per acre, then in this case you would add 4 lbs. of herbicide to each 36 gallons of water in the tank.

Agitation:
If herbicides are allowed to settle or separate in the sprayer tank, distribution in the orchard will not be uniform. Provide constant agitation when using wettable powders, or any other insoluble formulation (emulsions, emulsifiable concentrates, dry flowables, liquid flowables, and suspensions). Use defoaming adjuvant when needed to control excessive foam.

8.2 Groundcover Management

Management of the orchard floor is an essential and often expensive piece of the overall orchard management scheme. A poorly designed and managed orchard floor will increase costs in several important ways, including increased

mowing costs, reduced yield due to weed competition, and wear and tear on equipment. Several orchard floor management options to consider are:

1. Clean Cultivation/Fall Cover

This option can be effective with young trees, in particular as a management system that eliminates weed competition and encourages tree growth. These benefits do not come without cost. Soil erosion in particular is a real risk. Late summer seeding to a fall cover crop such as spring oats is essential to limit erosion. This fall cover must be planted early enough to allow ample autumn growth to protect soil from cold penetration in winter. Loss of organic matter with this system is another liability–soil organic matter is broken down quickly with repeated cultivation. In addition to these potential risks, calcium availability to trees may be reduced and soil compaction problems may develop.

2. Mulch

Mulching offers some attractive potential benefits, including improved soil moisture retention and weed suppression. Unfortunately, mulching also offers a couple of key liabilities that make it impractical as a general orchard practice. Perhaps most importantly, mulch provides an ideal habitat for voles (mice). Also, while the use of mulch will increase levels of organic matter and key nutrients including potassium and magnesium, its use will likely lead to reduced calcium levels.

The use of wood-based mulch such as wood chips and bark may be valuable on excessively drained soils

3. Permanent Sod

Permanent sod, often including an under-tree herbicide strip, is the orchard floor management system most commonly used. A permanent sod offers many important benefits. It reduces soil erosion; gives support (especially important when soils are wet) for heavy equipment needed for brush removal, pesticide application, and mowing; reduces dust and dust deposits on fruit; reduces tree rack or wobble during wind events; insulates against cold penetration in winter; increases movement of key nutrients including calcium into the tree root zone; and may provide winter refuge for a beneficial mite species.

A permanent sod also allows soil organic matter levels to increase over time, a condition which when coupled with proper soil pH management, eliminates the need to apply phosphorous throughout the life of the orchard.

The key to success with this system is establishment (preferably prior to planting) of a permanent sod floor. Combinations of slow-growing grass types such as dwarf hard fescues and perennial ryegrasses are preferable.

The process of establishing an orchard floor should include elimination of perennial weeds and grasses through use of an herbicide such as glyphosate (Roundup). In addition, correction of soil drainage deficiencies, soil pH and nutrient adjustment based on soil test recommendations, and preparation of a smooth, stone-free soil surface for seeding are all key elements for success. A 2-year soil preparation process that includes a full summer of cover cropping with a vigorous cover crop such as Sudan grass or Japanese millet is ideal. Seeding of a new orchard floor is best done in late summer or early autumn. In older plantings, the permanent sod is often a 'wild' mix of more vigorous grasses and herbaceous plants, a mix that requires extensive management including several mowings annually. In addition, the orchard floor is often rough and rutted from years of equipment traffic and dotted with rock outcroppings, adding to the management cost.

Some drawbacks are associated with permanent ground cover. Certain plant species such as alfalfa can promote pest populations (e.g., tarnished plant bug). Ground cover also provides competition for water and nutrients, especially to young trees. If not properly managed, it also provides habitat for voles. These drawbacks can be minimized with appropriate management of the orchard floor.

Mowing is the most important orchard floor management tool. Establishment of an orchard floor composed of slow growing grass species can reduce mowing requirements significantly. With an orchard floor composed of vigorous 'wild' species, several timely mowings will be required to prevent undue competition for trees and reduce vole populations by limiting their preferred habitat. A final mowing in late autumn (using a flail type mower) can reduce the potential apple scab infection risk the following spring.

Herbicides are generally used to manage groundcover around tree trunks and in that portion of the under-tree area that is difficult to mow. For mature trees on seedling or semi-dwarf rootstock, this herbicide strip may extend up to 6 feet or more out from tree trunks. With dwarf rootstock trees, the herbicide strip generally extends 2 feet or less out from the trunks. Maintaining herbicide strips as narrow as practical is important in reducing the risk of soil erosion and tree rack as well as cold penetration into the root zone of trees. In addition, narrow strips may facilitate movement of mite predators from the orchard floor into trees in summer. Less total herbicide is used per acre when these strips are narrow, reducing risk for environmental problems including herbicide leaching and runoff.

It is important to use herbicides judiciously for maintenance of these strips. Ideally, the use of herbicides will leave a living groundcover and root system or a mat of killed ground cover to protect soil from erosion and cold penetration. The overuse of herbicides, even in narrow strip systems, will lead to a barren soil strip and a high risk of erosion, tree rack, and cold temperature injury to tree root systems.

Herbicide timing should be chosen so as to assure that live groundcover, or a matting of killed groundcover will be

present when soil erosion is likely, especially during the dormant season, and when thunderstorms are likely. Practices that promote extensive moss growth have not been identified, but it is evident that some herbicides inhibit moss establishment and others do not.

Maintaining or increasing soil organic matter (humus) should be an objective of orchard groundcover management in New England. Soil organic matter is much more than the dead leaves, stems, and roots produced by the groundcover and orchard trees. As plant tissues decay, through the activity of soil microorganisms (bacteria, actinomycetes, fungi, algae, protozoa, and nematodes) they produce **humus**, a complex mixture of organic compounds that gives topsoil its characteristically dark brown color. The soil microbes themselves die, contributing to the total pool of biomass that forms humus. In sod-covered soils, humus typically constitutes the bulk of soil organic matter. But humus is not permanent. Its constituents undergo a slow, but continuing process of decay. If soil is kept bare, the major food source for soil microorganisms is eliminated, and humus can then be expected to disappear faster than its is formed.

Humus is a major source of nitrogen, phosphorous, and sulfur. These three essential elements are abundant in biological tissue, the source of humus. Humus also has a controlling influence on the availability of essential micro-nutrients, not because its parent biological tissues were high in micro-nutrients, but because humus can form "chelates" with copper, zinc, manganese, etc. that are released from soil minerals. Chelated micronutrients are held against leaching from the soil, and under the right conditions, are available to plant roots.

Another value of humus derives from its electrostatic attraction for oppositely charged nutrient elements, protecting them against leaching. This property, called cation exchange capacity, is also exhibited by clay particles. Cation exchange capacity, together with chelation, allow soils to hold nutrients until picked up by plant roots. Soils in which these properties are at a low level, as in soils with little clay or organic content, are naturally low in agricultural productivity, because they cannot supply as much mineral nutrition as the crops are capable of using.

Additional benefits of soil organic matter are:

- It increases moisture-retention in sandy soils. Organic matter can hold up to 20 times its weight in water.
- It acts as "glue" to hold very small soil mineral particles together in units called aggregates. Aggregation permits a loose, open, granular condition that aids penetration by water, air, and roots, and resists erosion.
- It has the ability to absorb many organic pesticides, holding them near the soil surface, where they are more likely to be degraded by biological activity and sunlight, rather than leach to groundwater.

8.3 Herbicides and Their Use

If you use herbicides, you are responsible for their safe and proper use. The label is the law. Be aware of the potential for contamination of waterbodies, groundwater, and food.

8.3.1 Types of Herbicides

Herbicides can be separated into two broad categories: those applied to the soil before weeds have emerged (pre-emergence or 'residual' herbicides) and those applied directly to visible weeds (post-emergence or 'contact' herbicides). A few pre-emergence herbicides also have some activity against emerged weeds.

Residual herbicides have a lasting effect on the soil. How long weed growth is prevented by an application of residual herbicide depends on how quickly it is broken down on the soil by sunlight, microbial activity, or soil chemistry, and whether the herbicide is volatilized or leached below the upper inch or so of soil. Non-residual herbicides have little or no effect except on weeds that are present at the time of application.

Finally, some herbicides are effective only on grasses; some only on broadleaf weeds, and others show degrees of activity against both types of vegetation. No herbicide is effective against all species in all categories of weeds. Some herbicides are effective on certain weed species outside of the indicated category. For a list of specific weeds controlled, see product labels. The use of residual herbicides in particular should be limited to specific needs. The routine use of residual herbicides may increase the chance of creating a bare soil environment around trees (with an increased risk of soil erosion, tree rack, and cold temperature injury to tree roots). And it may facilitate the development of weed populations that are difficult to control with currently available herbicide options.

8.3.2 Manage to Prevent Resistance

Repeated use of a single herbicide, or herbicides with a shared specific mode of action without rotation or the use of alternative tactics such as cultivation or weed suppressing cover crops, may lead to herbicide-resistant weed populations.

Herbicides for which the risk of resistance is greatest include: diuron (Karmex), oryzalin (Surflan), oxyfluorfen (Goal), paraquat (Gramoxone), and terbacil (Sinbar).

Combining pre-emergence herbicides with different modes of action is one technique that reduces the risk of weeds developing herbicide tolerance. The use of post-emergence herbicides such as glyphosate (Roundup) also helps, as do non-herbicide practices such as close-mowing and

cultivation. Weed scouting before herbicide application is useful to identify which species are present. Scouting after herbicide application can reveal weed escapes or species shifts.

8.3.3 Herbicide Selection

No herbicide product is completely effective against weeds *and* always harmless to the trees. Good management requires choosing the proper product, or combination of products, to fit the situation. Give special attention to age of the trees and soil factors.

Age of the trees. Young trees have tender, green bark that can be damaged or penetrated by contact herbicides, both systemic and non-systemic. Damage to a high value perennial crop, like apples, can have major and prolonged financial impact. Pay close attention to the development of corky, dead outer bark on the portion of the trunk that will be contacted by a contact herbicide. Properly applied trunk paint or vole guards will help if they completely block the spray from contacting the green bark. However, the most important consideration is the careful application of herbicides, using shielded sprayers or wipe-on applicators where appropriate to minimize the risk of herbicide contacting the bark.

The most common and serious damage occurs on young fruit trees when unprotected bark is contacted by concentrated doses of herbicides that have both contact and systemic activity (e.g. glyphosate, sulfosate and 2,4-D). These products can be used in young orchards, but their use requires precautions to prevent significant exposure of the trees.

Non-systemic products can also damage young trees, usually by burning a dead area into the trunk within about a foot of the soil surface. This can occur if the product is overly concentrated in the spray solution, and/or mixed with higher rates of liquid nitrogen fertilizers.

Young trees have shallow root systems, and most of their roots are within the herbicide treated area. Young tree roots may be highly exposed to root active herbicides that leach into the upper foot of soil -- simazine, diuron, terbacil (and to a lesser extent norflurazon and dichlobenil) all have the potential to damage trees in young or dwarf orchards, particularly on light sandy soils. Use caution and low rates when using these hericides.

Soil Factors. Organic matter and increased binding sites that come with finer soil texture are important soil qualities that hold potentially mobile herbicides in the upper 2–4 inches of soil where they act to control weeds rather than affect fruit tree roots. If the product label suggests that you take these factors into consideration, do so. Orchards often have bands of lighter, shallower or gravelly soils running through them. Identify and record these poor soil areas. Use products and rates that are safe on the weakest soils, not the average.

8.3.4 Herbicides can Damage Trees

To avoid tree injury, know the potential for injury, and follow label instructions carefully. Injury can be local (affecting only tissue directly hit by spray), or it may be systemic. Systemic injury can produce symptoms some distance from the site of contact, due to the ability of some herbicides to translocate within the plant.

Note the potential for tree damage by these herbicides:

- **glyphosate, sulfosate**: Are absorbed by foliage, root suckers, young-green bark and fresh pruning wounds, resulting in systemic injury. Do not apply after mid summer (July 15).
- **diuron, oxyfluorfen, terbacil:** Are absorbed by foliage and young bark, resulting in local injury. Shield bark of first- and second-leaf trees to prevent damage.
- **paraquat, glufosinate-ammonium:** Are absorbed by foliage, and bark, resulting in local injury.
- **2,4-D:** Is absorbed by foliage, bark, and roots, resulting in systemic injury. **Do not use 2,4-D near or in grapes!!!**
- **dichlobenil, diuron, simazine, terbacil, and 2,4-D** can, under some conditions, be taken up by roots, resulting in injury or other symptoms. Root uptake is most likely in soils containing very little clay or organic matter. In the case of 2,4-D, the chemical is highly water-soluble, so movement to roots is possible where groundcover is insufficient to absorb (trap) the 2,4-D.
- The presence of burr knots may increase the risk of herbicide uptake by trees if herbicide comes in contact with bark tissue.

Other listed herbicides may produce injury to trees if not used at appropriate label rates and timings, taking into account tree age, soil texture, and soil organic matter.

Herbicides do not have federal residue tolerances for fruit, so direct spray and drift must be kept off fruit. If accidental spraying occurs, the exposed fruit should be removed.

8.3.5 Leaching & Runoff Potential

Leaching (downward herbicide movement through soil) is influenced by characteristics of the soil (texture, compaction, organic content, pH, wetness, temperature). In addition, certain soil microorganisms and living weeds can sometimes metabolize absorbed herbicides, rapidly or gradually altering them to non-phytotoxic forms that may have different leaching characteristics. Leaching potential is also affected by certain characteristics of the herbicide, including water solubility, electrostatic properties, vapor pressure, and photodecomposition.

Because numerous complex interactions can occur between herbicides and the soil environment, it is impossible to

accurately generalize leaching behavior for a wide range of possible soil situations.

Downward movement is most likely with chemicals that do not degrade quickly and do not adsorb strongly to clay or organic matter. The potential for tree damage or groundwater contamination is greatest with such chemicals when heavy rain comes soon after application, or where spills occur. Special attention should be given to the mixing and loading operation, as spills can quickly overload detoxifying processes of soil and sunlight.

Runoff (surface loss of herbicides from treated areas) can be avoided by the same means used to avoid soil erosion. Sloping ground and absence of groundcover increase surface runoff. Living sod or other dense groundcover and organic mulches inhibit runoff. Where problems persist, grass strips and berms can be used to separate treated areas from sensitive borderlands. Practices that prevent concentration of rain water into narrow channels will help. Wheel ruts often become stream-beds during heavy rainfall, as do channels from previous rainfalls. Travel lanes should run across rather than with the slope. Maintain and operate equipment with caution to prevent spills.

8.3.6 Need for Rain or Irrigation

Herbicides used for pre-emergence weed control generally require 0.5–1 inch of rain or irrigation, or shallow cultivation to initiate herbicidal action. The need for prompt incorporation varies.

Warm bright days speed surface breakdown and evaporation of certain herbicides. Some herbicides must be incorporated within 24 hours after application, while other materials can be stable for 3–4 weeks or more. Specific information is provided on product labels if rapid incorporation is necessary.

8.3.7 Persistent Weeds

Perennial and biennial species that persist where pre-emergence herbicides have been used can often be killed by one or more treatments with glyphosate, 2,4-D, or a combination of these two. Such species include bindweed, brambles, Canada thistle, dandelion, dock, evening primrose, goldenrod, horsenettle, plantain, poison ivy, and vetch. Yellow nutsedge can be killed with glyphosate, glufosinate, or paraquat, properly timed. Mid-June to mid-July is the best time for paraquat and glufosinate, while August and September are best for glyphosate. These late summer applications also carry the greatest risk of damage to the crop if foliage or green tissue is contacted by improper application. Note that preharvest interval requirements may influence choice of timing.

8.3.8 Application Method

Regardless of which herbicides are chosen, proper application is essential to insure safety and efficacy. Take the time to set up and check the mechanics of the weed sprayer. This is too often neglected. Every time an herbicide sprayer is brought out for use, it needs to be checked, both for level application across the boom and rate per sprayed acre. There are many ways to calibrate orchard herbicide sprayers: use the one you are most comfortable with. If you do not already have a good method, try the procedure outlined at the end of this section.

Most orchards are sprayed with a single sided boom sprayer, with two, three, or four flat fan nozzles placed about a foot apart, starting at the distant tip of the boom. The boom is adjusted so that the spray from each nozzle over-laps about 1/3 of the pattern from the adjacent nozzles on either side at the level of the target. The “target” can be either weed growth if you are spraying contact herbicides, or the soil surface, if you are applying soil residual products.

Some growers use single “flood-jet” style nozzles to apply contact materials on both sides of a tree row with a single pass by the sprayer. This is somewhat effective, but not without problems, including injury to tree trunks. Most single nozzle band applications wider than a foot or two distribute herbicide unevenly. Single nozzle band application should not be used with most soil residual materials, or for products that may injure the young tree if applied to the trunk.

The use of anti-drift agent(s) is recommended, particularly for contact and systemic herbicides. With some herbicides and target weeds, addition of a surfactant, spreader-sticker, and or crop oil concentrate is also recommended. See label for details

8.3.9 Rate of Herbicide

For many pre-emergence herbicides, the lower recommended rate is the best choice for coarse texture orchard soils (sandy loam or loamy sand), provided moisture conditions are suitable. Some preemergence herbicides are strongly adsorbed onto soil organic matter and/or clay particles. Therefore, on relatively high organic soils (above 3.5 percent by Walkley-Black method) and on clay loam soils, the higher label rate may be needed for pre-emergence control.

Soil texture and organic matter content can be determined by soil testing laboratories. Several different methods are used to estimate soil organic matter. For the same soil, different methods can give much different results. To properly interpret label recommendations regarding soil organic matter, ask your soil testing laboratory to indicate its estimate of organic matter as though it had been done by the Walkley-Black method.

Surface litter (non-decomposed organic tissues) can bond some herbicides, resulting in failure of the chemical to reach the soil where germinating seeds can be killed. Herbicides that are so affected will include a label recommendation for removal of surface litter, or clean cultivation prior to application of the herbicide.

Rates for post-emergence herbicides vary according to weed species and growth stage. Drought conditions that slow weed growth may make weeds more tolerant of post-emergence herbicides applied during that time.

Unless product labels suggest addition of surfactants or other adjuvants, their use is not likely to improve herbicide activity. Post-emergence herbicides should be used with enough water to avoid missing any plants or plant parts, while avoiding runoff, although systemic herbicides such as Roundup can be effective at low water volumes and incomplete plant contact.

8.3.10 Timing Herbicide Applications

Product labels limit timing of some herbicides to certain months, weed growth stage, temperatures, crop growth stage, or days to harvest. Detailed information is included on the product labels.

8.3.11 Tankmixes

- If no statement concerning tank mixing of two or more herbicides is given on product labels, mixing is legal, though a test for compatibility will be necessary.
- Do a small-scale jar test as follows: Place one pint of water in a quart jar. Add each pesticide or a pre-mix of pesticide in water, one at a time, and shake well with each addition. Use each product in about the same proportion to water as it will be in the field mixture. One half of a measuring teaspoon of herbicide in a pint of water is approximately equivalent to one pint or one pound of herbicide in 25 gallons water. Unless labels indicate otherwise, add pesticides in this order: wettable powders, followed by flowables, emulsifiable concentrates, water solubles, and recommended adjuvants. However, when compatibility enhancers are used (tankmix adjuvants or spreader/stickers) these should be added first to the water. Invert the jar 10 times, then inspect the mixture immediately and again after 30 minutes. If a uniform mix cannot be made or if non-dispersable oil, sludge, or clumps of solids form, the mixture is incompatible and should not be used. Minor separation after 30 minutes (without sludge or clumps) that remixes readily with 10 jar inversions, is tolerable if spray tank agitation is good.
- When you tankmix in volume, put 2/3 of the water in the tank first. Then add pesticides one by one, with wettable powders first. Agitate for thorough mixing after each addition, before pouring in the next. Finish filling the tank with water.
- Maintain continuous agitation until the tank is empty.

8.3.12 Established Orchard Herbicide Program

A late spring and late fall application of herbicides to herbicide strips of established orchards is recommended. Specifically:

> Late fall herbicide application should include a translocated contact herbicide (2,4-D, or glyphosate if perennial weeds are present and trees can be shielded or missed) AND a residual herbicide (Kerb, Solicam, Surflan, Prowl, Chateau).
>
> Late spring herbicide application should include a different residual herbicide (Karmex, Sinbar, Solicam, Surflan, Devrinol, Prowl, Chateau) and a contact herbicide if perennial weeds are present or annual weeds have emerged.

These two applications may give effective season-long control, improve consistency of treatment, decrease risk of crop injury, and decrease competition by weeds in early spring.

('Groundcover Management and Herbicides' adapted from original New England Apple Pest Management Guide, by William Lord, University of New Hampshire. Adapted and edited for most recent version by George Hamilton, UNH Cooperative Extension, and Jon Clements, UMass Extension.)

Table 8.3.1. Herbicides registered for use in tree-fruit orchards.

Minimum time between planting and use indicated if specified on label.
NB = Nonbearing trees only; Y= listed on label; N = not listed on label.

Product	Apple	Pear	Apricot	Tart Cherry	Sweet Cherry	Nectarine	Peach	Plum	Prune
Aim 2EC, 1.9EW	Y	Y	Y	Y	Y	Y	Y	Y	Y
Casoron 4G	4 wk	4 wk	N	4 wk	4wk	N	N	N	N
Chateau WDG	Y	Y	Y	Y	Y	Y	Y	Y	Y
Devrinol 50DF	Y	Y	Y	Y	Y	Y	Y	Y	Y
Fusilade DX	NB	NB	Y	Y	Y	Y	Y	Y	Y
Gallery 75DF	NB	NB	NB	NB	NB	NB	NB	NB	NB
Glyphosate	Y	Y	Y	Y	Y	Y	Y	Y	Y
Goal 2XL, Galigan 2E	Y	Y	Y	Y	Y	Y	Y	Y	Y
Gramoxone Inteon	Y	Y	Y	Y	Y	Y	Y	Y	Y
Karmex 80DF, Diuron 4L, 80DF	1 yr	1 yr	N	N	N	N	3 yr	N	N
Kerb 50 W[1]	Y	Y	Y	Y	Y	Y	Y	Y	Y
Matrix	1 yr	1 yr	1 yr	1 yr	1 yr	1 yr	1 yr	1 yr	1 yr
Poast	Y	Y	Y	Y	Y	Y	Y	NB	NB
Princep 4L, Simazine 4L, 90DF, Caliber 90, etc.	1 yr	1 yr	N	1 yr	1 yr	N	1 yr	1 yr	N
Prowl 3.3E	NB	NB	NB	NB	NB	NB	NB	NB	NB
Prowl H2O	Y	Y	Y	Y	Y	Y	Y	Y	Y
Rely 200	1 yr	N	N	N	N	N	N	N	N
Select	NB	NB	NB	NB	NB	NB	NB	NB	NB
Sinbar 80WP[2]	3 yr/NB	NB	NB	NB	NB	NB	3yr/NB	NB	NB
Solicam DF	Y	1 yr	1 yr	18 mo	18 mo	6 mo	6 mo	1 yr	1 yr
Stinger	N	N	Y	Y	Y	Y	Y	Y	Y
Surflan AS	Y	Y	Y	Y	Y	Y	Y	Y	Y
Unison	Y	Y	Y	Y	Y	Y	Y	Y	Y
Weedar 64, Amine 4, *2,4-D Amine	1 yr	1 yr	1 yr	1 yr	1 yr	1 yr	1 yr	1 yr	1 yr

Sinbar + Karmex tank mix at lower rates - Apples and peaches established at least 2 yr..
[1] Kerb. Not less than 6 mo after fall transplanting nor less than 1 yr after spring transplanting of labeled crops.
[2] Low rate for newly planted and young, non-bearing fruit trees (except apple).

Table 8.3.2. Effectiveness of herbicides in tree-fruit crops.

Material	AG	AB	PG	PB	WBV	YN	BW	HN	CT	SB	PW	RW
carfentrazone-ethyl	—	G	—	P	—	—	P	—	—	—	G	G
clethodim (Select)	G	—	G	—	—	—	—	—	—	—	—	—
clopyralid	—	F	—	F[5]	—	—	—	F	G	—	—	F
dichlobenil (Casoron 4G)	G	G	G	G	—	G	—	G	G	—	G	G
2,4-D	—	G	—	G	F	—	G	F	F	-	G	G
diuron (Karmex)	G	G	F	—	—	—	—	—	—	—	G	G
fluazifop (Fusilade)	G	-	F	—	—	—	—	—	—	—	—	—
glyphosate (Roundup, Touchdown)	G	G	G	G	G[1]	G[2]	G	G[1]	G[1]	F	G	G
flumioxazin (Chateau WDG)	F	G	–	F	–	–	P	P	P	–	E	G
isoxaben (Gallery)	—	G	—	—	—	—	F	—	—	—	G	G
napropamide (Devrinol)	G	F	—	—	—	—	—	—	—	—	F	P
norflurazon (Solicam)	G	F	F	—	—	F	—	—	—	—	F	—
oryzalin (Surflan)	G	F	—	—	—	—	—	—	—	—	G	P
oxyfluorfen (Goal)	F	G	—	—	—	—	—	—	—	—	G	G
paraquat (Gramoxone Max)	G	G	F	F	F	G[3]	F	F	F	—	G	F
pendimethalin (Prowl)	G	F	—	—	—	—	—	—	—	—	G	—
pronamide (Kerb)	G	—	G	—	—	—	—	—	—	—	—	—
rimsulfuron (Matrix)	G	G	—	—	—	F	—	—	F	—	F	F
sethoxydim (Poast)	G	—	F	—	—	—	—	—	—	—	—	—
simazine (Princep)	F	G	—	—	—	—	—	—	—	—	G[4]	—
terbacil (Sinbar)	G	G	F	F	—	F	—	F	—	—	F	G

Key: E = excellent; **G** = good; **F** = fair; **P** = poor;.

[1] Combination with 2,4-D amine has improved effectiveness.
[2] Best results with late-summer (after August 1) applications.
[3] Best results with early mid-summer (before July 15) applications.
[4] Resistant types may require use of alternative materials.
[5] Not broadspetrum; see label for specific weed targets.

Abbreviations: AG = Annual grasses; **AB** = Annual broadleaves; **PG** = Perennial grasses; **PB** = Perennial broadleaves; **WBV** = Woody brush, vines; **YN** = Yellow nutsedge; **BW** = Bindweeds; **HN** = Horsenettle; **CT** = Canada thistle; **SB** = Smooth bedstraw; **PW** = Pigweeds; **RW** = Ragweed.

9 Wildlife Damage Management

9.1 Deer and Rabbits

Several commercial repellents are available to reduce deer or rabbit browsing to orchards (Table 9.1.1). The effectiveness of repellents is extremely variable and is affected by factors such as deer or rabbit numbers, feeding habits, and environmental conditions. Repellents may be cost-effective for controlling wildlife damage when:

1. light to moderate damage is evident,
2. small acreages are damaged, and
3. few applications will be needed for adequate control.

If these three conditions are not satisfied, it is best to look at the cost-benefit ratios for fencing and/or state permits for removing deer

With the use of repellents some damage must be tolerated, even if browsing pressure is low. None of the existing repellents provides reliable protection for more than 5 weeks when deer or rabbit densities are high. If browsing pressure is severe, a long-term damage management program should be implemented, including potential habitat modifications, reductions in animal numbers, and an evaluation of fencing alternatives.

A landowner can use a variety of non-chemical alternatives to reduce wildlife damage to fruit trees. These techniques fall into three primary categories: exclusion, habitat modification, and wildlife population reductions. Fencing is the most common exclusion technique used to prevent damage to crops. Helpful information can be found at: http://wildlifecontrol.info

Habitat modifications can reduce damage levels by making areas less suitable for problem wildlife species. Damage prevention with cultural manipulations should begin with site selection and plant establishment. Removal of brush, stone piles, and non-mowed wet areas in and near orchards, will reduce the attractiveness of sites to rodents and rabbits. Mowing in established plantings can reduce preferred foods of wildlife, remove protective cover, enhance predation, and expose animals to severe weather conditions. Sites adjacent to croplands should also be managed to reduce pest numbers, as nuisance wildlife may reinvade orchards from these habitats.

Wildlife population reductions may be necessary to reduce damage to tolerable levels. When trapping, care and experience are necessary to reduce captures of non-target species. Live-traps should be substituted for body-gripping traps in areas where pets or endangered wildlife may inadvertently be captured. In rural locations, shooting can be used to effectively remove problem animals. When practical, reductions in populations of game species (i.e., deer, rabbits, etc.) should occur during open hunting seasons. Check with your state department of wildlife management to help reduce deer or wildlife abundance and impacts on agricultural and forested lands.

Wildlife population reduction by lethal methods often fails to provide long-term relief from damage. Where habitat conditions are suitable, and exclusion is not attempted, most pests will repopulate the site soon after lethal control efforts have ceased. Habitat modification and exclusion methods usually require more initial effort and expense, but these techniques may provide longer-term damage prevention, especially when a few pest individuals can inflict substantial losses.

9.2 Meadow and Pine Voles

Two species of voles cause damage in New England orchards. Meadow voles are found throughout the region and probably inhabit every sod orchard. Pine voles are a problem in mostly southern New England orchards, especially in southeast Massachusetts, Connecticut, and Rhode Island. Several orchards in these states have both species present, and may experience considerable damage to trees during severe weather, or when other food sources become unavailable.

The contrasting living habits of meadow and pine voles have important implications for their detection and control. Meadow voles live primarily above the ground surface in dense sod or vegetation. Pine voles live primarily below ground and damage the root systems of trees. When feasible, hand placement of baits in tunnels or under roofing shingles, slabs of wood, or similar protected bait stations, is the preferred method for baiting pine voles. The optimum times to apply baits are in the early spring and after the fall harvest.

For orchards with meadow vole problems, an annual post-harvest baiting program using a *zinc phosphide-treated bait is strongly recommended. Both grain-based and pelletized baits are available from commercial sources (Table 9.1.1). Do not apply baits (particularly grain-based products) to areas with bare ground, including vegetation-free herbicide strips under trees, as this may increase the chance of feeding and mortality of non-target song and game birds. Hand-place rodenticides under bait stations (i.e., shingles) instead of broadcast baiting orchards frequented by wild turkeys. Pelletized baits are preferred over *zinc phosphide-treated corn. Research indicates corn baits are less effective and more attractive to non-target wildlife. Always follow label directions for rates and observe all precautions. Because there is evidence that bait shyness may occur with repeated use of *zinc phosphide baits, a single, complete bait coverage of the orchard site

during a period of fair weather is desirable. Ideally, this should closely follow a post-harvest mowing.

Because of their underground habits, pine voles are more difficult to control. In orchards with recurring pine vole problems, the placement of toxic baits beneath previously established baiting stations (1 or 2 per tree) is a reliable method. In addition, toxicants can be hand-placed directly in active underground burrows. Some rodenticides may also be hand-broadcast directly beneath the tree's drip-zone, directing the bait toward burrow entrances. Not all formulations are approved for broadcast application, so follow label directions. Chlorophacinone may provide better control for pine voles because of their habit of caching food in underground burrows. (Chlorophacinone may have a special use label in your state – check with your Extension specialist.) As with meadow voles, late fall is the best time for control efforts. Avoid using acute toxicants such as *zinc phosphide more than once every 6 months, preferably only once per year. However, heavy pine vole infestations, as indicated by numerous burrows and fresh dirt castings at several adjacent trees, may require a second application of bait about 2 weeks after the first.

The most important consideration in the timing of a control program is to achieve the greatest vole reduction just before onset of severe winter conditions. Voles that remain alive in the orchard will survive under the protection of snow cover and can inflict considerable tree damage during winter months. Monitoring orchards for signs of vole activity enables growers to detect vole population increases. Apple activity indices can provide a reliable measure of rodent numbers and the potential for damage.

Young orchards (trees ranging in age from 1-15 years) are most susceptible to pine vole damage. Also, young trees inter-planted in older orchards are extremely vulnerable and must be protected from pine voles. Persistent pine vole populations in older orchards (trees 30-60 years) should be hand-baited to limit potential vole damage in adjacent younger orchard blocks.
Although toxic baits offer reliable control and should be used where voles are abundant, cultural practices can reduce or even eliminate the need for toxic baits. Careful mowing and herbicide treatment will lower rodent numbers because voles require green, growing vegetation for survival and breeding. The meadow vole is especially vulnerable to close mowing of orchard driveways, and rotary mowers are much more effective than sickle-bar types for removing orchard ground cover and thatch.

The use of an herbicide strip beneath the trees and along the tree rows is a second cultural practice which can effectively eliminate meadow voles. Although close-mowing coupled with herbicide treatments can provide outstanding meadow vole control, recent evidence indicates these management practices will reduce but not eliminate pine voles.

Clean cultural practices, including removing dropped apples, winter prunings, and vegetation near the base of trees, all aid in reducing vole population buildups. Wire or nylon guards can be used for protecting younger trees from voles as well as rabbits, as long as they are both high enough and buried in the ground a couple inches. Still, good ground cover management = good vole management!

IMPORTANT NOTE: *Zinc phosphide is a restricted-use pesticide and may be purchased and used only by certified applicators or used by someone under the supervision of a certified applicator.

9.3 Woodchucks

Woodchucks are found in agricultural lands throughout much of eastern North America. Woodchucks may cause damage by digging burrows and building associated dirt mounds, which can damage farm machinery or tree root systems; and by tearing the bark on the trunk of trees during scent-marking activities.

Woodchucks causing damage may be taken in any manner by owners, lessees and members of their immediate families, or authorized employees, occupying or cultivating lands without a license or permit. Consult your state department of wildlife management if you have questions about a specific situation. Landowners have usually relied on lethal methods to reduce woodchuck damage. However, lethal controls are marginally successful for controlling woodchuck populations, as animals invade orchards from surrounding areas and reoccupy burrow systems.

Shooting and trapping can be used to remove problem woodchucks from fields. Shooting may be illegal or unsafe under some circumstances. Where legal, woodchucks can be captured using #2 leghold traps, #160 or #220 body-gripping traps, or live traps baited with apples and set near burrow entrances. Only live traps should be used where pets or livestock might be inadvertently captured. Woodchucks captured live cannot be legally transported off your property and should be humanely euthanized.

Electric fencing can be effective for reducing wood chuck damage. Electric, high-tensile deer fences may be modified to exclude woodchucks by adding additional wires at 5- to 6-inch intervals up to 18 inches high.

9.4 Beavers

Beavers will occasionally chew bark on fruit trees, and most damage often occurs within 300 feet of a permanent water source, such as a stream or pond. Removal of a problem beaver or destruction of a dam or lodge, usually requires a permit issued by the appropriate state or local authority. Contact your state wildlife management agency to get more information about resolving beaver conflicts -- shooting or trapping beavers causing damage to agricultural crops may be authorized.

Removal of a problem beaver or family group may reduce tree damage for several years. However if damage persists, other management options may be needed to reduce economic losses. Beavers seldom stray far from water, and installing a 2-strand electric fence between the pond or stream and the orchard may eliminate beaver access and damage. Also, putting metal vole guards or cages around the base of each tree will protect them from rodent chewing including voles, rabbits, and beavers.

There are no EPA-registered toxicants or repellents for managing beaver damage. Mixing sand with latex paint, then coating the bottom of tree trunks, has shown some effectiveness in reducing rodent chewing. Growers will need to integrate exclusion techniques along with occasional beaver removal to reduce tree damage in orchards.

(Prepared by P. D. Curtis and M. E. Richmond, NYS Wildlife Damage Management Program, Department of Natural Resources; adapted for New England by Jon Clements, UMass Extension)

Table 9.1.1. Common and product names of commercial rodenticides, fumigants, and repellents used in orchards.

Common Name	Product Name	EPA Reg. No.	Use
*Zinc phosphide	Bonide Orchard Mouse Bait	4-152	Rodenticide
*Zinc phosphide	PROZAP® Zinc Phosphide Pellets	61282-49	Rodenticide
*chlorophacinone	rozol® VOLE BAIT (check state registration status)	7173-242	Voles
13.8% Ammonium Soap	Hinder [1]	5481-508	Repellent
37% Putrescent Egg Solids	Deeraway Big Game Repellent Liquid Spray Kit	50932-6-74794	Repellent
20% Thiram	Nott Chew-Not	358-105	Repellent
2.5% Capsaicin	Hot Sauce Animal Repellent	72-574	Repellent

* Restricted-use pesticide; may be purchased and used only by certified applicators or used by someone under the supervision of a certified applicator.

[1] Application to apples under hot, humid conditions may result in fruit-finish (spray-burn ring) problems.

10 Nutrient Management of Apple Orchards

10.1 Introduction

When developing mineral nutrient management programs for tree fruits, it is important to consider the nutrient demand-supply relationship throughout the season. Early season canopy development and fruit growth require large amounts of nitrogen (N), while fruit quality development and the acquisition of adequate cold hardiness by the tree later in the season require only a minimum supply of N. Thus, an ideal seasonal pattern of tree nitrogen status should be to start the season with relatively high nitrogen status to promote rapid leaf development and early fruit growth. As the season progresses, nitrogen status should decline gradually to guarantee fruit quality development and wood maturity before the onset of winter. There are three sources of nitrogen supply tree fruits can use. First is reserve nitrogen that has accumulated in the tree from the previous growing season. This source of nitrogen is readily available for initial growth during the spring. In fact, spur leaf development and early fruit growth are mainly supported by the reserve N. The second source is the natural N supply from the soil mineralization process. This process provides substantial amounts of nitrogen for trees growing on soils with high organic matter. The third is nitrogen fertilizers applied to the soil or to the foliage. To determine the amount of fertilizer nitrogen needed, we need to know the total tree demand and the amounts the other two nitrogen sources can provide. However, there is not enough information currently available on this demand-supply relationship to make this approach practical. Instead, soil and leaf analyses have been developed over the years to help growers diagnose tree nutrient status and soil nutrient availability and make adjustments on their fertilization programs accordingly.

10.2 Soil Analysis

Soil analysis is very useful for determining lime requirement and mineral availability in the soil before orchard establishment. For existing orchards, it provides information necessary for interpreting leaf analysis results and modifying fertilization programs.

A soil nutrient analysis should be performed before planting a new orchard and every 2 to 3 years after orchard establishment. The soil sample taken should be representative of the soil type and conditions within the orchard. Generally, the area included in any one-sample collection should not exceed 10 acres. Scrape away the surface 1-inch of soil, then collect samples from the 1 to 8 inch depth, and separate samples from 8 to 16 inches. In a 10 acre orchard, a minimum of 10 to 20 subsamples is suggested. Thoroughly mix the 1-8 inch subsamples together to provide a representative sample for the topsoil, and treat the 8 to 16 inch subsamples similarly to get a representative sample for subsoil. Soil samples can be sent to **The Connecticut Agricultural Experiment Station Slate Laboratory**, P.O. Box 1106, New Haven, CT 06504 (203-974-8521); **University of Connecticut Soil Nutrient Analysis Laboratory**, 6 Sherman Place, U-102, Storrs, CT 06269-5102 (860-486-4274); **University of Maine Soil Testing Service Analytical Laboratory**, 5722 Deering Hall, Orono, ME 04469-5722 (207-581-3591); **University of Massachusetts Soil & Plant Tissue Testing Laboratory**, West Experiment Station, Amherst, 01003 (413-545-2311); **University of New Hampshire Cooperative Extension Soil Testing Program**, Spaulding Life Science Center, Room G28A, 38 College Road, Durham, New Hampshire 03824 (603-862-3200); or **University of Vermont Agricultural & Environmental Testing Laboratory**, 209 Hills Building, Burlington, VT 05405 (802-656-3030).

10.3 Preplant Soil Preparation

Table 10.3.1. Soil management groups

Soil Group	Texture
I	Clayey soils, fine-textured soils.
II	Silty loam soils with medium to moderately fine texture.
III	Silty loam soils with moderately coarse texture.
IV	Loamy soils, coarse- to medium-textured soils.
V	Sandy soils, very coarse-textured soils.

10.3.1. Liming

The pH values of orchard soils should be maintained in the range of 6.0 to 6.5 throughout the soil profile to optimize plant growth and nutrient availability. For preplant soil preparation, we recommend the pH of topsoil (0–8 inch depth) be adjusted to 7.0 and that of subsoil to 6.5. Most soils in New York and New England have pH values lower than optimum and need liming to raise the pH prior to planting a new orchard. This also ensures adequate calcium and magnesium supplies in the soil.

The amount of lime required to adjust topsoil pH to 7.0 and subsoil pH to 6.5 is determined by the current pH values of the topsoil and subsoil (determined from a soil analysis) and the buffering capacity of the soil, i.e. exchange acidity or the acid portion of the cation exchange capacity (CEC), of topsoil and subsoil (also determined from a soil analysis). Using these values, the lime requirement can be determined from Table 10.3.2 for topsoil and from Table 10.3.3 for subsoil. The amount of lime to be added is the sum of topsoil plus subsoil requirement. When complete

soil tests are not available, Table 10.3.4 may be used to estimate lime requirement.

Exchange acidity (used in Tables 10.3.2 and 10.3.3) may be reported on the soil test, but if not, it can be calculated easily from the percent base saturation and the cation exchange capacity. First, add the percent base saturation of K, Mg, and Ca. Next, subtract that total from 100% to obtain the percent acidity. Finally, multiply the cation exchange capacity by the percent acidity to get the exchange acidity.

Example
Topsoil

1. Soil test: pH 6.0, cation exchange capacity of 10.6 me/100gc, base saturation of 2.4 % K, 6.4% Mg, and 16.2% Ca
2. Calculate total percent base saturation: 2.4% + 6.4% + 16.2% = 25.0%
3. Calculate the percent acidity: 100% - 25.0% = 75%
4. Calculate the exchange acidity: 0.75 x 10.6 = 8.0 me/100gc
5. Determine 100% ENV lime requirement from Table 10.3.2: 2.5 tons/acre

Subsoil

1. Soil test: pH 5.2, cation exchange capacity of 5.7 me/100gc, base saturation of 1.1% K, 3.4% Mg, and 8.0% Ca
2. Calculate total percent base saturation: 1.1% + 3.4% + 8.0% = 12.5%
3. Calculate the percent acidity: 100% - 12.5% = 87.5%
4. Calculate the exchange acidity: 0.875 x 5.7 = 5.0 me/100gc
5. Determine 100% ENV lime requirement from Table 10.3.3: 2.0 tons/acre

Total lime to be applied to the topsoil and subsoil: 4.5 tons 100% ENV lime/acre

The lime recommendations in Tables 10.3.2, 10.3.3, and 10.3.4 are for 100% effective neutralizing value (ENV). The actual lime rate to be applied is calculated by dividing the recommended 100% ENV rate by the ENV of the lime to be used.

The desired levels of soil calcium and magnesium are listed in Table 10.3.5 for different soil management groups. If soil magnesium levels are below the desired level, then high-Mag lime should be used for liming.

Lime should be thoroughly harrowed into the surface soil, then plowed to work it as deeply as possible into the soil. If large amounts of lime are required (more than 3 tons per acre), split application is recommended, working one-half or two thirds of the total amount of lime into the soil as indicated above, plus thoroughly harrowing the remainder into the topsoil after plowing.

Table 10.3.2. Tons of 100% ENV lime per acre required to increase pH to 7.0 for topsoil (0 to 8 inches)

	Exchange Acidity (me/100g soil)																				
Soil pH	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
4.4 - 4.5	2.7	3.2	3.7	4.3	4.8	5.3	5.9	6.4	6.9	7.4	8.0	8.5	9.0	9.6	10.1	10.6	11.2	11.7	12.2	12.8	13.3
4.6 – 4.7	2.6	3.2	3.7	4.2	4.7	5.3	5.8	6.3	6.9	7.4	7.9	8.4	9.0	9.5	10.0	10.5	11.1	11.6	12.1	12.7	13.2
4.8 - 4.9	2.6	3.1	3.7	4.2	4.7	5.2	5.7	6.3	6.8	7.3	7.8	8.3	8.9	9.4	9.9	10.4	11.0	11.5	12.0	12.5	13.0
5.0 - 5.1	2.6	3.1	3.6	4.1	4.6	5.1	5.6	6.1	6.6	7.2	7.7	8.2	8.7	9.2	9.7	10.2	10.7	11.2	11.8	12.3	12.8
5.2 - 5.3	2.4	2.9	3.4	3.9	4.3	4.7	5.3	5.7	6.3	6.8	7.2	7.7	8.2	8.6	9.2	9.6	10.2	10.6	11.1	11.6	12.0
5.4 - 5.5	2.1	2.6	3.0	3.4	3.8	4.2	4.7	5.1	5.5	5.9	6.3	6.7	7.2	7.6	8.1	8.5	8.8	9.3	9.7	10.2	10.6
5.6 - 5.7	2.0	2.3	2.7	3.1	3.5	3.9	4.2	4.6	5.0	5.4	5.8	6.2	6.5	6.9	7.3	7.7	8.1	8.5	8.8	9.2	9.6
5.8 - 5.9	1.8	2.1	2.4	2.8	3.1	3.5	3.8	4.2	4.5	4.9	5.2	5.5	5.9	6.2	6.7	6.9	7.2	7.6	7.9	8.3	8.6
6.0 - 6.1	1.6	1.9	2.2	2.5	2.8	3.2	3.5	3.8	4.1	4.4	4.7	5.0	5.4	5.7	6.0	6.3	6.6	6.9	7.2	7.6	7.9

Table 10.3.3. Tons of 100% ENV lime per acre required to increase pH to 6.5 for subsoil (8 to 16 inches)

	Exchange Acidity (me/100g soil)																				
Soil pH	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
4.4 - 4.5	2.4	2.8	3.3	3.8	4.2	4.7	5.2	5.7	6.1	6.6	7.1	7.6	8.0	8.5	9.0	9.4	9.9	10.4	10.9	11.3	11.8
4.6 - 4.7	2.3	2.8	3.3	3.7	4.2	4.7	5.1	5.6	6.0	6.5	7.0	7.4	7.9	8.4	8.8	9.3	9.8	10.2	10.7	11.2	11.6
4.8 - 4.9	2.3	2.7	3.2	3.7	4.1	4.6	5.0	5.5	5.9	6.4	6.9	7.3	7.8	8.2	8.7	9.1	9.6	10.0	10.5	10.9	11.4
5.0 - 5.1	2.2	2.7	3.1	3.5	4.0	4.4	4.9	5.3	5.7	6.2	6.6	7.0	7.5	7.9	8.3	8.7	9.2	9.6	10.1	1.05	11.0
5.2 - 5.3	2.0	2.4	2.8	3.2	3.6	4.0	4.4	4.8	5.2	5.6	6.0	6.4	6.8	7.2	7.6	8.0	8.4	8.8	9.2	9.6	10.0
5.4 - 5.5	1.6	1.9	2.2	2.6	2.8	3.1	3.5	3.8	4.1	4.4	4.7	5.0	5.4	5.6	6.0	6.3	6.6	6.9	7.2	7.6	7.9
5.6 - 5.7	1.3	1.6	1.8	2.1	2.4	2.6	2.8	2.9	3.4	3.6	3.9	4.1	4.4	4.6	4.9	5.1	5.4	5.6	5.9	6.2	6.4
5.8 - 5.9	1.0	1.21	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0
6.0 - 6.1	0.8	0.9	1.1	1.3	1.4	1.6	1.7	1.9	2.0	2.2	2.4	2.5	2.7	2.8	3.0	3.1	3.3	3.5	3.6	3.8	3.9

Table 10.3.4. General lime recommendations for a depth of 16 inches (tons of 100% ENV lime per acre)

Soil pH	Sands	Sandy Loams	Loams & Silt Loams	Silty Clay Loams
4.5	4.5	10.0	16	22
4.6 - 4.7	4.5	10.0	15.5	21.5
4.8 - 4.9	4.5	9.5	14.5	20.5
5.0 - 5.1	3.5	8.5	13.0	18.0
5.2 - 5.3	2.5	7.0	11.0	14.5
5.4 - 5.5	1.7	5.0	7.0	10.2
5.6 - 5.7	1.7	3.5	5.0	7.7
5.8 - 5.9	1.2	2.5	4.5	6.0
6.0 - 6.1	1.0	2.5	3.5	5.0
6.2 - 6.3	0.7	1.7	2.5	3.5
6.4 - 6.5	0.5	1.2	1.7	2.5
6.6 - 6.7	0.4	0.9	1.2	1.7

10.3.2. Other Preplant Nutrients

Potassium: The desired levels of soil potassium are listed in Table 10.3.5 for the different soil management groups. The difference between the desired level and the soil test result in both the topsoil and the subsoil is the amount to be added to the soil. [(Desired Level topsoil – actual level topsoil) +(Desired Level subsoil – actual level subsoil) = lb./acre K2O per 16-inch depth.

Phosphorus: Incorporation of appropriate rates of phosphorus during preplant soil preparation is the best means of providing adequate phosphorus for the life time of the orchard. The recommended amounts of preplant phosphorus for various soil test levels are listed in Table 10.3.6. The amount of phosphorus to be added is the sum of topsoil plus subsoil requirement.

Nitrogen: During preplant soil preparation, an application of nitrogen at 40 lb./acre is suggested for cover crop establishment. An additional 40 lb./acre is suggested when the cover crop is plowed down or when seeding the permanent grass sod.

Boron: Typical boron levels for different soil textures are given in Table 10.3.7. If soil test shows boron levels are in the low to medium range, then 2 to 3 lb. of boron is recommended for preplant soil preparation.

Table 10.3.5. Approximate levels of Calcium, Magnesium, and Potassium for topsoil (0 to 8 inches) and subsoil (8 to 16 inches) of different soil management groups

Soil	CEC (me/100g)		Ca (lb./acre)		Mg (lb./acre)		K2O (lb./acre)	
Group	Topsoil	Subsoil	Topsoil	Subsoil	Topsoil	Subsoil	Topsoil	Subsoil
I	25	17	7800	4600	950	550	520	300
II	20	13	6200	3700	750	450	450	260
III	18	12	5600	3300	700	400	430	250
IV	16	11	5000	2900	600	350	400	240
V	12	8	3700	2200	450	250	330	200

Table 10.3.6. Soil test phosphorus values and rates of phosphate (P_2O_5) application for orchards

Soil Test P Results		Amount of P_2O_5 to Apply (lbs/acre)	
(ppm)	(lbs/acre)	Pre-planting	Established orchards*
<0.5	<1	120	60
0.5-1.5	1-3	100	60
2-4	4-8	60	30
>4.5	>9	40	0

* Do not apply phosphate to established orchards unless leaf analysis also indicates a need.

Table 10.3.7. Boron soil test levels for soils with different textures

Relative Soil Test Levels	Loamy Sand	Sandy Loam	Loam & Silt	Rate of Boron (lbs/a)
Very High	>0.60 ppm (>1.2 lbs/a)	>0.90 ppm (>1.8 lbs/a)	>1.20 ppm (>2.4 lbs/a)	0
High	0.36-0.60 ppm (0.7-1.2 lbs/a)	0.61-0.90 ppm (1.2-1.80 lbs/a)	0.81-1.20 ppm (1.6-2.4 lbs/a)	1
Medium	0.20-0.35 ppm (0.4-0.7 lbs/a)	0.30-0.60 ppm (0.6-1.2 lbs/a)	0.40-0.80 ppm (0.8-1.6 lbs/a)	2
Low	<0.20 ppm (<0.4 lbs/a)	<0.30 ppm (<0.6 lbs/a)	<0.40 ppm (<0.8 lbs/a)	3

Note: Soil test results for boron should be judged in relation to leaf analysis results. Leaf analysis is considered to be a better indicator of boron status.

10.4 Fertilization Program for Young Trees

When new trees are planted in the spring, immediate supply of adequate water is essential to settle the soil around the roots, but application of nitrogen fertilizer is not recommended. This is because the initial tree growth is mainly supported by the nutrient reserves within the tree and the uptake of nutrients from the soil is often delayed due to the damaged root system. In addition, applying large amounts of dry fertilizers at planting may cause damage to the roots. The first application of nitrogen fertilizer should be made at budbreak at a rate of 0.6 to 1.0 ounce of actual nitrogen per tree. Liquid nitrogen fertilizers are preferred. If dry fertilizers have to be used, make sure to avoid any contact with the trunk. A second application at the same rate should be made 4 weeks after budbreak. To improve early season tree growth, 2 to 3 sprays of 6 lbs of urea per 100-gal water is recommended at 10 to 14-day intervals beginning at 3 weeks after budbreak. In early October, 2 sprays of foliar urea at 25 lbs per 100 gal are also suggested.

In the second year, when new shoots begin their rapid growth (early to mid-May), apply 0.1 to 0.2 pounds of actual nitrogen per tree and a similar N spray program as in year 1. If trees have a substantial crop and the variety is susceptible to bitter pit, a foliar calcium program is recommended.

10.5 Fertilization Program for Established Orchards

10.5.1 Using Leaf Analysis

Leaf analysis indicates the concentration of nutrients that are present in the foliage. If leaf samples are taken correctly and the results are interpreted properly, it provides a good

tool for developing an effective fertilization program. Leaf analysis standard for fruit trees are listed in Table 10.4.1.

Leaf samples should be collected between 60 to 70 days after petal fall, which generally corresponds to late July and early August. Mid-shoot leaves should be sampled from current season terminal shoots on the periphery of the tree. Sample trees should represent the general conditions of the orchard in terms of vigor, crop load, etc. Each sample should consist of about 100 leaves collected from several trees in the area being sampled. Do not mix leaves from different varieties, soil conditions, tree vigor, or crop load. Record observations on terminal shoot length, thickness, crop load, and fruit size. Leaf samples can be sent to: **Maine Agricultural and Forest Experiment Station Analytical Laboratory**, 5722 Deering Hall, University of Maine, Orono, ME 04469-5722 (207-581-3591); **UMass Soil & Plant Tissue Testing Laboratory**, West Experiment Station, University of Massachusetts, Amherst, 01003 (413-545-2311); **University of New Hampshire Cooperative Extension Soil Testing Program**, Spaulding Life Science Center, Room G28A, 38 College Road, Durham, New Hampshire 03824 (603-862-3200); or **University of Vermont Agricultural & Environmental Testing Laboratory**, 209 Hills Building, University of Vermont, Burlington, VT 05405 (802-656-3030).

Please note that the desired levels in Table 10.4.1 are given as general references. Individual state plant-tissue testing laboratories may use somewhat different optima. If given, follow the nutrient recommendations of the laboratory conducting the analyses and your local fruit specialist.

It should be recognized that leaf analysis has its limitations. First, leaf samples are taken relatively late in the growing season. Even if you can get the leaf analysis results back immediately, you may not have enough time left during the season to correct mineral deficiencies if there are any. Secondly, routine leaf analysis cannot detect the transient nutrient demand by certain physiological processes early in the season. For example, trees have a large transient demand for boron at bloom. Finally, even if leaf analysis shows no mineral nutrient deficiency, you still need to have a maintenance program in place to make up the amount of nutrients that is lost in harvested fruit and fallen leaves every year. Therefore, two fertilization programs are suggested here for established trees. One is a maintenance program. The other is a corrective program for trees with nutrient deficiency.

Table 10.5.1. Leaf analysis standards for tree fruits (dry weight basis).

Element	Crop	Desired Level
Nitrogen	Young nonbearing apples and pears	2.4-2.6%
	Young bearing apples and pears	2.2-2.4%
	Mature soft apples and pears	1.8-2.2%
	Mature hard apples and processing	2.2-2.4%
	Cherries, plums, prunes	2.4-3.4%
	Peaches	3.0-4.0%
Phosphorus	All crop	0.13-0.33%
Potassium	All crops	1.35-1.85%
Calcium	All crops	1.3-2.0%
Magnesium	Apples and pears	0.35-0.50%
	Stone fruits	0.40-0.60%
Boron	Apples and pears	35-50 ppm
	Stone fruits	30-40 ppm
Zinc	All crops	30-50 ppm
Copper	All crops	7-12 ppm
Manganese	All crops	50-150 ppm
Iron	All crops	50+ ppm

10.5.1.1. Maintenance program

This program is suggested when leaf analysis shows no nutrient deficiency or no deficiency symptoms are observed.

Timing	Foliar Sprays	Ground Applications
Green tip	One spray of 2 to 4 lbs of a fixed copper product per 100 gal (C-O-C-S or Kocide).	
Tight cluster to pink	One spray of tank mixed 3 lbs of urea and 1 lb Solubor/100 gal	Apply 20 to 40 lbs of actual nitrogen/acre to soil.
Petal fall to early cover sprays	One spray of Zn-EDTA at label rate at second cover. **Plus** One spray of 3 to 4 lb of calcium chloride/100 gal at third cover. **Plus** Two sprays of 15 lb of Epsom salt/100 gal at petal fall, and second cover.	Apply 40 to 60 lbs of potassium/ acre to soil at petal fall.
End of shoot growth to harvest	Three to four sprays of 3 to 4 lbs of calcium chloride/100 gal at 14-day intervals for bitter pit susceptible varieties.	
After harvest		Apply 40 to 60 lb of potassium/ acre to soil. **Plus** Every 2 to 3 years, apply appropriate amount of lime determined from soil analysis.

10.5.1.2. Corrective program

This program is suggested when leaf analysis shows nutrient deficiency, or deficiency symptoms are observed. Match fertilizer applications to specific nutrient deficiency. (See table on next page.)

Timing	Foliar Sprays	Ground Applications
Green tip	One spray of 2 to 4 lbs of a fixed copper product per 100 gal (C-O-C-S or Kocide)	
Prebloom period	Two sprays of tank-mixed 1 lb of Solubor, 3 lbs of urea, and Zn-EDTA at label rate per 100 gallon, one at 1/2" green and the other at tight cluster to pink	Apply 40 to 60 lbs of actual nitrogen/acre to soil.
Petal fall to early cover sprays	Two foliar sprays of 5 lbs of urea/100 gal at petal fall and first cover. **Plus** Two sprays of Zn-EDTA at label rate at petal fall and second cover. **Plus** Two foliar sprays of 1 lb of Solubor/100 gal at first and third cover. **Plus** Three sprays of 15 lbs of Epsom salt/100 gal applied at petal fall, first and second covers. **Plus** One foliar spray of 3 to 4 lbs of calcium chloride per 100 gal at third cover.	Apply 60 to 150 lbs of Potassium/acre to soil at petal fall.
End of shoot growth to harvest	Five to six sprays of 3 to 4 lbs of calcium chloride/100 gal at 14-day intervals.	Apply 60 to 150 lbs of potassium to soil at the end of shoot growth.
After harvest	Two sprays of 25 lbs of urea/100 gal at 7 to 10-day intervals. **Plus** One spray of 1 lb of actual copper/acre as copper sulfate.	Soil application of 60 to 150 lbs of potassium/acre as sulfate of potash-magnesia. **Plus** Soil application of dolomitic lime to increase calcium and magnesium supply based on soil and leaf analyses.

10.5.2 Special Considerations in Foliar Application of Nutrients

To minimize the number of sprays applied in the orchard, it is frequently desirable to combine various nutrient materials or to add them in tank mixes with pesticides. Before doing so, however, one needs to make sure they are compatible.

Generally, urea, Solubor, Zn-EDTA, and Epsom salts are compatible. Urea, Solubor, and Zn-EDTA have been used together safely in prebloom sprays on apples and pears. A tank mix of urea and Epsom salts has sometimes injured young apple foliage; if both are required, they should be applied separately. Epsom salts and some of the boron products listed in Table 10.4.5 may increase the pH of the tank mix, and if used with pH-sensitive pesticides, pH of the tank mix should be tested and adjusted by using a suitable acidifying agent. Solubor and presumably other forms of boron should not be tank-mixed with any pesticide contained in water-soluble plastic packages because it inhibits the dissolution of the plastic. Foliar nutrients, in general, and Solubor, in particular, should not be tank-mixed with oil.

Although Epsom salts, Solubor and Zn-EDTA are compatible for use in postbloom sprays, many orchardists prefer not to add all three to one tank. A petal fall spray may then contain Epsom salts alone or with Solubor; the first cover spray a combination of Epsom salts and Solubor; the second cover spray a combination of Epsom salts and Zn-EDTA; and the third cover spray a combination of Solubor and Zn-EDTA.

Calcium chloride may be physically incompatible with Epsom salts, resulting in plugging of sprayer nozzles. Calcium chloride cannot be tank-mixed with Zn-EDTA because some of the dissolved calcium may displace Zn, causing phytotoxicity.

It should be pointed out that some Zn-chelate products contain a large percentage of unchelated Zn, which may cause injury to foliage and fruit. Therefore, before using a new Zn product in your orchard, test the product by spraying a few trees at the label rate to see if any phytotoxicity occurs.

More detailed information concerning nutrient management for orchards can be found in Cornell Cooperative Extension Information Bulletin 219, *Orchard Nutrition Management* by Warren Stiles and Shaw Reid. See the section on "Tree Fruit Reference Materials" at the end of this publication for ordering information.

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10.6 Characteristics of Commonly Available Fertilizers

Table 10.6.1. Nitrogen fertilizers

Common Name	N (%)	Pounds of Formulated Product per pound of N	Acidity or Basicity (lb $CaCO_3$/lb	
			Acidity	Basicity
Ammonia, anhydrous	82	1.22	1.8	—
Ammonia, aqua	20	5.00	1.8	—
Ammonium nitrate	33.5	2.98	1.8	—
Ammonium polyphosphate	12	8.33	4.1	—
Ammonium sulfate	20.5	4.88	5.4	—
Calcium nitrate	15.5	6.45	—	1.3
Diammonium phosphate	16-18	5.56	4.1	—
Monoammonium phosphate	11	9.09	5.3	—
Nitrate of soda-potash	15.5	6.45	—	1.3
Potassium nitrate	13	7.69	—	2.0
Sodium nitrate	16	6.25	—	1.8
Urea	45	2.22	1.6	—
Nitrogen solutions	variable[1]	—	—	—

[1]Nitrogen solutions may consist of mixtures of urea plus ammonium nitrate, aqua ammonia, or anhydrous ammonia plus urea or ammonium nitrate or both of these materi als. Consult supplier for analysis.

Table 10.6.2. Phosphorus fertilizers

Common Name	P_2O_5 (%)	Pounds of Formulated Product per Pound of P_2O_5	N (%)
Ordinary superphosphate	20	5	0
Concentrated superphosphate	46	2.27-2.17	0
Ammoniated superphosphate	40*	2.5*	5*
Monoammonium phosphate	52*	1.92*	13 *
Diammonium phosphate	46*	2.17*	18 *
Urea-ammonium phosphate	28	3.57	28

*Values may vary depending on fertilizer source.

Table 10.6.3. Potassium fertilizers

Common Name	Chemical Formula	K_2O (%)	Pounds of Formulated Product per Pound of K_2O
Muriate of Potash	KCl	60	1.67
Sulfate of Potash	K_2SO_4	53	1.89
Sulfate of Potash Magnesia	K_2SO_4•2Mg SO_4	22	4.54
Potassium polyphosphate	KPO_3	40	2.50
Potassium carbonate	K_2CO_3	67	1.50
Potassium nitrate	KNO_3	44	2.27

Table 10.6.4. Boron fertilizers[1]

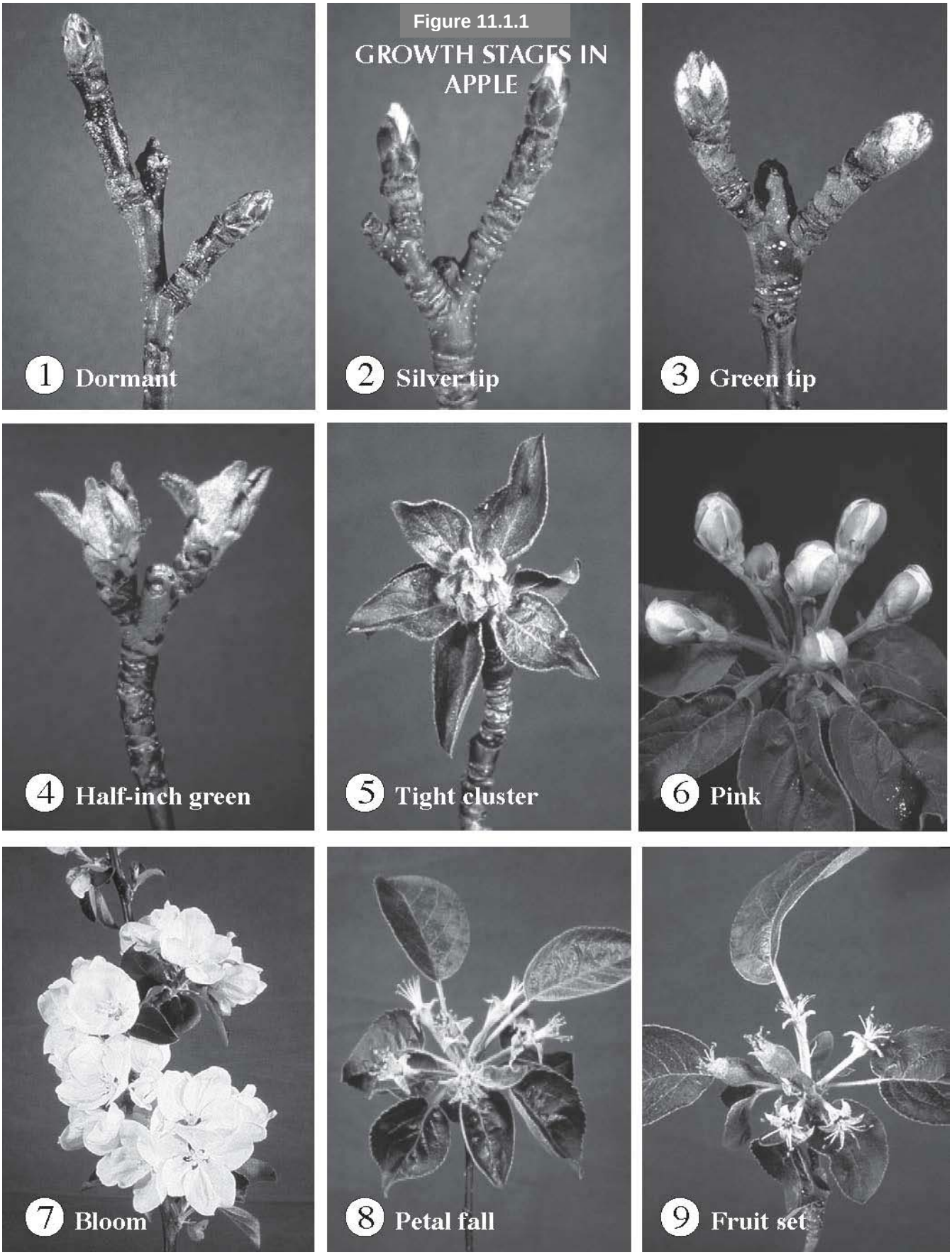
Product Name	B (%)	Form of B*	Increase in Spray Water pH	Cost per Pound of B
B-17	17.0	BA	none	low
Mor-Bor 17	17.3	BA	none	low
Spray-Bor	16.5	NaB	moderate	low
Solubor	20.5	NaB	high	very low
Solubor DF	17.4	NaB	high	n/a
Albion Liquid B	5.0	NaB	high	high
Liquibor	2.5	BA, NaB	high	high
Borosol 10	10.0	BA	very high	moderate
N-Boron	5.4	BA	very high	n/a

*Form of boron indicates boron compound used in formulating the product: **BA:** boric acid; **NaB:** sodium polyborates.
[1]From Dr. Frank Peryea, Washington State University.

Table 10.5.6. Miscellaneous fertilizers

Name	Mineral Element	Content (%)	Name	Mineral Element	Content (%)
Gypsum	Ca	24	Kieserite	Mg	17.3
Superphosphate	Ca	20	Magnesium oxide	Mg	49-56
Concentrated superphosphate	Ca	14	Magnesium sulfate	Mg	16
Calcium nitrate	Ca	24	Zinc chelate	Zn	variable
Calcium chloride (77-80%)	Ca	27.8	Zinc sulfate	Zn	36%
Calcium chloride (35% liquid)	Ca	12.6	Basic zinc sulfate	Zn	50-52
Calcium chelates	Ca	variable	Copper chelate	Cu	variable
Epsom salts	Mg	10	Copper sulfate	Cu	25%

Figure 11.1.1


GROWTH STAGES IN APPLE
1 Dormant
2 Silver tip
3 Green tip
4 Half-inch green
5 Tight cluster
6 Pink
7 Bloom
8 Petal fall
9 Fruit set

11 General Pest Management Considerations – Apples

11.1 Diseases

Apple Rust Diseases

• Biology & Cultural

[1.1] Varieties that are susceptible to cedar apple rust include: Arlet, Braeburn, Fuji, Gala, Ginger Gold, Goldrush, Golden Delicious, Idared, Jonathan, Lodi, Mutsu (Crispin), and Rome. All varieties are susceptible to quince rust under favorable weather conditions. See Table 6.2.3 for a precise listing of temperature and wetting periods necessary to cause cedar-apple rust infections. Maintain short intervals during periods of wet weather in orchards where quince rust fruit infections have been a problem. Quince rust infections are most likely to develop when long wetting periods (48 hours or more) occur between tight cluster and first cover and the average temperature is greater than 50° F.

Refer to the reference materials list at the end of this publication for a Fact Sheet containing more details on the biology and management of this pest.

• Pesticide Application Notes

[1.2] Where apple rust diseases are a problem, sprays normally must be applied at 7- to 10-day intervals from pink until 2–3 wk after petal fall. Rally, Rubigan, Procure, and Bayleton have kickback activity against cedar apple rust. If an infection period should occur when foliage is poorly protected, it is recommended that one of these materials be applied within 3 days of the start of the infection period or as soon thereafter as weather conditions permit. The strobilurin fungicides (Sovran, Flint) provide moderate protection against rust diseases when applied on a 7-day schedule, but they have little or no kickback activity.

[1.3] The lower rate and extended season use of the EBDC fungicides is adequate for control of rust diseases, and the extended timing is necessary to control rust infections on terminal leaves. It is illegal to combine or integrate the two treatment regimes.

[1.4] Where apple rusts are a problem, include a suitable rust fungicide in the first two cover sprays.

Apple Scab

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Pesticide Application Notes

[2.1] See discussion of inoculum reduction in the disease management section. Scab fungicide sprays beginning at green tip are absolutely essential in orchards with high carry-over inoculum or orchards where scab control with SI fungicides was less than satisfactory in previous years. If early season infections are allowed to become established, even the best fungicide programs will not prevent development of fruit scab in orchards where the scab fungus has developed resistance to all three of the fungicide groups (dodine, benzimidazoles, SI's) that previously provided presymptom and postinfection activity against apple scab.

[2.2] Fungicide rates per acre should never be reduced below either (i) 50% of the per-acre rate listed on the label or (ii) 1.5 multiplied by the rate/100 gal listed on the label. This applies even when spraying small trees. Although tree-row volume calculations may suggest that lower rates are appropriate, applying less than 50% of the per-acre rate has frequently resulted in unsatisfactory scab control and/or more rapid development of fungicide resistance.

In orchards with SI-resistant scab, a combination of a mancozeb fungicide at 3 lb/A plus a captan formulation that supplies 1.5 lb of active ingredient/A has provided excellent scab control when used in prebloom and bloom sprays. (A captan rate of 1.5 lb active ingredient/A translates to 3 lb/A of Captan 50W, 30 oz/A of 80W, or 1.5 qt/A for the 4L formulations.) This combination provides a better residual activity through heavy rains than would be available from either product used alone and it preserves the option of using mancozeb sprays after petal fall. The mancozeb-captan combination cannot be used close to prebloom oil sprays because of captan-oil incompatibilities.

For reasons of economy and resistance management, it is recommended that SI and strobilurin fungicides not be used until tight cluster, even when fungicidal protection is needed earlier; in such cases, make a single application of an alternative fungicide (captan, copper, EBDC) at green tip and half-inch green, then begin the SI/strobilurin program at tight cluster. Do not apply captan or sulfur within 10 days of an oil spray. Do not apply liquid captan formulations with sulfur on sulfur-sensitive varieties. A further discussion of apple scab fungicide characteristics is presented in the section "Apple Scab Fungicides" and in Table 6.1.2.

[2.3] Check fungicide compatibility with desired insecticide or oil; see [1.1].

[2.4] Sovran and Flint are excellent protectants, but they have only 48–72 hours of post-infection activity compared with 72–96 hr for the SI fungicides. Sovran and Flint also lack the presymptom activity that makes the SI fungicides so effective (in the absence of SI resistance) for arresting scab epidemics after primary scab lesions become visible in trees. Sovran and Flint have proven very effective against apple scab when applied at 7–9-day intervals to control primary scab, but they have not performed as well when used to control secondary scab in trees where scab lesions are already visible. Sovran and Flint control rust diseases fairly well when used as protectants, but they have little or no post-infection activity against rust diseases.

CAUTION: Sovran has caused moderate to severe phytotoxicity (leaf burning) on several sweet cherry

varieties when sprayed directly onto them at high labeled rates. The *most sensitive varieties were: Somerset, Sweetheart, Valera, Van, and Vandalay;* these varieties might also be injured by spray drift containing Sovran. Minor to moderate injury occurred on Cavalier, Coral Champagne, Emperor Francis, Royalton, Schmidt, Summit, and Viva; there is less danger of injury due to spray drift on these varieties. Many other sweet and sour cherry varieties (including Bing, Brooks, Cashmere, Gold, Hardy Giant, Hartland, Hedelfingen, Hudson, Kristin, Lapins, Lambert, Montmorency, Napoleon, Nelson Black Sweet, Rainier, Royal Ann, Sam, Stark Crimson, Stella, Sue, Tehranivee, Tulare, Ulster, Vega, Vic, Viscount, and Windsor) showed no injury when sprayed directly with high labeled rates. The Sovran manufacturer recommends: (i) Do not apply Sovran near or allow drift onto cherries in the highly sensitive group (Somerset, etc.); and (ii) thoroughly rinse spray equipment (tanks, hoses, nozzles) after spraying Sovran and before using this equipment on sensitive cherry varieties.

[2.5] Although Inspire Super, Rubigan, Procure and Rally have up to 96 hr of kickback activity, this activity depends strongly on rate. Do not use tree-row volume calculations with these products. They provide good curative activity when used at higher label rates (e.g., at least 4 oz/A of Inspire Super, 10 fl oz/A of Rubigan or Procure, or 6 oz/A of Rally) but are much less active at lower rates if applied more than 48 hr after infection. When applied beyond the effective kickback period, many infection sites are merely suppressed but not eradicated. In such cases, if a 2nd spray is applied 7–10 days later, most of these lesions will finally be killed or inactivated; however, if no additional material is applied, the suppressed lesions may eventually become active again.

IMPORTANT: Good spray coverage is especially critical for SI fungicides. Poor spray coverage not only provides poor control but speeds the selection of scab strains that are resistant to the SI fungicides. Experience has shown that inadequate control occurs more frequently when spray concentrations are greater than 6X than when concentrations are 6X or less. Inadequate control due to poor spray coverage is also relatively common in unpruned or very tall trees.

[2.6] Primary inoculum pressure is generally at a peak from pink through bloom—this is a critical time to maintain full coverage with proper fungicide rates.

[2.7] Serious losses from apple scab are usually the result of secondary spread to developing fruits. Therefore, it is important to carefully check blocks for the presence of primary scab lesions from petal fall through the early cover spray period. This is particularly important because fruit are most susceptible to infection during the first few weeks of their development. If scab is detected, the management strategy should be to (i) thoroughly protect the sensitive young fruitlets from fungal spores that are present, AND (ii) limit the number of new spores that can be produced. To protect fruitlets, use (a) the full rate of captan (e.g., 2 lb/100 gal of the 50WP formulation), or (b) the reduced rate of an EBDC fungicide (if allowable) supplemented with a half rate of captan, or (c) a strobilurin fungicide combined with a contact fungicide. To limit new spore production, use (a) an SI fungicide through 2nd cover (to prevent new leaf lesions), or (b) a registered strobilurin fungicide (to prevent new leaf lesions and suppress spore production from existing lesions), or (c) dodine (to "burn out" existing lesions). SI's and dodine should be used only in orchards where there is no resistance to these fungicides. (**CAUTION:** Applications of dodine after bloom may cause russeting on russet-sensitive varieties). With repeated use, all three of these options will speed the development of resistance. Thus, they should be viewed as emergency "rescue" operations, and increased care should be taken in future seasons to avoid the development of primary scab that necessitated their use.

[2.8] The EBDC fungicides (mancozeb, maneb, Polyram) are labeled for use on apples in one of two different ways: (i) at a rate of 1.5–2 lb/100 gal (maximum 6 lb/A, no more than 24 lb/A per year), not to be applied after bloom; OR (ii) at a reduced rate of 3 lb/A (maximum 21 lb/A per year), which may be applied to within 77 days of harvest. It is illegal to use the reduced rate (3 lb/A) after bloom if the rate for any of the sprays prior to petal fall exceeded 3 lb/A.

[2.9] The danger of primary scab is over after 1st cover except when drought conditions delay spore release. If primary scab has been well controlled, fungicide schedules and rates can be relaxed after the danger of primary infection is past. For best control of mildew, apply an SI or strobilurin fungicide through 2nd cover on bearing trees and through 4th cover on non-bearing trees.

[2.11] The use of Inspire Super, Rally, Rubigan or Procure beyond 2nd cover is specifically NOT recommended, except in non-bearing orchards where they may be needed for mildew control during the summer. Spraying them during the summer increases the likelihood of selecting strains of the scab fungus that are tolerant of these compounds. Excessive use of Bayleton, Inspire Super, Rally, *Procure, or Rubigan also increases the possibility of developing powdery mildew resistance to these sterol-inhibitor compounds.

• Pesticide Resistance

[2.12] Apple scab and powdery mildew resistance to Topsin M and Thiophanate-methyl is widespread, though it has not been confirmed in New England. Once resistance develops it will persist indefinitely. Thus, these products should NOT be relied upon for apple scab or mildew control in orchards or regions with a long history of use.

[2.13] Sensitivity to the SI fungicides (Inspire Super, Rally, Procure, Rubigan) is declining among some populations of the apple scab and powdery mildew fungi. These materials still provide apple scab control in some orchards, but they are totally ineffective in other orchards. Declining efficacy usually appears in orchards with a history of regular SI use (3–5 applications for 10+ yr) under high disease pressure, whereas no decline is apparent in orchards where the materials have been used sparingly or in tight schedules with low levels of inoculum. In order to maintain the usefulness of these products, it is

recommended that they be used: (a) at full rates with thorough spray coverage; (b) only in tank-mix combinations with another effective scab fungicide; and (c) no more than 2–3 times per season.

[2.14] Sovran and Flint are prone to resistance development, and resistance to one member of this class confers resistance to other products in the class (cross-resistance). The primary strategies for reducing this risk are to rotate the strobilurins with unrelated fungicides, to limit the number of seasonal applications of a strobilurin (e.g., 3-4 per year), and to tank mix strobilurins with full rates of captan when treating trees with visible scab lesions.

Bitter Rot

• Pesticide Application Notes

[3.1] Although the EBDC fungicides are effective against bitter rot, the 77-day PHI does not allow them to be used in late summer when most bitter rot infections occur. Captan and Pristine are the best materials available. Bitter rot has the potential for "explosive" development, thus captan rates should be increased to their upper labeled range (equivalent to 1.5–2 lb/100 gallons of the 50WP formulation) if the disease begins to develop and hot, wet weather is anticipated. Under such conditions, tight spray schedules should be maintained until 2 wk before harvest. The higher captan rates should be used even in combinations with Topsin M, since these fungicides have very little effect against bitter rot. Flint at 2.5 oz/A is also effective against bitter rot.

Black Rot, White Rot (frog-eye leaf spot and fruit infections)

• Biology & Cultural

[4.1] Black rot inoculum is retained within trees in dead wood (e.g., old fire blight strikes) and fruitlet mummies; therefore, it is important to remove these sources to whatever extent possible. The critical periods for controlling black rot fruit infections are (a) from the 1st through 3d cover sprays, when fruitlets killed by thinning sprays become infected (they become inoculum sources), and (b) during late summer, when maturing fruit are especially susceptible. Where black rot was not controlled well the previous year, protectant sprays may be needed at 2–3-week intervals until late August.

Black rot cankers cannot be controlled with fungicide sprays. Cankers develop primarily after wood has been weakened by other factors (e.g., drought, winter injury). However, the white rot fungus may establish superficial cankers on trees that receive only mancozeb and/or SI sprays during the primary scab period. Those superficial cankers can suddenly girdle limbs if trees become severely drought-stressed. Using a copper fungicide at green tip and/or including a fungicide with activity against black rot/white rot in the prebloom scab control program should help to control superficial white rot cankers.

• Pesticide Application Notes

[4.2] Many sprays aimed at scab and rust are also effective against the black rot fungus. Topsin M and Thiophanate-methyl are highly effective. Captan and the strobilurin fungicides (Sovran, Flint) provide good control. The SI fungicides (Bayleton, Inspire Super, Rally, *Procure, Rubigan) do not control black rot. Polyram and mancozeb fungicides are effective at the maximum label rate but have little activity when used at the lower rates that are labeled as applications after petal fall. Ziram at 1.5–2 lb/100 gallons (dilute basis) is only moderately effective (OK when inoculum levels are low), but is often ineffective at 1lb/100 gallons (dilute basis) or less.

NOTE: The frog-eye leaf spot phase of black rot is sometimes misdiagnosed, because identical symptoms can be caused by (a) spray materials that are phytotoxic to leaves; or (b) cedar apple rust infections whose development is arrested by the application of an SI fungicide or by a host-resistance response such as occurs when the rust fungus begins attacking unsprayed McIntosh, Empire, or Liberty leaves. Mancozeb and Polyram are the best materials for protecting against rust-induced leaf spotting.

[4.3] Topsin-M, Thiophanate-methyl, Captan, and the strobilurins are the only fungicides that provide effective control of black rot during the critical periods if disease pressure is moderate to high. Ziram at 1.5–2 lb/100 gallons (dilute basis) is only moderately effective (OK when inoculum levels are low), but is often ineffective at 1lb/100 gallons (dilute basis) or less, as are mancozeb and Polyram at the reduced rates allowed after bloom.

Blister Spot

• Pesticide Application Notes

[5.1] This is an economic problem primarily on Crispin (Mutsu), but Fuji occasionally shows symptoms when planted near Crispin. Apply the 1st spray 10–14 days after petal fall. A delay in applying this spray will significantly reduce control in most years. Two additional sprays should be applied at weekly intervals if any rain occurs. Do not apply more than 3 sprays. The use of 2–4 lb Kocide or C-O-C-S/100 gal between green tip and 1/2-inch green in the spring may reduce overwintering inoculum and provide a small amount of additional control. Additionally, application of Aliette (or phosphorous acid or phosphite products) during pink, petal fall, and early cover sprays may also reduce infections.

• Pesticide Resistance

[5.2] Streptomycin-resistant blister spot bacteria are present in Crispin orchards in western New York. Streptomycin will continue to provide some control after resistance is first detected, but this degree of control will gradually diminish in succeeding years if strep is continuously used. Recent research indicates that resistance levels within an orchard diminish significantly after one season if no strep is applied. Thus, once resistance becomes pronounced, strep is likely to be most effective if used only

in alternate years. There are no alternative bactericides for use in apple orchards against blister spot.

Blossom End Rots

• Biology & Cultural

[6.1] Blossom end rot can be caused by *Botrytis cinerea, Sclerotinia sclerotiorum,* and *Botryosphaeria obtusa*. It occurs sporadically and is most likely to become a problem if the weather is warm and wet between bloom and 1st cover. McIntosh, Delicious, Rome, and Paulared are most commonly affected.

• Pesticide Application Notes

[6.2] Where blossom end rot has occurred before, use captan, Sovran, Flint, Topsin M or Thiophanate-methyl in the bloom, petal fall, and 1st cover sprays if the weather conditions are favorable for infection. Vangard and Scala will control infections caused by *Botrytis*, but they may be less effective against blossom end rots caused by *Sclerotinia* or *Botryosphaeria.*

Crown Rot (Collar Rot)

• Biology & Cultural

[7.1] Crown rot is primarily associated with trees on moderately to highly susceptible rootstocks (particularly MM.106 and young trees on M.26). It can also develop on moderately resistant rootstocks planted in poorly drained sites or in very wet years. Seedling and M.9 appear to be the least susceptible of the common rootstocks.

Refer to the reference materials list at the end of this publication for a Fact Sheet containing more details on the biology and management of this pest.

• Pesticide Application Notes

[7.2] Ridomil should be considered in sections of the orchard where crown rot has been a problem, or where the combination of marginal drainage and rootstock susceptibility indicates a potential problem. Make a solution containing 8 fl oz Ridomil Gold 4EC/100 gal of water and apply this solution to the soil around the trunk at the following rate:

Trunk diameter (in.)	Solution (qt)
1	1
1–3	2
3–5	3
5	4

Apply just as growth begins in the spring and repeat immediately after harvest. Do not apply to newly planted trees. Ridomil is an effective protective fungicide, but is unlikely to cure trees in moderate to severe stages of decline.

[7.3] Apply 4 lb/A of Aliette 80WP as a foliar spray, or use one of the phosphorous acid or phosphite products labeled for this use. Make 1st application in spring after sufficient foliage is present to absorb chemical. Repeat every 60 days; maximum 4 applications/yr. Unlikely to cure trees in moderate to severe stages of decline.

Fire Blight

• Biology & Cultural

[8.1] Fire blight is a potentially damaging disease on highly susceptible varieties such as Crispin (Mutsu), Fuji, Gala, Gingergold, Honeycrisp, Idared, Jonathan, Lady Apple, Monroe, Paulared, R. I. Greening, and Wayne. Many other varieties can become diseased if conditions are particularly favorable for disease development. The potential for tree loss is especially high when susceptible varieties are grown on susceptible M.26 and M.9 rootstocks (or interstems), since blight can move into them from the scion or infected root suckers and kill the tree.

[8.2] Pruning out infected shoots to limit the spread of shoot blight is of doubtful benefit on large trees but is recommended on young or small trees, particularly those on M.9 or M.26 rootstocks or interstems. To effectively limit damage, strikes should be pruned out as soon as they appear throughout the terminal growth period; begin checking for symptoms about 90–100 degree days (base 55° F) after an expected infection event such as rain during bloom or a summer hailstorm. Should blight develop, it is also important to maintain control of pear psylla and potato leafhopper because these insects can contribute to shoot blight infections. Recent research indicates that aphids and white apple leaf hopper are less important in spread of fire blight.

Refer to the reference materials list at the end of this publication for a Fact Sheet containing more details on the biology and management of this pest.

• Monitoring & Forecasting

[8.3] Serious fire blight problems are usually the result of infection during bloom. The need for streptomycin sprays during bloom depends upon a combination of both orchard risk factors and weather risk factors. If weather conditions favor blossom blight infections, streptomycin is strongly recommended for orchards where risk factors are high (highly susceptible scion and rootstock cultivars, active fire blight or past history of fire blight in the orchard or in neighboring orchards).

Streptomycin is effective in preventing blossom infections. However, precise timing is required because only those blossoms that are open at the time of the application are protected and there is no redistribution to new blossoms by rainfall. It is currently recommended that in orchards at moderate or high risk, streptomycin should be applied if weather has been relatively warm since full pink AND forecasts indicate the probability of rain or showers in the next 24 hr at temperatures greater than 60° F. A program to initiate spraying once 200 degree hours (base 65° F) have accumulated since full pink (first open blossom in the orchard) has proven effective in several locations and should serve as an approximate guideline. [Example: To calculate degree hours for a particular day, assume 6 hr at the high temperature, 6 hr at the low, and 12 hr at the

average of the two. Thus, for a day with a high of 80° F, a low of 60° F, and an average of 70° F, the number of accumulated degree hours can be calculated as: 6 hr x 15 degrees above 65 for the high + 6 hr x 0 degrees above 65 for the low + 12 hr x 5 degrees above 65 for the average, or 90 + 0 + 60 = 150 accumulated degree hours]. Thus, once 200 or more degree hours have accumulated, strep should be sprayed before the next forecasted rain, providing that temperatures are 60° F or higher. Fire blight forecast models MaryBlytTM and Cougar Blight are commonly used to predict fire blight risk in New England. Cougar Blight is available at the following web site http://www.ncw.wsu.edu/ treefruit/fireblight/2000f.htm.

The need for additional streptomycin treatments should be determined starting 3 days after an application, and streptomycin should then be reapplied to protect newly opened blossoms before the next rain occurs. Streptomycin also provides control if applied within 24 hr after a wetting event begins. Antibacterial activity depends upon absorption by the blossoms; therefore, streptomycin should not be applied immediately before or during a rain. Thorough coverage is essential for control. The application of streptomycin at concentrations greater than 6X has been associated with reduced levels of control and is, therefore, not recommended. Refer also to [8.5] and [8.7].

• Pesticide Application Notes

[8.4] Copper applied at green tip will not eliminate the need for streptomycin at bloom. However, it is effective in reducing the population of overwintering fire blight bacteria and is a useful component of an overall fire blight control program. Thorough coverage of the entire tree is necessary for maximum effectiveness, so dilute or high gallonage sprays are preferred. This is also an effective scab spray, but is likely to cause injury if applied beyond 1/4-inch to 1/2-inch green. The oil should be added at a rate of 1 qt per 100 gal of actual spray solution in the tank (i.e., do not concentrate the oil). Oil is added to increase efficiency of the copper, but will not control mites when applied at this time and rate. If using Bordeaux mix, prepare as described in the section "Fungicides." Add the oil after adding lime, but before making the mix up to final volume. Several other commercial copper formulations in addition to those listed are labeled for this use on apples. Although they have not been tested, research on other crops suggests that most copper formulations should give comparable rates of control at comparable rates of metallic copper.

[8.5] To reduce the chance of developing resistance, the routine use of streptomycin to control the spread of shoot infections is discouraged. However, an application of streptomycin is recommended following a hailstorm in fire blight-affected orchards, provided that such a spray can be applied without violating the preharvest interval. This application may be critical if even moderate amounts of blight were present before the storm. Sprays should be completed within 24 hr after the start of the hail.

[8.6] Apogee is a growth regulator that has given good control of fire blight infection of shoots, but is ineffective for control of blossom infections. Apogee should be applied in late bloom or early petal fall (when shoots are 1–3 inches long) at 6–12 oz/ 100 gal, with a second application 3-4 weeks later (Important: see recommendation and comments under "Growth Regulator Uses in Apples" section for more information about Apogee and water quality requirements). Because Apogee has no effect on preventing or slowing fire blight infections for at least 10 days after application, the need for application must be determined prior to the appearance of fire blight symptoms in the orchard. The need for application should be based upon the number of fire blight infection periods that occur during bloom and the severity of fire blight the previous season, as well as the susceptibility of the scion variety and rootstock. If Apogee is to be applied to trees less than 5 years old, the rate of application should be reduced to 3–6 oz/100 gal, and the grower must balance the benefit of shoot blight control against the drawback of reduced shoot growth. Apogee may affect thinning programs (see "Growth Regulator Uses in Apples").

[8.7] Serenade can be integrated into a fire blight control program, but it has been consistently less effective than streptomycin. Therefore, Serenade should be used only in a rotational program with streptomycin and not as the sole bactericide for fire blight management. Research suggests that streptomycin should be the first product applied during bloom, particularly when conditions are very favorable for the development of fire blight. Serenade should be applied 24 hr after the infection event.

Powdery Mildew

• Biology & Cultural

[9.1] Powdery mildew survives the winter in vegetative or fruit buds that were infected the previous season. Winter temperatures below –11° F can kill the mycelium in the buds and temperatures below -24° F can kill many of the infected buds, thereby reducing overwintering infections and inoculum potential for the next growing season. Baldwin, Cortland, Crispin, Gala, Ginger Gold, Honeycrisp, Idared, Jonathan, Monroe, Paulared, and Rome are highly susceptible varieties. Other less-susceptible varieties may also become seriously diseased in certain years, particularly if planted near trees where mildew is not well controlled. Rain is not necessary for infection to occur; therefore, mildew sprays must be maintained even during prolonged dry spells when scab sprays aren't necessary. Mildew develops slowly at temperatures below 50° F so mildew sprays are relatively unimportant until temperatures regularly exceed this level. Refer to the reference materials list at the end of this publication for a Fact Sheet containing more details on the biology and management of this pest.

• Pesticide Application Notes

[9.2] Sulfur is effective against mildew, but it has short residual activity and must be reapplied every 7 days for good results. There is danger of phytotoxicity on some varieties, particularly at higher temperatures (80° F and above) or if applied with or near an oil spray. The SI

fungicides (Bayleton, Inspire Super, Rally, Procure, Rubigan) are the most effective materials for control of powdery mildew. SI programs can usually start about 1 week later than sulfur programs and are effective at 10–14-day intervals. They have provided good commercial control when used from pink through 1st or 2nd cover. The strobilurin fungicides (Sovran, Flint) provide good control of powdery mildew, but have been slightly less effective than the SIs. Rotational programs involving SI's followed by strobilurins are as effective as previous SI-only programs and will help manage the development of resistance to both fungicide groups. Topsin M was an excellent powdery mildew fungicide, but it has provided poor control in many orchards in recent years.

[9.3] JMS Stylet Oil also provides mite control but has incompatibility problems with several other pesticides, including captan and sulfur. Refer to label for specific restrictions.

[9.4] Although triadimefon is labeled for use at rates below 1 oz/100 gal, rates below 1 oz/100 gal are ineffective against powdery mildew in many orchards because mildew is has developed resistance to lower rates of this fungicide.

[9.5] Do not delay mildew sprays beyond pink.

Sooty Blotch and Fly Speck

• Biology & Cultural

[10.1] Sooty blotch and fly speck develop gradually during periods of very high humidity; thus they are favored by frequent showers, prolonged cloudy weather, poor air circulation, dense tree canopies, and clustered fruit. These diseases are particularly damaging when rainy weather persists through summer and allows repeated cycles of secondary spread. Inoculum for sooty blotch and flyspeck often comes from alternate hosts in adjacent woods and hedgerows, such as trees, shrubs, vines, particularly wild brambles. Removal of these plants to whatever extent possible (e.g., bush-hogging fencerows or ditchbanks) will aid in disease control. Summer pruning, which increases air movement through the tree canopy, also aids in control of these diseases. After spores land on unprotected fruit, 270 hr of accumulated wetting are required before flyspeck will become evident on fruit.

Refer to the reference materials list at the end of this publication for a Fact Sheet containing more details on the biology and management of this pest.

• Pesticide Application Notes

[10.2] Ascospores of the flyspeck fungus can be blown into orchards beginning near petal fall, but fungicides applied for scab control are usually adequate to control these early season infections. The real risk of flyspeck infection escalates when secondary spores become available in woodlots and hedgerows. This occurs after approximately 270 hours of accumulated wetting (rains and dew periods) counting from petal fall. Topsin M, Sovran, Flint, and Pristine all arrest development of flyspeck infections on fruit if they are applied after infections have occurred, but the infections resume growing after fungicide residues are depleted. Applications of Topsin M, Sovran, Flint, or Pristine should then be renewed at 14–21 day intervals. If all fungicide coverage is removed by heavy rains (> 3 inches after the last spray) during late August or early September, a late-season spray may be needed to control disease on cultivars that will not be harvested within 25–30 days after fungicide coverage is depleted. Effectiveness of late-season sprays is largely dependent on spray coverage within the tree.

[10.3] Captan is relatively weak against sooty blotch and very weak against flyspeck; if using Captan for control of summer rot diseases, tank-mix with Topsin M, Flint or Sovran if sooty blotch and fly speck control are needed.

[10.4] For the best residual control of all summer diseases during the 30–50-day interval between the last spray and harvest, use either Pristine or Captan plus Topsin M in the last spray.

[10.5] Repeated tests in the Hudson Valley have shown that Ziram plus sulfur provides better control of these diseases than Ziram alone.

11.2 Insects and Mites

American Plum Borer refer to *Dogwood Borer*

Apple Aphid, Spirea Aphid

• Pesticide Application Notes

[11.1] *Vydate applied in the summer against leafminer will also control apple aphid. *Danitol will also provide suppression of European red mite. Do not make more than one application of Actara per season. Suggested action threshold: 30–40% of all terminals infested, OR 50% or more of the terminals with at least 1 aphid and less than 20% of the aphid-infested terminals with predators, OR 10% of fruit with honeydew or aphids. Natural enemies usually eliminate the need for chemical controls in New England.

Apple Maggot

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet and Sampling Guide containing details on the biology and management of this pest.

• Pesticide Application Notes

[12.1] 2–4 sprays at 14-day intervals beginning late June to early July, except: use 7-day intervals for Sevin and *Lannate. Do not use *Lannate on Early McIntosh, Dutchess, or Wealthy varieties. *Asana, *Battalion, *Decis, Delegate, *Proaxis, *Warrior or , Delegate, or SpinTor applied against other pests during this period will also control apple maggot. *Danitol will also provide suppression of European red mite. Suggested action threshold: capture of an average of 1-2 apple maggot flies

per red sphere trap hung in block, or an average of 5 flies per red sphere trap baited with apple volatiles. Refer to Fig. 8 and IPM Pub. No. 207 (*Apple IPM: A guide for sampling and managing major apple pests in New York State*) for details on trap monitoring.

[12.2] Frequent applications (7–10-day intervals) of Surround and maximal coverage (no less than one third of tree row volume dilute spray volume per acre) are advised in New England while there is active foliar growth.

Apple Rust Mite

• Biology & Cultural

[13.1] Occurs from late June to harvest, particularly on varieties with pubescent leaves; does not generally coincide with high red mite populations. Injury is a yellowish browning of leaves or white blotches on upper leaf surfaces.

• Pesticide Application Notes

[13.2] Only 1 application per season allowed on apple Suggested action threshold: 150–200 mites/leaf.

Codling Moth, Lesser Appleworm, and Oriental Fruit Moth

• Biology & Cultural

Refer to the reference materials list at the end of this publication for Fact Sheets containing details on the biology and management of codling moth and oriental fruit moth. Oriental Fruit Moth is not likely to be found in northern VT, NH or ME.

• Monitoring & Forecasting

[14.1] For orchards not receiving insecticide applications for plum curculio and apple maggot, or where codling moth is otherwise a significant problem, a Michigan field model can be used to estimate the optimum time to begin insecticide treatments. For larvicides (e.g. Assail,Calypso, Imidan, Guthion, Avaunt, SpinTor, Delegate) the optimum timing is at the beginning of codling moth egg hatch, which occurs at 250 degree-days (base 50° F) after 1st sustained adult catch for the 1st generation, and 1260–1370 DD after this same biofix date for the 2nd generation. However, when using insect growth regulators (IGR) Intrepid or Rimon, or Altacor which has both ovicidal-and larvicidal activity the optimum timing is earlier. For Intrepid, recommended first application timing for codling moth is 100-200 degree-days after biofix. For Rimon, and Altacorthe recommended first application timing for codling moth is 50-100 degree-days after biofix for first generation, and at 1000 degree days for second generation.

• Biological & Non-chemical Control

[14.2] Where pheromone disruption of codling moth is used, dispensers should be applied before initiation of the 1st flight, which usually begins around petal fall. Isomate-C TT releases pheromone for 120-140 days.

Where pheromone disruption of oriental fruit moth is used, dispensers should be applied before initiation of the 2nd flight (late June to mid-July depending on location in New England); the need for re-application depends on residual field life of specific formulations: Isomate-M 100, 90 days; Checkmate and 3M Sprayable, 14 days. The residual life of the 3M sprayable deposit can be extended by the addition of a spreader-sticker such as Nu-Film-17 at 1 pt/A.

For both codling moth and oriental fruit moth, border insecticide sprays, or to the outer five rows, of pheromone disruptionorchards may be needed if there are unmanaged host trees or other sources of mated adult moths within 300 meters of or in other high pressure situations.

• Pesticide Application Notes

[14.3] Insecticide applied at petal fall and first cover against plum curculio contributes to control of codling moth, lesser appleworm and oriental fruit moth. In many orchards this incidental control displaces the need for insecticide applications targeted specifically for these pests.

Altacor, *Asana, *Battalion, Belt, *Decis, *Proaxis, *Warrior or applied during this period will also provide control of codling moth, lesser appleworm, and oriental fruit moth, as will the insecticides listed for r apple maggot. Do not use within 30 days of full bloom unless fruit thinning is desired. *Guthion, Dimethoate and Biobit labeled only for codling moth. *Calypso, Dipel, *Imidan and Lorsban not registered for lesser appleworm. *Lannate not registered for oriental fruit moth.; Avaunt or Calypso, and to a lesser extent Assail, applied in first or second cover spray will control plum curculio. §Carpovirusine and §Cyd-X labeled for use against codling moth only. Use of a non-ionic surfactant is recommended with Assail.

[14.4] Summer sprays against oriental fruit moth should be timed to start approximately at the 10% hatch point, 175-200 DD (base 45° F) after the first adult catch of the second brood. Typical dates for optimum first application range from the 1st to the 3rd week of July in southern and northern New England, respectively. Best timing for a second application is 10-14 days after the first. In high pressure blocks, a final spray should be applied two weekswk before harvest to control late season larvae. Use of a non-ionic surfactant is recommended with Assail. Suggested action threshold: Avg. of >15 adults/week caught per pheromone trap.

Comstock Mealybug

• Biology & Cultural

[15.1] This pest problem is apparently encouraged by excessive use of synthetic pyrethroids (more than 2 applications/season).Refer to the reference materials list at the end of this publication for a Fact Sheet containing more details on the biology and management of this pest.

• Pesticide Application Notes

[15.2] One spray advised against newly emerged crawlers, usually in late May (petal fall period). In severe cases, sprays against the 2nd generation may also be elected.

[15.3] Spray when crawlers 1st appear in summer, usually early Aug., and a 2nd spray 7–10 days later. Actara applied against other pests at this time will provide control of Comstock mealybug. Do not make more than one application of Actara per season.

Cutworms

• Biology & Cultural

[16.1] Cutworm problems are uncommon in apples in New England. Control of broadleaf weeds under trees is important.

• Pesticide Application Notes

[16.2] Apply spray when migrating larvae, or shoot or fruit injury, are first observed, usually in August. Do not use *Lannate on Early McIntosh, Dutchess, or Wealthy varieties.

Dogwood Borer, American Plum Borer

• Biology & Cultural

Refer to the reference materials list at the end of this publication for Fact Sheets containing details on the biology and management of these pests. American plum borer can be a problem particularly in orchards adjacent to stone fruit plantings.

• Pesticide Application Notes

[17.1] One coarse spray of Lorsban to trunk burr knots between half-inch green and petal fall. If fresh borer activity is noted in early July, follow up with one additional spray of Lorsban (July 1–5) or two of *Thionex to burr knots (July 1–5 and August 1–5). PHI's = 28 days.

European Apple Sawfly

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Pesticide Application Notes

[18.1] Particularly a problem in Southeastern New England; 1 spray at petal fall. Do not use *Lannate on Early McIntosh, Dutchess, or Wealthy varieties. Suggested action threshold: Cumulative capture of 3 adults/trap by 90% petal fall if no insecticide was applied at pink, or of 6 adults if an insecticide was applied at pink (white sticky-board trap).

[18.2] Actara, Avaunt, *Calypso and Lorsban will also control plum curculio when applied at this time. Do not make more than one application of Actara per season.

• Biology & Cultural

[19.1] Control of broadleaf weeds under trees is important.

• Pesticide Application Notes

[19.2] 1st generation spray: when migrating larvae, or shoot or fruit injury are first observed, usually in mid-June; 2nd generation: when larvae or injury to shoots or fruit is observed, usually in August. Be sure to note PHI limitations. Do not use *Lannate on Early McIntosh, Dutchess, or Wealthy varieties. SpinTor applied against late season leafrollers will also provide corn borer control (PHI = 7 days).

European Red Mite

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet and other resources containing details on the biology and management of this pest.

• Biological & Non-chemical Control

[20.1] The predaceous mite, *Typhlodromus pyri*, which is native to some apple production regions in New England, can successfully control populations of European red mite in commercial apple orchards so that no applications of miticides are required for seasonal control when selective pesticide programs are followed. This species also has been successfully introduced to some New England orchards. Refer to Tables 6.1.1 and 7.1 for ratings of pesticide effects on predatory mites, and to IPM Pub. No. 215 (*Achieving Biological Control of European Red Mite in Northeast Apples: An Implementation Guide for Growers*) for guidelines to implementing this approach.

• Pesticide Application Notes

[20.2] Oil is recommended at the 2–3 gal rate during the dormant period. This spray will also control European fruit scale.

[20.3] Good coverage is essential. Phytotoxicity from oil is more likely if sprays are concentrated more than 3X.

[20.4] Use 2 gal rate until tight cluster; reduce to 1 gal from tight cluster to pink. Good coverage is essential (300 gal/A recommended). San Jose scale, lecanium scale, and red bug are also controlled. See the "Acaricides" section of Fruit Crop Protectants for information on mixing and compatibility with fungicides. Suggested action threshold: 10% of spurs with eggs.

[20.5] One spray of Zeal, Apollo, Onager, Savey, or Envidor as soon as mite population exceeds threshold and within the first few weeks after petal fall before 1st generation mites lay their full capacity for 2nd generation eggs in enough water to obtain adequate coverage can provide season long control. The rate of formulated Apollo in finished spray solution should be 4–8 oz per acre. Envidor, Apollo, Onager, Savey and Zeal are limited to 1 application per season.

[20.6] One application of oil up to pink if not previously applied at 1/2-inch green. Tank mixing Apollo, Onager or Savey with oil at tight cluster can extend period of residual efficacy in the summer. Suggested action threshold: 10% of spurs with eggs.

[20.7] Pink spray suggested only if oil, Zeal, Envidor, Onager, Savey or Apollo was not used earlier. *Vydate may provide some mite suppression; effective also on leafminer larvae and rosy apple aphid. Complete coverage of all leaf surfaces is required for best results. Envidor, Apollo, Onager, Savey and Zeal limited to 1 application per season. Suggested action threshold: 2.5 nymphs/leaf.

[20.8] *Agri-Mek can be used anytime from petal fall to about 4 weeks afterward, but is most effective when applied before foliage begins to harden off, generally within the first 2 weeks after petal fall. Should be applied in combination with a horticultural spray oil (not a dormant oil) or other penetrating surfactant.

[20.9] Treatment with other materials generally not recommended at petal fall unless all previous sprays were either omitted or completely ineffective. Control failures with Kelthane have been reported from some New England orchards. Acramite, Envidor, Zeal and Nexter limited to 1 application per season; Kelthane, Kanemite and Portal limited to a maximum of 2 applications per season. *Vydate is a mite suppressant requiring back-to-back applications for control. Suggested action threshold: 1 mite/leaf or 30% of leaves with one or more mites. See Tables 6.1.1 and 7.1 for information about effects of pesticides on predatory mites.

[20.10] In orchards under an effective prebloom mite control program, a summer oil can effectively suppress mite populations when applied at petal fall and in 2 subsequent cover sprays at rates of 1qt–2 gal/100 gal finish spray solution, using a minimum of 100 gallons of spray per acre. Some leaf spotting may occur at the 2-gal/100 rate. The lowest rates in these 3 applications may not be adequate for season-long control under conditions of severe population pressure; however, effective control has been achieved in such conditions using 1/2 –1 gal/100 in a seasonal program starting at petal fall and continuing on a 2-week schedule until mid-August. Use of oil at concentrate rates increases the likelihood of phytotoxicity and is therefore not recommended. Do not exceed 1 1/2 gal per acre of PureSpray Green per application. Apple variety and spray drying conditions should be taken into account to minimize any possible effects on fruit finish.

[20.11] If oil is not to be used during the summer, 1 application of Acramite, Apollo, Envidor, Kanemite, Kelthane, Nexter, Savey, Onager, Zeal or *Vendex at 1st to 2nd cover, as needed. Apollo, Onager and Savey are primarily ovicides that will not directly reduce motile mite numbers. Use 8.8-10.7 oz of Nexter only for twospotted spider mite. For Kelthane and *Vendex, a 2nd application may be elected 10–14 days later (or, for Kanemite, 21 days later), as needed. Suggested action threshold: refer to Figs. 4–6 and IPM Pub. No. 207 (*Apple IPM: A guide for sampling and managing major apple pests in New York State*) for appropriate (date-dependent) threshold and sampling procedure.

Green Fruitworms

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Pesticide Application Notes

[21.1] Growers can usually wait until petal fall to assess the need for this treatment. Do not use *Lannate on Early McIntosh, Dutchess, or Wealthy varieties. It is recommended that pyrethroids not be used more than 1–2 times/season in any orchard. Suggested action threshold: 3 larvae/tree on standard-size tree (27–40 trees/A); 1 larva/tree at density of 140 trees/A (semi-dwarf planting), lower for more closely spaced plantings.

Japanese Beetle

• Biology & Cultural

[22.1a] Adults emerge from the soil between early July and mid-August to feed on numerous trees and shrubs. In apple trees, beetles devour the tissue between the veins, leaving a lace-like skeleton. Severely injured leaves turn brown and often drop. Adults are most active during the warmest parts of the day and prefer to feed on plants that are fully exposed to the sun.

• Pesticide Application Notes

[22.2b] Although pheromone traps are available and can be hung in the orchard in early July to detect the beetles' presence, they are generally NOT effective at trapping out the beetles. Fruit and foliage may be protected from damage by applying Sevin, Assail or †Calypso; repeated applications may be required.

Mullein Plant Bug

• Biology & Cultural

[22.1] Although predaceous on aphids and mites, nymphs occasionally damage fruit by feeding on flowers or young fruitlets. Damage appears as raised corky lesions and, in severe cases, fruit deformities. Most problematic in Red and Golden Delicious, Northern Spy, Empire and Spartan varieties.

Refer to the reference materials list at the end of this publication for a Fact Sheet containing more details on the biology and management of this pest.

• Monitoring & Forecasting

[22.2] During bloom, tap 2 yr-old flower-bearing shoots over a black beating tray, especially in problem spots and those in proximity to areas containing mullein and evening primrose. Suggested action threshold: 10 nymphs per 40 limbs (4 on each of 10 trees). High populations can also be predicted from pheromone trap catches the preceding fall (more than 6/trap/day any time after Sept. 1).

• Pesticide Application Notes

[22.3] Susceptible to most insecticides applied at petal fall, but much damage has usually occurred by then. Broad spectrum pyrethroid insecticides (such as *Asana, *Battalion, *Decis, *Proaxis, *Warrior) or Lorsban applied at pink against other pests will provide incidental control, Mullein plant bug is not specifically listed as target pest on label for all of these products. Actara will also control spotted tentiform leafminer, rosy apple aphid and tarnished plant bug when applied at this time. Do not make more than one application of Actara per season. Assail and *Calypso will also control rosy apple aphid, spotted tentiform leafminer, 1st generation oriental fruit moth, and will suppress San Jose scale.

[22.4] Do not apply Assail when bees are actively visiting the area to be sprayed.

Obliquebanded Leafroller

• Biology & Cultural

OBLR is not a significant pest in most of New England. Refer to the reference materials list at the end of this publication for a Fact Sheet and Sampling Guide containing details on the biology and management of this pest.

• Pesticide Application Notes

[23.1] Bt materials are most effective against smaller larvae.

[23.2] Spray at petal fall to control overwintered larvae. Do not use Lannate on Early McIntosh, Dutchess, or Wealthy varieties. Lorsban will also control plum curculio. *Lannate will also control white apple leafhopper. *Danitol will also provide suppression of European red mite. Addition of a penetrating surfactant will improve efficacy of *Proclaim and SpinTor; application at petal fall will also control spotted tentiform leafminer. *Proclaim use limited to 4.8 oz/A of formulated product per season. Suggested action threshold: 3% infested tips (clusters and terminals); refer to Fig. 2 and IPM Pub. No. 207 (*Apple IPM: A guide for sampling and managing major apple pests in New York State*) for sampling procedure.

[23.3] For Bt products, greater efficacy against summer brood larvae has been shown with 2–4 sprays at the low rate on a 7-day interval, starting 10–12 days after first adult catch. For remaining products, 2–3 sprays, 10–14 days apart, against larvae, starting 360 DD (base 43° F) after 1st adult trap catch. Addition of a penetrating surfactant will improve efficacy of *Proclaim and SpinTor; SpinTor use limited to 3 applications per season. *Proclaim use limited to 4.8 oz/A of formulated product per season. It is recommended that pyrethroids not be applied more than 1–2 times/ season in any orchard. Use high rate of *Asana in problem orchards. Suggested action threshold: 3% infested terminals, refer to Fig. 2, and IPM Pub. No. 207 (*Apple IPM: A guide for sampling and managing major apple pests in New York State*) for sampling procedure.

Oystershell Scale

• Pesticide Application Notes

[24.1] Apply sprays at petal fall and 1st cover. Be aware of Sevin's fruit-thinning effects.

Plum Curculio

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Monitoring & Forecasting

[25.1] Because the length of plum curculio's immigration and oviposition period is affected by weather patterns after petal fall, spray coverage should be maintained until 308 DD (base 50° F) from petal fall.

• Pesticide Application Notes

[25.2] Petal fall and 1st cover sprays in northern New England; petal fall, 1st and 2nd cover sprays in southern New England.

[25.3] Frequent applications (7–10-day intervals) of Surround and maximal coverage (minimum of 100 gal/A) are advised in New York while there is active foliar growth.

[25.4] Actara, Avaunt, *Calypso and Lorsban will also control European apple sawfly when applied at this time. Do not make more than one application of Actara per season.

Redbanded Leafroller

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Pesticide Application Notes

[26.1] Sprays effective against adults during 1/2-inch green and larvae at petal fall and 1st cover.

[26.2] Control is obtained from sprays applied at petal fall and 1st cover. Do not use *Lannate on Early McIntosh, Dutchess, or Wealthy varieties. Suggested action threshold: 2–3 larvae/tree.

[26.3] 3 applications advised starting in early June and at 12- to 14-day intervals to control second brood in problem areas. Suggested action threshold: 2–3 larvae/tree.

Rosy Apple Aphid

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet and Sampling Guide containing details on the biology and management of this pest.

• Monitoring & Forecasting

[27.1] Examine fruit clusters at the pink stage for the presence of wingless adults and nymphs. Refer to IPM Pub. No. 207 (*Apple IPM: A guide for sampling and*

managing major apple pests in New York State) for sampling procedure. Suggested action threshold: one infested cluster. Cortland is the variety most commonly affected in New England.

• Pesticide Application Notes

[27.2] One spray of Lorsban, even if mixing with oil, or of *Supracide, from green tip to tight cluster. Research indicates greater effectiveness if control applied at pink. Alternatively, spray once with Esteem at half-inch green, or one spray of Beleaf from green tip to pink bud. Suggested action threshold: 1 colony/100 fruit clusters.

[27.3] Good coverage is required for adequate control. Research indicates better effectiveness of all materials when used at pink. Do not use *Lannate on Early McIntosh, Dutchess, or Wealthy varieties. *Vydate and *Danitol may give some mite suppression when applied now. Do not exceed 4 pt *Vydate per acre. *Diazinon may cause slight russeting on Golden Delicious. Actara will also control spotted tentiform leafminer, mullein plant bug and tarnished plant bug when applied at this time. Do not make more than one application per season. Assail will also control mullein plant bug, spotted tentiform leafminer, 1st generation oriental fruit moth, and will suppress San Jose scale. Pyrethroids will also provide effective control, but because of their toxicity to predatory mites, they are not recommended unless treatment is also required to control spotted tentiform leafminer and tarnished plant bug at this time. Suggested action threshold: 1 colony/100 clusters.

[27.4] This insect is difficult to control after pink; most damage has already occurred by this time. *Diazinon may cause slight russeting on Golden Delicious. *Calypso and Lorsban will also control plum curculio.

San Jose Scale

• Biology & Cultural

[28.1] Pruning to open up canopy is advised.

Refer to the reference materials list at the end of this publication for a Fact Sheet containing more details on the biology and management of this pest.

• Monitoring & Forecasting

[28.2] 1st generation crawler emergence starts about 3 wk after petal fall (500 DD base 50° F from March 1, or 310 DD after 1st male catch); 2nd in late July-August (1451 DD from March 1, or 400 DD after 1st male catch of the 2nd generation).

• Pesticide Application Notes

[28.3] Prebloom sprays more effective if applied dilute, at high volume; follow up with summer applications. Suggested action threshold: 3–6 encrusted areas/tree.

[28.4] 2 sprays against first and peak (7–10 days later) crawler activity in both generations. The addition of horticultural oil will improve performance of Assail. Suggested action threshold: 1–2 crawlers/trap (sticky tape around limb).

Spotted Tentiform Leafminer, Apple Blotch Leafminer

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet and Sampling Guide containing details on the biology and management of this pest.

• Pesticide Application Notes

[29.1] A pyrethroid will also control rosy apple aphid and tarnished plant bug at pink. Do not exceed 14.5 oz of *Asana per acre per treatment; *Asana and *Danitol not registered for apple blotch leafminer. Actara and Avaunt will also control mullein plant bug and tarnished plant bug, and Actara will control rosy apple aphid, when applied at this time. Improved activity of Delegate may be obtained by addition of an adjuvant such as horticultural mineral oil. Do not make more than one application of Actara per season. Suggested action threshold: 2 or more eggs/fruit cluster leaf; refer to Fig. 1 and IPM Pub. No. 207 (*Apple IPM: A guide for sampling and managing major apple pests in New York State*) for sampling procedure.

[29.2] Do not use *Lannate on Early McIntosh, Dutchess, or Wealthy varieties. All materials at petal fall will also control white apple leafhopper; *Danitol and Lannate 90SP not labeled for apple blotch leafminer. Actara, Avaunt and *Calypso will also control plum curculio and European apple sawfly when applied at this time. Improved activity of Delegate may be obtained by addition of an adjuvant such as horticultural mineral oil. Do not make more than one application of Actara per season. Suggested action threshold: against sap-feeding larvae, if mines exceed 1/leaf, or if eggs exceeded 2/leaf at pink. (Refer to Fig. 3 and IPM Pub. No. 207 [*Apple IPM: A guide for sampling and managing major apple pests in New York State*] for sampling procedure.)

[29.3] For 2nd brood: Do not apply *Vydate within 30 days of bloom. Do not use *Lannate on Early McIntosh, Dutchess or Wealthy varieties. Improved activity of Delegate may be obtained by addition of an adjuvant such as horticultural mineral oil. Suggested action threshold: if 2nd brood sap-feeding mines exceed 2/leaf on mature terminal leaves. Before first tissue-feeding mines appear, examine 10 mature terminal leaves from each of 5 trees. (Refer to Fig. 7 and IPM Pub. No. 207 [*Apple IPM: A guide for sampling and managing major apple pests in New York State*] for sampling procedure).

[29.4] Abba .15EC must be mixed with horticultural oil to be effective. Preferred timing is when eggs or early sap feeders are present. It must not be applied during bloom

[29.5] Esteem 0.86E Minimum 50 gallons per acre. Thorough coverage is critical for good control. Proper timing for first generation is just before or during pink stage.

[29.6] SpinTor must be mixed with an approved adjuvant to be effective. Optimal timing is when miners are in sap-feeding stage

Tarnished Plant Bug

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Pesticide Application Notes

[30.1] One spray advised at tight cluster to petal fall if an unusually high prebloom population is present. A pyrethroid at pink will also control spotted tentiform leafminer and rosy apple aphid. It is recommended that pyrethroids not be used more than 1–2 times/season in any orchard. Actara and Avaunt will also control mullein plant bug and spotted tentiform leafminer. Actara and Beleaf will control rosy apple aphid, when applied at pink. Do not make more than one application of Actara per season. Suggested action threshold: 2–3 bleeding sites/10-terminal sample.

[30.2] Battalion maximum 26.9 fl. oz/A per season, and 7 days between applications

[30.3] Decis 1.5EC: maximum 3.6 fl oz/A per season. Allow 7 days between applications.

[30.4] Lambda T: maximum of 1.6 pts/aacre per year

[30.5] *Thionex 50W: max. 2 applications during fruiting period

[30.6] Tombstone 2 EC: Minimum 100 GPA for ground equipment. Maximum of 2.8 fl oz/A per season

[30.7] Becautious about using Vydate soon after bloom. Fruit thinning can result

Variegated Leafroller, Sparganothis Fruitworm

• Pesticide Application Notes

[31.1] Occasionally a problem in the Hudson Valley, NY; in July if needed. Do not use *Lannate on Early McIntosh, Dutchess, or Wealthy varieties. Bt products and *Leverage not registered for Sparganothis fruitworm. Suggested action threshold: 3 larvae/tree on standard-size tree (27–40 trees/A); 1 larva/tree at density of 140 trees/A (semi-dwarf planting), lower for more closely-spaced plantings.

White Apple Leafhopper, Potato Leafhopper

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest. White apple leafhopper overwinters in New England, but potato leafhopper cannot. It typically appears in June.

• Pesticide Application Notes

[32.1] At petal fall or as nymphs appear later in summer. Will also control rose leafhopper. Do not use Sevin or *Vydate before 2nd cover unless fruit thinning is desired. Sevin not labeled for potato leafhopper. Do not apply more than 2 applications of *Thionex during fruiting period. Do not use *Lannate on Early McIntosh, Dutchess, or Wealthy varieties. Actara, Avaunt and *Calypso will also control plum curculio and European apple sawfly when applied at petal fall. Do not make more than one application of Actara per season. Suggested action threshold: average of 1 nymph/leaf.

[32.2] For potato leafhopper nymphs, 2–3 applications at the 0.5 oz rate are more effective than a single application at 2.0 oz.

Woolly Apple Aphid

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest. Woolly apple aphid is frequently held in check by a tiny parasitic wasp. Pesticide sprays can deplete the parasite population and trigger problems.

• Pesticide Application Notes

[33.1] In July when small colonies appear on periphery of canopy. Repeat applications may be necessary. Use of a non-ionic surfactant is recommended with Assail. Do not repeat* Diazinon applications closer than 14 days. Slight russeting may occur on some varieties, such as Golden Delicious. Suggested action threshold: as nymphs migrate to terminals.

11.3 Storage Disorders

Storage Rots

• Pesticide Application Notes

[34.1] Postharvest drench treatment of apples for control of storage rots is not recommend except when fruit must also be treated with diphenylamine (DPA) or calcium chloride. Holding tanks in postharvest drenching equipment must have good agitation to keep fungicides in suspension, and solutions must be replenished regularly as directed on the product labels.

Mertect 340F (thiabendazole) is no longer effective in many storages because strains of *Penicillium expansum* have developed resistance to the thiabendazole-plus-DPA combination. Storage operators who have noted decay problems in recent years should either switch to Penbotec or Scholar for their postharvest treatments, or they should use a mixture of Mertect 340F plus the full label rate of captan.

Penbotec and Scholar are new fungicides with modes of action that are different from each other and from that of Mertect 340F. Both of these fungicides are very effective against both blue mold (*P. expansum*) and gray mold (*B. cinerea*). Both are compatible with DPA and calcium chloride. Both are recommended for use as the sole fungicide in postharvest drenches (i.e., they do not need to be combined with captan).

To slow selection of pathogens with resistance to Penbotec and Scholar, it is recommended that storage operators alternate use of these products from one year to

the next. Much of the inoculum for *P. expansum* recycles from one year to the next on apple bins. By using Penbotec in one season and Scholar the next (or Scholar the first year and Penbotec the next year), spore populations on bins will not be subjected to selection pressure by the same fungicide in successive years.

Some countries that import apples from the US may not accept fruit treated with Penbotec, Scholar, or Captan. For the latest information on maximum residue levels (MRL's) that have been established in various countries, check the following website: http://mrldatabase.com .

None of the postharvest treatments will control pinpoint scab, latent bitter rot or black rot infections that are present at harvest, or postharvest decays caused by *Alternaria*.

Chlorinated water can also be used to disinfect fruit after harvest. Numerous commercial formulations of calcium hypochlorite and sodium hypochlorite are available with postharvest labels. However, chlorine only kills spores in the treatment solution and on the fruit surface at the time of treatment. It does not provide any residual protection. *Chlorine is **not** compatible with diphenylamine.* Thus, chlorination is most useful for disinfesting flume water on apple packing lines rather than as postharvest treatment prior to storage. Follow directions on the product label for maintaining appropriate levels of chlorine in treatment solutions.

Storage Scald

• Pesticide Application Notes

[35.1] Active ingredient may vary according to manufacturer: use label instructions to check rate required to obtain desired concentration. See Table 11.4.1 for varietal requirements.

Senescent Breakdown (Mcintosh)

• Pesticide Application Notes

[36.1] The addition of calcium chloride to the postharvest scald and storage rot treatment is effective in reducing McIntosh breakdown. Only calcium chloride that meets Food Chemical Codex specifications can be used in postharvest treatment of apples. Calcium treatment will be of little benefit to apples harvested after the projected optimum harvest date. Fruit injury from calcium chloride has been found to be associated with iron in the solution. Coat steel tanks or use plastic tanks and piping to minimize this problem.

11.4 Notes On Scald Control

11.4.1 Materials

All DPA (diphenylamine) formulations are suspensions and become weaker with use. Replenishment with full-strength material does not replace the DPA removed by the apples. Test kits are available to determine concentrations of make-up material. Do not exceed 30 bins or 750 bushels/100 gal of made-up DPA; empty the reservoir tank and start again with fresh material.

Cartons containing apples that have been treated postharvest with DPA and fungicide must be so labeled.

11.4.2 Application Equipment

Bins of apples are sometimes dipped into a tank containing postharvest preservatives, but more often the bins are moved by conveyors, rollers, or truck bed under a cascade of the preservatives. The bins should be moved slowly under the cascade, with 35-40 gal of preservatives being delivered into each bin. The pump should be sized to deliver 35-40 gal of preservatives/bin at the desired rate of bin movement under the cascade. If stacked bins are moved under the cascade, the top bins should receive 35-40 gal and side nozzles should be positioned to deliver additional gallonage to the lower bins, even though drainage holes are provided in the bin floors. Application equipment is commercially available, but operators usually fabricate their applicators to meet the needs of their own operation. Dirty truckloads should be rinsed with clean water before treatment to minimize the accumulation of dirt in the reservoir tank.

11.4.3 Variety Requirements

Materials and concentrations for the major apple varieties in New England are listed in Table 10.3.1. Important: DPA retards chlorophyll loss in Golden Delicious and, therefore, should not be used unless the apples have developed full yellow color at harvest.

The very low susceptibility of Empire to scald indicates that it can be safely stored without any preservative treatment. However, if preservative treatment is demanded, then use 1000 ppm DPA in the drench solution.

Table 11.4.1. Recommended diphenylamine concentrations for varieties subject to scald.

Variety	Diphenylamine (ppm)
Baldwin	1000-1500
Braeburn	1000
Cortland	2000
Delicious	1000-1500
Empire	1000
Golden Delicious	1000
Idared	1000
Jonagold	1000
McIntosh	1000
Mutsu	2000
Rome	1500
Stayman	1500

11.5 Apple Spray Table

Table 11.5.1. Pesticide Spray Table – Apples.

(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Silver Tip						
Apple scab inoculum reduction		Urea fertilizer ground spray	40 lb/A	0	0	[2.1]
Crown rot (collar rot)		Ridomil Gold 4EC	see comments	12	see comments	[7.2]
	OR	Aliette 80WP	see comments	12	14	[7.3]
European red mite, European fruit lecanium		§oil	2-3 gal/100 gal	12	0	[20.2]
Green Tip						
Apple Scab		Captan 50WP	1-2 lb/100 gal	24(E)	0	[2.1, 2.2]
		or Captan 80WP	0.65-1.25 lb/100 gal			
		or Captec or Captan 4L	0.5-1 qt/gal			
	OR	Dithane/Manzate/Maneb/ Penncozeb 75DF	1-2 lb/100 gal	24	BL,77(A)	[1.3, 2.2]
		or Polyram 80DF	1-2 lb/100 gal			
	OR	Vanguard 75WG	5 oz/A	12	72	
	OR	Scala 600SC	7-10 fl oz/A	12	72	
Fire blight		§Bordeaux mixture, 8-8-10				[8.4]
		(copper sulfate)	8 lb/100 gal	24	BL	
		(spray lime)	8 lb/100 gal			
	plus	(§oil)	1 qt/100 gal			
	OR	§Champ Flowable	1-2 qt/100 gal	24	BL	
	OR	§C-O-C-S	2-4 lb/100 gal	24	BL	
	OR	§Cuprofix MZ Disperss	3.3-6.6 lb/100 gal	24	HIG	
	OR	§Kocide 2000	2-4 lb/100 gal	24	HIG	
		or other copper products	see comments			
European red mite		§oil	2 gal/100 gal	12	0	[20.3]
Rosy apple aphid		Beleaf 50SG	2.0-2.8 oz/A	12	21	[27.2]
	OR	*Lorsban 4EC	1 pt/100 gal	96	PB	
		or Lorsban 75WG	0.3-0.67 lb/100 gal			
	OR	*Supracide 25WP	1-2 lb/100 gal	(E)	PB	
	OR	Voliam flexi	6.0-7.0 oz/A	12	35	
Half-Inch Green						
Apple scab		Same materials as Green Tip spray				[2.3]
	OR	Flint 50WG	0.67-0.8 oz/100 gal	12	14	[2.4, 2.14]
	OR	Sovran 50WG	1.0-1.6 oz/100 gal	12	30	
Dogwood borer, American plum borer		*Lorsban 4EC	1.5 qt/100 gal	96	28	[17.1]
		or Lorsban 50WS	1.5 lb/100 gal	96	28	
		or Lorsban 75WG	2 lb/100 gal	96	28	
European red mite		§oil	2 gal/100 gal	12	0	[20.4]

Table 11.5.1. Pesticide Spray Table – Apples.
(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Redbanded leafroller		*Guthion 50WS	0.5 lb/100 gal	14-44 days (E)	14-21	[26.1]
	OR	Imidan 70WP	.75 lb/100 gal	72	7	
Rosy apple aphid		Refer to Green Tip				[27.2]
San Jose scale		Esteem 35WP	4-5 oz/A	12	45	
		plus oil	2 gal/100 gal	12	0	
	OR	*Lorsban 4EC	1 pt/100 gal	96	PB	[28.3]
		or Lorsban 50WS	3 lb/A			
		or Lorsban 75WG	0.3-0.67 lb/100 gal			
	OR	§oil	2 gal/100 gal	12	0	
	OR	*Supracide 25WP	0.5 lb/100 gal	(E)	PB	
Tight Cluster						
Apple Scab		Captan 50WP	1-2 lb/100 gal	24(E)	0	
		or Captan 80WP	0.65-1.25 lb/100 gal			
		or Captec or Captan 4L	0.5-1 qt/gal			
	OR	Dithane/Manzate/Maneb/ Penncozeb 75DF	1-2 lb/100 gal	24	BL,77(A)	[2/2]
		or Polyram 80DF	1-2 lb/100 gal			
	OR	Flint 50WG	0.67-0.8 oz/100 gal	12	72	[2.4, 2.14]
	OR	Sovran 50WG	1.0-1.6 oz/100 gal	12	30	[2.4, 2.14]
	OR	either:				
		Rally 40WP	1.5-2 oz/100 gal	24	14	[2.5, 2.13]
		or Rubigan 1EC	3-4 fl oz/100 gal	12	30	
		or *Procure 50WS	3-4 oz/100 gal	12	14	
		plus either:				
		Captan 50WP	1 lb/100 gal	24 (E)	0	
		or Captan 80WP	0.65-1.25 lb/100 gal			
		or Captec or Captan 4L	1 pt/100 gal			
		or Dithane/Manzate/Maneb/ Penncozeb 75DF	1 lb/100 gal	24	BL,77(A)	
		or Polyram 80DF	1 lb/100 gal	24	BL,77(A)	
	OR	Inspire Super MP	4 fl oz/A Inspire + 4 oz/A Vangard	12	72	
		plus				
		or Dithane/Manzate/Maneb/ Penncozeb 75DF	1 lb/100 gal	24	BL,77(A)	
		or Polyram 80DF	1 lb/100 gal	24	BL,77(A)	
Powdery mildew		Topsin M70WP	4-8 oz/100 gal	12	0	[2.12]
	OR	Thiophanate-methyl 85WDG	3-5 oz/100 gal	12	0	[2.12]
	OR	*§JMS Stylet-Oil*	1-2% solution	12	0	[9.3]
	OR	Rally 40WP	1.5-2 oz/100 gal	24	14	
	OR	*Procure 50WS	3-4 oz/100 gal	12	14	
	OR	Rubigan 1EC	3-4 fl oz/100 gal	12	30	

Table 11.5.1. Pesticide Spray Table – Apples.
(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Powdery Mildew *(continued)*	*OR*	§Sulfur 95WP	2 lb/100 gal	24	0	
		or §Sulfur 6F	2 pt/100 gal			
		or Sulfur, many other products; see label				
	OR	Bayleton/Triadimefon 50DF	1-2 oz/100 gal	12	45	[9.4]
	OR	Flint 50WG	0.67-0.8 oz/100 gal	12	14	
	OR	Sovran 50WG	1.0-1.6 oz/100 gal	12	30	
Dogwood borer, American plum borer		*Lorsban 4EC	1.5 qt/100 gal	96	28	[17.1]
		or Lorsban 50WS	1.5 lb/100 gal	96	28	
		or Lorsban 75WG	2 lb/100 gal	96	28	
European red mite		Apollo 4SC	1-2 oz/100 gal	12	45	[20.5]
	OR	§oil	1 gal/100 gal	12		[20.6]
	OR	Envidor 2SC	16-18 fl oz/A	12	7	
	OR	Onager	12-24 oz/A	12	28	[20.5]
	OR	Savey 50DF	3 oz/A	12	28	[20.5]
	OR	Zeal 72WS	2-3 oz/A	12	14	[20.5]
Rosy apple aphid		Refer to Green Tip				[27.2]
San Jose scale		Refer to Half-Inch Green				[28.3]
Tarnished Plant bug	*OR*	*Asana XL 0.66EC	2-5.8 oz/100 gal		21	
	OR	Avaunt 30 WDG	5-6 oz/A	12	14	
	OR	*Battalion 0.2EC	7-14.1 fl oz/A	12	21	
	OR	*Baythroid 2E	2.0-2.4 fl oz/A	12	7	
		or *Baythroid XL 1L	2.0-2.4 fl oz/A	12	7	
	OR	Beleaf 50SG	2.0-2.8 oz/A	12	21	
	OR	*Danitol 2.4EC	10.67-16 fl oz/A	24	14	
	OR	*Pounce 3.2EC	4-16 fl oz/A	12	PF	
		or *Pounce 25WP	6.4-25.6 oz/A			
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	21	
	OR	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	
	OR	*Warrior II	1.28-2.56 fl oz/A	24	21	
Pink						
Apple rust diseases		Dithane/Manzate/Maneb/ Penncozeb 75DF	1 lb/100 gal	24	BL,77(A)	[1.3]
		or Polyram 80DF	1 lb/100 gal	24	BL,77(A)	
	OR	Ferbam 76WDG	1-1.5 lb/100 gal	24	7	
	OR	Rally 40WP	1.5 oz/100 gal	24	14	
	OR	*Procure 50WS	3 oz/100 gal	24	14	
	OR	Rubigan 1EC	3 fl oz/100 gal	12	30	
	OR	Bayleton/Triadimefon 50DF	1-2 oz/100 gal	12	45	
Apple scab		Captan 50WP	1-21b/100 gal	24 (E)	0	[2.6, 2.7]
		or Captan 80WP	0.65-1.25 lb/l00 gal			
		or Captec or Captan 4L	0.5- I qt/100 gal			
	OR	Sovran 50WG	1.0 - 1.6 oz/100 gal	12	30	[2.4, 2.14]
	OR	Flint 50WG	0.67-0.8 oz/100 gal	12	14	[2.4, 2.14]

Table 11.5.1. Pesticide Spray Table – Apples.
(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Apple scab *(continued)*	*OR*	Topsin M 70WP	2-3 oz/100 gal	12	0	[2.12]
		plus either:				
		Captan 50WP	1 lb/100 gal	24(E)	0	
		or Captan 80WP	5/8 lb/100 gal			
		or Captec or Captan 4L	1 pt/100 gal			
		or Dithane/Manzate/Maneb/ Penncozeb 75DF	1 lb/100 gal	24	BL,77(A)	[2.2]
		or Polyram DF	1 lb/l00 gal	24	BL,77(A)	[2.2]
	OR	*either:*				
		Rally 40WP	1.5-2 oz/100 gal	24	14	[2.5, 2.13]
		or Rubigan 1EC	3-4 fl oz/100 gal	12	30	
		or *Procure 50WS	3-4 oz/100 gal	12	1	
		plus either:				
		Captan 50WP	1 lb/100 gal	24(E)	0	
		or Captan 80WP	5/8 Ib/100 gal			
		or Captec or Captan 4L	1 pt/l00 gal			
		or Dithane/Manzate/Maneb/ Penncozeb 75DF	1 lb/l00 gal	24	BL,77(A)	[2.2]
		or Polyram 80DF	1 Ib/100 gal	24	BL,77(A)	[2.2]
Black rot (frog-eye leafspot and fruit infections)		See comments				[4.2]
Blister spot		Aliette 80WDG	0.5-1.0 lb/100 gal	12	14	[5.1]
Powdery mildew		Same materials as Tight Cluster spray				[9.5]
Dogwood borer, American plum borer		*Lorsban 4EC	1.5 qt/100 gal	96	28	[17.1]
		or Lorsban 50WS	1.5 lb/100 gal	96	28	
		or Lorsban 75WG	2 lb/100 gal	96	28	
European red mite		Envidor, Savey, Onager, Zeal, or Apollo, same as Tight Cluster				[20.7]
	OR	*Vydate 2L	1-2 pt/100 gal	48	14	
	OR	Zeal 72WS	2-3 oz/A	12	14	[20.7]
Mullein plant bug		Actara 25WDG	4.5 oz/A	12	35	[22.3]
	OR	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	21	
	OR	Assail 30SG	4.0-8.0 oz/A	12	7	
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	21	
	OR	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	
		or *Warrior II	1.28-2.56 fl oz/A	24	21	
Oriental fruit moth		Pheromone mating disruption				
		Checkmate OFM-F	1.32-2.93 oz/A	0	0	
	OR	Isomate-M 100	100 ties/A	0	0	
Rosy apple aphid		Actara 25WDG	4.5 oz/A	12	35	[27.3]
	OR	Assail 30SG	2.5-4.0 oz/A	12	7	
	OR	*Battalion 0.2EC	14.1 fl oz/A	12	21	
	OR	Beleaf 50SC	2.0-2.8 oz/A	12	21	

Table 11.5.1. Pesticide Spray Table – Apples.
(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Rosy apple	*OR*	Calypso 4F	2-4 fl oz/A	12	30	
aphid *(continued)*	*OR*	*Diazinon AG600	12.75 oz/100 gal	96	21	
	OR	*Lannate 2.4L	0.75 pt/100 gal	72	14	
		or *Lannate 90SP	0.25 lb/100 gal			
	OR	Lorsban 50WS	12 oz/100 gal	96	PB	
		or *Lorsban 4EC	1pt/100 gal		PB	
		or Lorsban 75WG	0.3-0.67 lb/100 gal			
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	21	
	OR	*Thionex 50WP	1 lb/100 gal	24	21	
		or *Thionex 3EC	0.67 qt/100 gal			
	OR	Voliam flexi	6.0-7.0 oz/A	12	35	
	OR	*Vydate 2L	1-2 pt	48	14	
	OR	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	
		Or Warrior II	1.28-2.56 fl oz/A	24	21	
Spotted tentiform		Actara 25WDG	4.5 oz/A	12	35	[29.1]
leafminer, Apple	*OR*	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	21	
blotch leafminer	*OR*	Assail 30SG	2.5 oz/A	12	7	
	OR	Avaunt 30WDG	5-6 oz/A	12	14	
	OR	§Aza-Direct 1.2L	12.5-42 fl oz/A	4	0	
	OR	*Baythroid 2E	2.0-2.4 fl oz/A	12	7	
		or *Baythroid XL 1L	2.0-2.4 fl oz/A	12	7	
	OR	*Calypso 4F	0.5-1.0 fl oz/100 gal	12	30	
	OR	*Danitol 2.4EC	10.67-16 fl oz/A	24	4	
	OR	Delegate 25WG	4.5-7.0 oz/A	4	7	
	OR	*Pounce 3.2EC#	4-8 fl oz/A	12	PF	
	OR	Proaxis 0.5CS	2.6-5.1 fl oz/A	24	21	
	OR	*Proclaim 5SG	0.8-1.2 oz/100 gal	12	14	
	OR	§Pyrenone 0.5EC	12 fl oz/A	12	1	
	OR	*Vydate 2L	1 pt/100 gal	48	14	
	OR	*Warrior 1CS	2.5-5.1 fl oz/A	24	21	
		or Warrior II	1.28-2.56 fl oz/A	24	21	
Tarnished plant bug		Refer to Tight cluster				[30.1]
Bloom						
Apple rust diseases		Refer to Pink spray for materials and comments				
Apple scab		Same materials and rates as Pink spray				
Black rot		Captan, Sovran, Flint, Topsin M, Thiophanate-methyl	same rates as for scab, mildew and rusts			[4.2]
Blister spot		Aliette 80WDG	0.5-1.0 lb/100 gal	12	14	[5.1]
Blossom end rot		Captan, Sovran, Flint, Scala, Vangard, Topsin M, Thiophahate-methyl	same rates as for scab, mildew and rusts			[6.2]

Table 11.5.1. Pesticide Spray Table – Apples.
(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Fire blight (Blossom blight)		§Agrimycin 17WP or Streptrol 17WP or Firewall 17WP	0.5 lb/100 gal	12	50	[8.3]
	OR	§Agrimycin 17WP or Streptrol 17WP or Firewall 17WP *plus* Glycerine *either* (CP or USP grade) or Regulaid	0.25 lb/100 gal 2 qt/100 gal of finished spray (do not concentrate) 1 pt/100 gal of finished spray (do not concentrate)	12	50	
	OR	Serenade ASO	2-6 qt/A	4	0	[8.7]
Fire blight (Shoot blight)		Apogee 27.5DF	4.5-9 oz	12	45	[8.6]
Powdery mildew		Same as Tight Cluster sprays				[9.2, 9.3]
Codling moth, Oriental fruit moth, Lesser appleworm		Checkmate OFM-F	1.32-2.93 fl oz/A	0	0	[14.2]
	OR	Isomate-M 100	100 ties/A	0	0	
	OR	Checkmate CM-F	2.4-4.8 fl oz/A	4	0	
	OR	Isomate-C TT	200 ties/A	0	0	
	OR	Checkmate CM-OFM Duel	150-200 dispensers/	0	0	
	OR	Isomate-CM/OFM TT	200 ties/A	0	0	
Mullein plant bug		Assail 30SG	4.0-8.0 oz/A	12	7	[22.4]
	OR	*Calypso 4F	0.5-1.0 fl oz/100 gal	12	30	
Obliquebanded leafroller	*OR*	§Biobit XL 2.1FC	1.5-5.5 pt/A	4	0	
	OR	§Dipel 10.3DF	0.5-2 lb/A	4	0	
	OR	*Intrepid 2F	8-16 oz/A	4	14	
	OR	§Javelin 7.5WDG	0.13-1 lb/100 gal	4	0	
	OR	Rimon 0.83EC	20-50 fl oz/A	12	14	
Petal Fall						
Apple rust diseases		Refer to Pink sprays for materials and comments				[4.2]
Apple scab		*Captan 50WP* or Captan 80WP or Captec or Captan 4L	1-2 lb/100 gal 0.65-1.25 lb/l00 gal 0.5- 1 qt/100 gal	24(E)	0	[2.7]
	OR	or Dithane/Manzate/Maneb/ Penncozeb 75DF or Polyram 80DF	1 lb/100 gal 1 lb/l00 gal	24	77	[2.7]
	OR	Flint 50WG	0.67-0.8 oz/100 gal	12	14	[2.4, 2.14]
	OR	Sovran 50WG	1.0-1.6 oz/100 gal	12	30	[2.4, 2.14]
	OR	Topsin M 70WP *plus either:* Captan 50WP or Captan 80WP or Captec or Captan 4L or Dithane/Manzate/Maneb/ Penncozeb 75DF	2-3 oz/100 gal 1 lb/100 gal 5/8 lb/100 gal 1 pt/100 gal 1 lb/100 gal	12 24(E) 24	0 0 77	[2.12] [2.7]

Table 11.5.1. Pesticide Spray Table – Apples.
(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Apple scab		or Polyram 80DF	1 lb/l00 gal	24	77	
(continued)	*OR*	*either:*				
		Rally 40WP	1.5-2 oz/100 gal	24	14	[2.5, 2.13]
		or Rubigan 1EC	3-4 fl oz/100 gal	12	30	
		or *Procure 50WS	3-4 oz/100 gal	12	14	
		plus either:				
		Captan 50WP	1 lb/100 gal	24(E)	0	
		or Captan 80WP	5/8 lb/100 gal			
		or Captec or Captan 4L	1 pt/l00 gal			
		or Dithane/Manzate/Maneb/ Penncozeb 75DF	1 lb/l00 gal	24	77	[2.7]
		or Polyram 80DF	1 Ib/100 gal	24	77	
Black rot		Captan, Sovran, Flint, Topsin M, Thiophanate-methyl	same rates as for scab, mildew and rusts			
Blossom end rot		Captan, Sovran, Flint, Scala, Vanguard, Topsin M, Thiophanate-methyl	same rates as for scab, mildew and rusts			[6.2]
Fire blight (Shoot blight)		Apogee 27.5D	6-12 oz	12	45	[8.6]
Powdery mildew		Same as Tight Cluster sprays				[9.2, 9.3]
Codling moth		Isomate-C TT (if not deployed during bloom)	200 dispensers/A			[14.2]
Comstock Mealybug		Assail 30SG	4.0-8.0 oz/A	12	7	
	OR	Centaur WDG	34.5 oz/A	12	14	
	OR	*Diazinon AG 600WBC	12.75 oz/100 gal	96	21	
		or *Diazinon 50WP	1 lb/100 gal			[15.2]
	OR	*Provado 1.6F	2 oz/100 gal	12	7	
	OR	Voliam flexi	6.0-7.0 oz/A	12	35	
Dogwood borer, American plum borer		Assail 30SG	4.0-8.0 oz/A	12	7	
	OR	*Lorsban 4EC	1.5 qt/100 gal	96	28	[17.1]
		or Lorsban 50WS	1.5 lb/100 gal	96	28	
		or Lorsban 75WG	2 lb/100 gal	96	28	
European apple Sawfly		*Guthion, *Imidan, or Lorsban 75WG, same as for codling moth at this time				[18.1]
	OR	Actara 25WDG	4.5-5.5 oz/A	12	35	[18.2]
	OR	Altacor 35WDG	2.5-4.5 oz/A	4	14	
	OR	Assail 30SG	5.0-8.0	12	7	
	OR	Avaunt 30WDG	5-6 oz/A	12	14	
	OR	*Baythroid 2E	2.4-2.8 fl oz/A	12	7	
		or *Baythroid XL 1L	2.4-2.8 fl oz/A	12	7	
	OR	*Calypso 4F	1-2 fl oz/100 gal	12	30	
	OR	*Lannate 2.4L#	1.5 pt/100 gal	72	14	
	OR	Voliam flexi	6.0-7.0 oz/A	12	35	
European red Mite		Acramite 50WS	0.75-1.0 lb/A	12	7	[20.9]
	OR	*Agri-Mek 0.15EC	2.5-5 oz/100 gal	12	28	[20.8]

Table 11.5.1. Pesticide Spray Table – Apples.
(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
European red Mite *(continued)*	*OR*	Apollo 4SC	1-2 oz/100 gal	12	45	
	OR	Envidor 2SC	16-18 fl oz/A	12	7	
	OR	Kanemite 15SC	31 fl oz/A	12	14	[20.9]
	OR	Kelthane 50WS	3-6 lb/A	48	7	
	OR	Nexter 75 WS	4.4-5.2 oz/A	12	25	[20.9]
	OR	Portal Miticide/Insecticide	1-2 pt/A	12	14	[20.9]
	OR	§PureSpray Green	1 qt-1.5 gal/100 gal	12	0	[20.10]
	OR	Savey 50DF	3-6 oz/A	12	28	
	OR	Onager	12-24 oz/A	12	28	
	OR	§Stylet-Oil	0.5-2 gal/100 gal	12	0	[20.10]
	OR	*Vendex 50WP	4-8 oz/100 gal	48	14	
	OR	Zeal 72WS	2-3 oz/A	12	14	[20.9]
Green fruitworms		Altacor 35WDG	2.5-4.0 oz/A	4	14	
	OR	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	28	
	OR	*Battalion 0.2EC	7-14.1 fl oz/A	12	21	
	OR	*Baythroid 2E	1.4-2.0 fl oz/A	12	7	
		or *Baythroid XL 1L	1.4-2.0 fl oz/A	12	7	
	OR	*Danitol 2.4EC	16 fl oz/A	24	14	
	OR	*Lannate 2.4L	0.75 pt/100 gal	72	14	
		or *Lannate 90SP	0.25 lb/100 gal			
	OR	Leverage 2.7SE	3.0-3.6 fl oz/A	12	7	
	OR	Lorsban 75WG	0.33-0.67 lb/100 gal	96	PF	
	OR	*Pounce 3.2EC	4-8 fl oz/A	12	PF	
		or *Pounce 25WP	6.4-25.6 oz/A			
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	21	
	OR	*Proclaim 5SG	0.8-1.2 oz/100 gal	12	14	
	OR	*Thionex 50WP	1 lb/100 gal	96	21	
		or *Thionex 3EC	0.67 qt	48	21	
	OR	Voliam flexi	4.0-7.0 oz/A	12	35	
	OR	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	
		or Warrior II	1.28-2.56 fl oz/A	24	21	
Mullein plant bug		Actara 25WDG	4.5-5.5 oz/A	12	35	[22.3]
	OR	Assail 30SG	4.0-8.0 oz/A	12	7	
	OR	*Calypso 4F	0.5-1.0 fl oz/100 gal	12	30	
	OR	Voliam flexi	6.0-7.0 oz/A	12	35	
Obliquebanded Leafroller		Altacor 35WDG	2.5-4.5 oz/A	4	14	
	OR	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	21	
	OR	*Battalion 0.2EC	7-14.1 fl oz/A	12	21	
	OR	*Baythroid 2E	2.4-2.8 fl oz/A	12	7	
		or *Baythroid XL 1L	2.4-2.8 fl oz/A	12	7	
	OR	Belt SC	3.0-5.0 fl oz/A	12	14	
	OR	§Biobit XL 2.1FC	1.5-5.5 pt/A	4	0	

Table 11.5.1. Pesticide Spray Table – Apples.
(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Obliquebanded	*OR*	*Danitol 2.4EC	16 fl oz/A	24	14	
Leafroller	*OR*	Delegate 25WG	4.5-7 oz/A	4	7	
(continued)	*OR*	§Deliver 18WG	0.5-2 lb/A	4	0	
	OR	§Dipel 10.3DF	0.5-2 lb/A	4	0	
	OR	§Entrust 80WP	2-3 oz/A	4	7	
	OR	*Intrepid 2F	12-16 fl oz/A	4	14	
	OR	§Javelin 7.5WDG	0.13-1 lb/100 gal	4	0	
	OR	*Lannate 2.4L	0.75 pt/100 gal	72	14	
		or *Lannate 90SP	0.25 lb/100 gal			
	OR	Lorsban 75WG	0.33-0.67 lb/100 gal	96	PF	
	OR	*Pounce 3.2EC	4-16 fl oz/A	12	14	
		or *Pounce 25WP	6.4-25.6 oz/A			
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	21	
	OR	*Proclaim 5SG	0.8-1.2 oz/100 gal	12	14	
	OR	Rimon 0.83EC	20-40 fl oz/A	12	14	
	OR	SpinTor 2SC	2.5 oz/100 gal	4	7	
	OR	Voliam flexi	4.0-7.0 oz/A	12	35	
	OR	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	
		or Warrior II	1.28-2.56 fl oz/A	24	21	
Oystershell scale		Centaur WDG	34.5 oz/A	12	14	
	OR	*Guthion Solupak	0.5 lb/100 gal	14-44 days (E)	14-21	[24.1]
	OR	*Sevin 80WS, 80S	1.25-3.75 lb/A	12	3	
		or Sevin XLR Plus 4EC	1.5-3 qt/A			
		or Sevin 4F	1.5-3 qt/A			
Plum curculio		Actara 25WDG	4.5-5.5 oz/A	12	35	[25.4]
	OR	Avaunt 30WDG	5-6 oz/A	12	14	[25.4]
	OR	*Battalion 0.2EC	7-14.1 fl oz/A	12	21	
	OR	*Baythroid 2E	2.4-2.8 fl oz/A	12	7	
		or *Baythroid XL 1L	2.4-2.8 fl oz/A	12	7	
	OR	*Calypso 4F	1-2 fl oz/100 gal	12	30	
	OR	*Danitol 2.4EC	16 fl oz/A	24	14	
	OR	*Guthion 50WS	0.5 lb/100 gal	14-44 days (E)	14-21	[25.2]
	OR	*Imidan 70WP	0.75-1 lb/100 gal	72	7	
	OR	Lorsban 75WG	0.33-0.67 lb/100 gal	96	PF	
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	21	
	OR	*Sevin 80WS, 80S	1.25-3.75 lb/A	12	3	
		or Sevin XLR Plus 4EC	1.5-3 qt/A			
		or Sevin 4F	1.5-3 qt/A			
	OR	§Surround 95WP	50 lb/100 gal	4	0	[25.3]
	OR	Voliam flexi	6.0-7.0 oz/A	12	35	
	OR	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	
		or Warrior II	1.28-2.56 fl oz/A	24	21	

Table 11.5.1. Pesticide Spray Table – Apples.
(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Redbanded Leafroller		Altacor 35WDG	2.5-4.5 oz/A	4	14	
	OR	*Baythroid 2E	2.4-2.8 fl oz/A	12	7	
		or *Baythroid XL 1L	2.4-2.8 fl oz/A	12	7	
	OR	Belt SC	3.0-5.0 fl oz/A	12	14	
	OR	§Biobit XL 2.1FC	1.5-5.5 pt/A	4	0	
	OR	§Deliver 18WG	0.5-2 lb/A	4	0	
	OR	§Dipel 10.3DF	0.5-2 lb/A	4	0	
	OR	*Guthion 50WS	0.5 lb/100 gal	14-44 days (E)	14-21	
	OR	*Imidan 70WP	0.75-1 lb/100 gal	72	7	
	OR	§Javelin 7.5WDG	0.13-1 lb/100 gal	4	0	
	OR	*Lannate 2.4L	0.75 pt/100 gal	72	14	
		or *Lannate 90SP	0.25 lb/100 gal			
	OR	Leverage 2.7SE	4.4-5.1 fl oz/A	12	7	
	OR	Lorsban 75WG	0.33-0.67 lb/100 gal	96	PF	
	OR	*Proclaim 5SG	0.8-1.2 oz/100 gal	12	14	
	OR	Voliam flexi	6.0-7.0 oz/A	12	35	
Rosy apple aphid		Assail 30SG	2.5-4.0 oz/A	12	7	[27.4]
	OR	Beleaf 50SG	2.0-2.8 oz/A	12	21	
	OR	*Calypso 4F	0.5-1.0 fl oz/100 gal	12	30	
	OR	*Diazinon AG600	12.75 oz/100 gal	96	21	
	OR	*Lannate 2.4L	0.75 pt/100 gal	72	14	
		or *Lannate 90SP	0.25 lb/100 gal			
	OR	Leverage 2.7SE	4.4-5.1 fl oz/A	12	7	
	OR	Lorsban 75WG	0.33-0.67 lb/100 gal	96	PF	
	OR	*Provado 1.6F	2 oz/100 gal	12	7	
	OR	Sherpa	2 oz/100 gal	12	7	
	OR	*Thionex 50WP	1 lb/100 gal	24	21	
		or *Thionex 3EC	0.67 qt/100 gal			
Spotted tentiform leafminer, Apple blotch leafminer		Actara 25WDG	4.5-5.5 oz/A	2	35	[29.2]
	OR	Assail 30SG	2.5 oz/A	12	7	
	OR	Avaunt 30WDG	5-6 fl oz/A	12	14	
	OR	Asana XL .66EC	2-5.8 fl oz/100 gal	12	21	
	OR	§Aza-Direct 1.2L	12.5-42 fl oz/A	4	0	
	OR	*Battalion 0.2EC	7-14.1 fl oz/A	12	21	
	OR	*Baythroid 2E	2.0-2.4 fl oz/A	12	7	
		or *Baythroid XL 1L	2.0-2.4 fl oz/A	12	7	
	OR	*Calypso 4F	0.5-1.0 fl oz/100 gal	12	30	
	OR	*Danitol 2.4EC	10.67-16 fl oz/A	24	14	
	OR	Delegate 25WG	4.5-7.0 oz/A	4	7	
	OR	*Lannate 2.4L#	0.75 pt/100 gal	72	14	
		or *Lannate 90SP	0.25 lb/100 gal			

Table 11.5.1. Pesticide Spray Table – Apples.
(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Spotted tentiform leafminer, Apple blotch leafminer *(continued)*	*OR*	Leverage 2.7SE	3.6-4.4 fl oz/A	12	7	
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	21	
	OR	*Proclaim 5SG	0.8-1.2 oz/100 gal	12	14	
	OR	*Provado 1.6F	2 oz/100 gal	12	7	
	OR	Sherpa	2 oz/100 gal	12	7	
	OR	Voliam flexi	6.0-7.0 oz/A	12	35	
	OR	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	
	OR	*Warrior II	1.28-2.56 fl oz/A	24	21	
Tarnished plant bug	*OR*	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	21	
	OR	*Battalion 0.2EC	7-14.1 fl oz/A	12	21	
	OR	*Baythroid 2E	2.0-2.4 fl oz/A	12	7	
		or *Baythroid XL 1L	2.0-2.4 fl oz/A	12	7	
	OR	Beleaf 50SG	2.0-2.8 oz/A	12	21	
	OR	*Danitol 2.4EC	10.67-16 fl oz/A	24	14	
	OR	Leverage 2.7SE	3.6-4.4 fl oz/A	12	7	
	OR	*Pounce 3.2EC	4-8 fl oz/A	12	PF	
		or *Pounce 25WP	6.4-25.6 oz/A			
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	21	
	OR	*Provado 1.6F	2 oz/100 gal	12	7	
	OR	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	
	OR	*Warrior II	1.28-2.56 fl oz/A	24	21	
White apple leaf-hopper, Potato leafhopper		Actara 25WDG	2-2.75 oz/A	12	14	[32.1]
	OR	*Agri-Mek 0.15EC	2.5-5 oz/100 gal	12	28	
	OR	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	28	
	OR	Assail 30SG	2.5-4.0 oz/A	12	7	
	OR	Avaunt 30WDG	5-6 oz/A	12	14	
	OR	§Aza-Direct 1.2L	12.5-42 fl oz/A	4	0	
	OR	*Battalion 0.2EC	7-14.1 fl oz/A	12	21	
	OR	*Baythroid 2E	1.4-2.0 fl oz/A	12	7	
		or *Baythroid XL 1L	1.4-2.0 fl oz/A	12	7	
	OR	*Calypso 4F	0.5-1.0 fl oz/100 gal	12	30	
	OR	*Danitol 2.4EC	10.67-16 fl oz/A	24	14	
	OR	*Lannate 2.4L#	0.75 pt/100 gal	72	14	
		or *Lannate 90SP	0.25 lb/100 gal			
	OR	Leverage 2.7SE	3.0-3.6 fl oz/A	12	7	
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	21	
	OR	*Provado 1.6F	2 oz/100 gal	12	7	
	OR	*Sevin 80WS, 80S	1.5 lb/100 gal	12	3	
		or Sevin XLR Plus 4EC	0.5 qt/100 gal			
		or Sevin 4F	0.5 qt/100 gal			
	OR	Sherpa	2 oz/100 gal	12	7	

Table 11.5.1. Pesticide Spray Table – Apples.
(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
White apple leaf-hopper, Potato leafhopper *(continued)*	*OR*	*Thionex 50WP	1 lb/100 gal	24	21	
		or *Thionex 3EC	0.67 qt/100 gal			
	OR	Voliam flexi	6.0-7.0 oz/A	12	35	
	OR	*Vydate 2L#	1-2 pt/100 gal	48	14	
	OR	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	
	OR	*Warrior II	1.28-2.56 fl oz/A	24	21	
Additional Summer Sprays						
Apple rust diseases		Refer to Pink sprays for materials and comments				
Apple Scab		Captan 50WP	1-2 lb/100 gal	24 (E)	0	[2.91]
		or Captan 80WP	0.65-1.25 lb/100 gal			
		or Captec or Captan 4L	0.5-1 qt/100 gal			
	OR	Dithane/Manzate/Maneb/ Penncozeb 75DF	1-2 lb/100 gal	24	77	[2.10]
		or Polyram 80DF	1 lb/100 gal			
	OR	Flint 50WG	0.67-0.8 oz/100 gal	12	14	[2.4, 2.14]
	OR	Sovran 50WG	1.0-1.6 oz/100 gal	12	30	[2.4, 2.14]
	OR	Pristine 38WP	14.5-18.5 oz/A	12	0	
	OR	Topsin M 70WP	4-8 oz/100 gal	12	0	[2.12]
		or Thiophanate-methyl 85WDG	3-5 oz/100 gal			
		plus either:				
		Captan 50WP	1 lb/100 gal	24 (E)	0	
		or Captan 80WP	5/8 lb/100 gal			
		or Captec or Captan 4L	1 pt/100 gal			
		or Dithane/Manzate/Maneb/ Penncozeb 75DF	1 lb/100 gal	24	77	[2.10]
		or Polyram 80DF	1 lb/100 gal	24	77	
	OR	*either:*				
		Rally 40WP	1.5-2 oz/100 gal	24	14	[2.5, 2.13]
		or Rubigan 1EC	3-4 fl oz/100 gal	12	30	
		or *Procure 50WS	3-4 oz/100 gal	12	14	
		plus either:				
		Captan 50WP	1 lb/100 gal	24 (E)	0	
		or Captan 80WP	5/8 lb/100 gal			
		or Captan 4L	1 pt/100 gal			
		or Dithane/Manzate/Maneb/ Penncozeb 75DF	1 lb/100 gal	24	77	[2.10]
		or Polyram 80DF	1 lb/100 gal	24	77	
Bitter Rot		Captan 50WP	1-2 lb/100 gal	24 (E)	0	[3.1]
		or Captan 80WP	0.65-1.25 lb/100 gal			
		or Captec or Captan 4L	0.5-1 qt/100 gal			
Black rot, White rot		Captan 50WP	1-2 lb/100 gal	24 (E)	0	[4.3]
		or Captan 80WP	0.65-1.25 lb/100 gal			
		or Captec or Captan 4L	0.5-1 qt/100 gal			
	OR	Flint 50WG	0.5 oz/100 gal	12	14	[2.14]

Table 11.5.1. Pesticide Spray Table – Apples.
(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Black rot, White rot *(continued)*	*OR*	Sovran 50WG	1.0-1.6 oz/100 gal	12	30	[2.14]
	OR	Pristine 38WP	14.5-18.5 oz/A	12	0	
	OR	Topsin M 70WP	4-8 oz/100 gal	12	0	[10.3, 10.4]
		plus either:				
		Captan 50WP	1 lb/100 gal	24 (E)	0	
		or Captan 80WP	5/8 lb/100 gal			
		or Captec or Captan 4L	1 pt/100 gal			
		or Dithane/Manzate/Maneb/ Penncozeb 75DF	1 lb/100 gal	24	77	[2.10]
		or Polyram 80DF	1 lb/100 gal	24	77	
Blister spot		Aliette 80WDG	0.5-1 lb/100 gal	12	14	[5.1]
Fire blight (Shoot blight)		Apogee 27.5DF	6-12 oz	12	45	[8.6]
(Shoot blight, after hailstorm ONLY)		Agrimycin 17WP	0.5 lb	12	50	[8.5]
Powdery mildew		Bayleton/Triadimefon 50DF	1-2 oz/100 gal	12	45	[9.4]
	OR	§JMS Stylet-Oil	1-2% solution	12	0	[9.3]
	OR	Rally 40WP	1.5-2 oz/100 gal	24	14	[2.11]
	OR	*Procure 50WS	3 oz/100 gal	12	14	
	OR	Rubigan 1EC	3 fl oz/100 gal	12	30	
	OR	Sovran 50WG	1.0-1.6 oz/100 gal	12	30	[2.14]
	OR	§Sulfur 95WP	2 lb/100 gal	24	0	
		or §Sulfur 6F	2 pt/100 gal			
Sooty blotch and Flyspeck		Topsin M 70WP or Thiophanate-methyl 85WDG	2-3 oz/100 gal 4-8 oz/100 gal	12	0	[10.1, 10.2]
		plus either:				
		Captan 50WP	1 lb/100 gal	24 (E)	0	[10.3, 10.4]
		or Captan 80WP	5/8 lb/100 gal			
		or Captec or Captan 4L	1 pt/100 gal			
		or Dithane/Manzate/Maneb/ Penncozeb 75DF	1 lb/100 gal	24	77	[2.10]
		or Polyram 80DF	1 lb/100 gal	24	77	
	OR	Flint 50WG	0.67-0.8 oz/100 gal	12	14	
	OR	Pristine 38WP	14.5-18.5/A	12	0	
	OR	Sovran 50WG	1.0 - 1.6 oz/100 gal	12	30	[2.14]
	OR	Ziram 76DF, 76WDG	1 lb/100 gal	48	14	
	OR	Ziram 76DF, 76WDG	1 lb/100 gal	48	14	[10.5]
		plus Sulfur 95WP	2 lb/100 gal	24		
Apple aphid, Spirea aphid		Actara 25WDG	4.5-5.5 oz/A	12	35	[11.1]
	OR	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	28	
	OR	Assail 30SG	2.5-4.0 oz/A	12	7	
	OR	§Aza-Direct 1.2L	12.5-42 fl oz/A	4	0	
	OR	*Battalion 0.2EC	14.1 fl oz/A	12	21	
	OR	Beleaf 50SG	2.0-2.8 oz/A	12	21	

Table 11.5.1. Pesticide Spray Table – Apples.
(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Apple aphid,	*OR*	*Calypso 4F	0.5-1.0 fl oz/100 gal	12	30	
Spirea aphid	*OR*	*Danitol 2.4EC	16 fl oz/A	24	14	
(continued)	*OR*	*Lannate 2.4L	0.75 pt/100 gal	72	14	
		or *Lannate 90SP	0.25 lb/100 gal			
	OR	Leverage 2.7SE	4.4-5.1 fl oz/A	12	7	
	OR	Movento	6.0-9.0 fl oz/A	24	7	
	OR	§M-Pede 49L	2 gal/100 gal	12	0	
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	21	
	OR	*Provado 1.6F	2 oz/100 gal	12	7	
	OR	§Pyrenone 0.5EC	12 fl oz/A	12	1	
	OR	Sherpa	2 oz/100 gal	12	7	
	OR	*Thionex 50WP	1 lb/100 gal	24	21	
		or *Thionex 3EC	0.67 qt/100 gal			
	OR	Voliam flexi	4.0-7.0 oz/A	12	35	
	OR	*Vydate 2L	1-2 pt/100 gal	48	14	
	OR	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	
	OR	*Warrior II	1.28-2.56 fl oz/A	24	21	
Apple maggot		Assail 30SG	8 oz/A	12	7	[12.1]
	OR	Avaunt 30WDG	5-6 oz/A	12	14	
	OR	*Baythroid 2E	2.4-2.8 fl oz/A	12	7	
		or *Baythroid XL 1L	2.4-2.8 fl oz/A	12	7	
	OR	*Calypso 4F	1-2 fl oz/100 gal	12	30	
	OR	*Danitol 2.4EC	16 fl oz/A	24	14	
	OR	*Guthion 50WS	0.5 lb/100 gal	14-44 days (E)	14	
	OR	*Imidan 70WP	0.75-1 lb/100 gal	72	7	
	OR	*Lannate 2.4L#	0.75 pt/100 gal	72	14	
	OR	§Surround 95WP	50 lb/100 gal	4	0	[12.2]
Apple rust mite		Kelthane 50WS	0.75-1.5 lb/100 gal	12	7	[13.2]
	OR	Nexter 75WS	5.2-10.7 oz/A	12	25	
Codling moth		Altacor 35WDG	2.5-4.5 oz/A	4	14	[14.1],[14.2], [14.4]
	OR	Assail 30SG	4.0-8.0 oz/A	12	7	
	OR	Avaunt 30WDG	5-6 oz/A	12	14	
	OR	§Aza-Direct 1.2L	12.5-42 fl oz/A	4	0	
	OR	*Baythroid 2E	2.0-2.4 fl oz/A	12	7	
		or *Baythroid XL 1L	2.0-2.4 fl oz/A	12	7	
	OR	Belt SC	3.0-5.0 fl oz/A	12	14	
	OR	§Biobit XL 2.1 FC	1.5-5.5 pt/A	4	0	
	OR	*Calypso 4F	1-2 fl oz/100 gal	12	30	
	OR	§Carpovirusine 0.99SC	7-13.5 fl oz/A	4	0	
	OR	Cyd-X 0.06SC	1-6 fl oz/A	4	0	
	OR	Delegate 25WG	4.5-7 oz/A	4	7	
	OR	§Deliver 18WG	0.5-2 lb/A	4	0	

Table 11.5.1. Pesticide Spray Table – Apples.
(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Codling moth	*OR*	§Dipel 10.3DF	0.5-2 lb/A	4	0	
(continued)	*OR*	§Entrust 80WP	2-3 oz/A	4	7	
	OR	*Guthion 50WS	0.5 lb/100 gal	14-44 days (E)	14	
	OR	*Imidan 70WP	0.75 lb/100 gal	72	7	
	OR	*Intrepid 2F	12-16 fl oz/A	4	14	
	OR	*Lannate 2.4L	1.5 pt/100 gal	72	14	
		or *Lannate 90SP	0.25 lb/100 gal			
	OR	Leverage 2.7SE	4.4-5.1 fl oz/A	12	7	
	OR	Rimon 0.83EC	20-40 fl oz/A	12	14	
	OR	Sevin XLR Plus, 4F	1-3 qt/A	12	3	
		or Sevin 80S, *80WS, 4F	1.25-3.75 lb/A			
	OR	SpinTor 2SC	2.5 oz/100 gal	4	7	
	OR	§Surround 95WP	50 lb/100 gal	4	0	[12.2]
	OR	Voliam flexi	6.0-7.0 oz/A	12	35	
Comstock		Assail 30SG	4.0-8.0 oz/A	12	7	[15.3]
mealybug	*OR*	*Diazinon 50WP	1 lb/100 gal	96	21	
	OR	Movento	6.0-9.0 fl oz/A	24	7	
	OR	*Provado 1.6F	2 oz/100 gal	12	7	
Cutworms		§Biobit XL 2.1FC	1.5-5.5 pt/A	4	0	[16.2]
	OR	§Dipel 10.3DF	0.5-2 lb/A	4	0	
	OR	*Lannate 2.4L#	0.75 pt/100 gal	72	14	
Dogwood borer,		*Lorsban 4EC	1.5 qt/100 gal	96	28	[17.2]
American plum		or Lorsban 50WS	1.5 lb/100 gal	96	28	
borer		or Lorsban 75WG	2 lb/100 gal	96	28	
	OR	Assail 30SG	8.0 oz/A	12	7	[17.1]
European corn borer		§Dipel 10.3DF	0.5-2 lb/A	4	0	[19.2]
	OR	*Lannate 2.4L	0.75 pt/100 gal	72	14	
European red		Acramite 50WS	0.75-1.0 lb/A	12	7	[20.11]
mite, Twospotted	*OR*	*Agri-Mek 0.15EC	2.5-5 oz/100 gal	12	28	[20.8]
spider mite	*OR*	Apollo 4SC	1-2 oz/100 gal	12	45	[20.11]
	OR	Envidor 2SC	16-18 fl oz/A	12	7	
	OR	Kanemite 15SC	31 fl oz/A	12	14	[20.11]
	OR	Kelthane 50WS	3-6 lb/A	48	7	
	OR	Nexter 75 WS	4.4-5.2 oz/A	12	25	[20.11]
	OR	Portal Miticide/Insecticide	1-2 pt/A	12	14	[20.9]
	OR	Savey 50DF	3-6 oz/A	12	28	
	OR	Onager	12-24 oz/A	12	28	
	OR	§Stylet-Oil	0.5-2 gal/100 gal	12	0	[20.10]
	OR	*Vendex 50WP	4-8 oz/100 gal	48	14	
	OR	Zeal 72WS	2-3 oz/A	12	14	[20.11]

Table 11.5.1. Pesticide Spray Table – Apples.
(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Japanese beetle		Assail 30SG	5-8 oz/A	12	7	[22.1a, 22.2b]
	OR	Calypso 4F	1-2 fl oz/100 gal	12	30	
	OR	Sevin XLR Plus, 4F	1.5-3.0 qt/A	12	3	
		or Sevin 80S, 80WS	1.88-3.75 oz/A	12	3	
Obliquebanded Leafroller		Altacor 35WDG	2.5-4.5 oz/A	4	14	
	OR	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	21	
	OR	*Battalion 0.2EC	7-14.1 fl oz/A	12	21	
	OR	*Baythroid 2E	2.4-2.8 fl oz/A	12	7	
		or *Baythroid XL 1L	2.4-2.8 fl oz/A	12	7	
	OR	Belt SC	3.0-5.0 fl oz/A	12	14	
	OR	§Biobit XL 2.1FC	1.5-5.5 pt/A	4	0	
	OR	*Danitol 2.4EC	16 fl oz/A	24	14	
	OR	Delegate 25WG	4.5-7 oz/A	4	7	
	OR	§Deliver 18WG	0.5-2 lb/A	4	0	
	OR	§Dipel 10.3DF	0.5-2 lb/A	4	0	
	OR	§Entrust 80WP	2-3 oz/A	4	7	
	OR	*Intrepid 2F	12-16 fl oz/A	4	14	
	OR	§Javelin 7.5WDG	0.13-1 lb/100 gal	4	0	
	OR	*Lannate 2.4L	0.75 pt/100 gal	72	14	
		or *Lannate 90SP	0.25 lb/100 gal			
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	12	
	OR	Rimon 0.83EC	20-40 fl oz/A	12	14	
	OR	*Proclaim 5SG	0.8-1.2 oz/100 gal	12	14	
	OR	SpinTor 2SC	2.5 oz/100 gal	4	7	
	OR	*Warrior 1SC	2.6-5.1 fl oz/A	24	21	
Oriental fruit moth, Lesser apple worm		Altacor 35WDG	2.5-4.5 oz/A	4	14	[14.2], [14.3]
	OR	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	21	
	OR	Assail 30SG	5.0-8.0 oz/A	12	7	
	OR	Avaunt 30WDG	5-6 oz/A	12	14	
	OR	*Baythroid 2E	2.0-2.4 fl oz/A	12	7	
		or *Baythroid XL 1L	2.0-2.4 fl oz/A	12	7	
	OR	Belt SC	3.0-5.0 fl oz/A	12	14	
	OR	*Calypso 4F	1-2 fl oz/100 gal	12	30	
	OR	Delegate 25WG	4.5-7 oz/A	4	7	
	OR	*Guthion 50WS	0.5 lb/100 gal	14-44 days (E)	14-21 (E)	
	OR	*Imidan 70WP	0.75-1 lb/100 gal	72	7	
	OR	*Intrepid 2F	12-16 fl oz/A	4	14	
	OR	Leverage 2.7SE	3.6-4.4 fl oz/A	12	7	
	OR	Rimon 0.83EC	20-40 fl oz/A	12	14	
	OR	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	
	OR	*Warrior II	1.28-2.56 fl oz/A	24	21	

Table 11.5.1. Pesticide Spray Table – Apples.
(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Oriental fruit moth, Lesser apple worm	*OR*	Pheromone disruption:				[14.2]
		§3M Sprayable Pheromone for OFM	1.7 oz/A			
(continued)	*OR*	Checkmate OFM-F	1.32-2.93 fl oz/A	0	0	
		or Checkmate CM-OFM Duel	150-200 dispensers/A	0	0	
	OR	§Isomate-M 100	100 ties/A	0	0	
		or Isomate-CM/OFM TT	200 ties/A	0	0	
Redbanded leafroller		Altacor 35WDG	2.5-4.5 oz/A	4	14	
	OR	*Baythroid 2E	2.4-2.8 fl oz/A	12	7	
		or *Baythroid XL 1L	2.4-2.8 fl oz/A	12	7	
	OR	Belt SC	3.0-5.0 fl oz/A	12	14	
	OR	§Biobit XL 2.1FC	1.5-5.5 pt/A	4	0	
	OR	Delegate 25WG	4.5-7.0 oz/A	4	7	
	OR	§Deliver 18WG	0.5-2 lb/A	4	0	
	OR	§Dipel 10.3DF	0.5-2 lb/A	4	0	
	OR	*Guthion 50WS	0.5 lb/100 gal	14-44 days (E)	14-21	
	OR	*Imidan 70WP	0.75-1 lb/100 gal	72	7	
	OR	§Javelin 7.5WDG	0.13-1 lb/100 gal	4	0	
	OR	*Lannate 2.4L	0.75 pt/100 gal	72	14	
		or *Lannate 90SP	0.25 lb/100 gal			
	OR	Leverage 2.7SE	3.6-4.4 fl oz/A	12	7	
	OR	*Proclaim 5SG	0.8-1.2 oz/100 gal	12	14	
San Jose scale		Assail 30SG	8 oz/A	12	7	[28.4]
	OR	Centaur WDG	34.5 oz/A	12	14	
	OR	Esteem 35WP	4-5 oz/A	24	45	
	OR	*Guthion 50WS	8-10 oz/100 gal	14-44 days (E)	14-21	
	OR	*Imidan 70WP	0.75-1 lb/100 gal	72	7	
	OR	Leverage 2.7SE	3.6-4.4 fl oz/A	12	7	
	OR	Movento	6.0-9.0 fl oz/A	24	7	
	OR	*Provado 1.6F	2 oz/100 gal	12	7	
	OR	Sherpa	2 oz/100 gal	12	7	
Spotted tentiform leafminer, Apple blotch leafminer		Actara 25WDG	4.5-5.5 oz/A	12	35	[29.3]
	OR	Agri-Mek 0.1EC	2.5-5 fl oz/100 gal	12	28	
	OR	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	28	
	OR	Assail 30SG	2.5 oz/A	12	7	
	OR	§Aza-Direct 1.2L	12.5-42 fl oz/A	4	0	
	OR	*Baythroid 2E	2.0-2.4 fl oz/A	12	7	
		or *Baythroid XL 1L	2.0-2.4 fl oz/A	12	7	
	OR	*Calypso 4F	0.5-1 fl oz/100 gal	12	30	
	OR	*Danitol 2.4EC	10.67-16 fl oz/A	24	14	
	OR	Delegate 25WG	4.5-7.0 oz/A	4	7	

Table 11.5.1. Pesticide Spray Table – Apples.
(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Spotted tentiform leafminer, Apple blotch leafminer *(continued)*	*OR*	*Lannate 2.4L#	0.75 pt/100 gal	72	14	
		or *Lannate 90SP	0.25 lb/100 gal			
	OR	Leverage 2.7SE	3.6-4.4 fl oz/A	12	7	
	OR	Proaxis 0.5CS	2.6-5.1 fl oz/A	24	21	
	OR	Proclaim 5SG	0.8-1.2 oz/100 gal	12	14	
	OR	*Provado 1.6F	2 oz/100 gal	12	7	
	OR	Sherpa	2 oz/100 gal	12	7	
	OR	*Vydate 2L#	0.5-1 pt/100 gal	48	14	
	OR	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	
		or *Warrior II	1.28-2.56 fl oz/A	24	21	
Variegated leaf-roller, Spargano-this fruitworm		§Biobit XL 2.1FC	1.5-5.5 pt/A	4	0	[31.1]
	OR	§Deliver 18WG	0.5-2 lb/A	4	0	
	OR	§Dipel 10.3DF	0.5-2 lb/A	4	0	
	OR	§Javelin 7.5WDG	0.13-1 lb/100 gal	4	0	
	OR	*Lannate 2.4L	0.75 pt/100 gal	72	14	
		or *Lannate 90SP	0.25 lb/100 gal			
	OR	Leverage 2.7SE	4.4-5.1 fl oz/A	12	7	
White apple leafhopper, Potato leafhopper		Actara 25WDG	2-2.75 oz/A	12	14	[32.1]
	OR	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	28	
	OR	Assail 30SG	2.5-4.0 oz/A	12	7	
	OR	Avaunt 30WDG	5-6 oz/A	12	14	
	OR	§Aza-Direct 1.2L	12.5-42 fl oz/A	4	0	
	OR	*Battalion 0.2EC	7-14.1 fl oz/A	12	21	
	OR	*Baythroid 2E	1.4-2.0 fl oz/A	12	7	
		or *Baythroid XL 1L	1.4-2.0 fl oz/A	12	7	
	OR	*Calypso 4F	0.5-1 fl oz/100 gal	12	30	
	OR	*Danitol 2.4EC	10.67-16 fl oz/A	24	14	
	OR	*Lannate 2.4L#	0.75 pt/100 gal	72	14	
		or *Lannate 90SP	0.25 lb/100 gal			
	OR	Leverage 2.7SE	3.0-3.6 fl oz/A	12	7	
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	21	
	OR	*Provado 1.6F	0.5-2 oz/100 gal	12	7	[32.2]
	OR	*Sevin 80WS, 80S	1.5 lb/100 gal	12	3	
		or Sevin XLR Plus 4EC	0.5 qt/100 gal			
		or Sevin 4F	0.5 qt/100 gal			
	OR	Sherpa	2 oz/100 gal	12	7	
	OR	*Thionex 50WP	1 lb/100 gal	24	21	
		or *Thionex 3EC	0.67 qt/100 gal			
	OR	*Vydate 2L#	1-2 pt/100 gal	48	14	
	OR	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	
		or Warrior II	1.28-2.56 fl oz/A	24	21	

Table 11.5.1. Pesticide Spray Table – Apples.
(Refer to back of book for key to abbreviations and footnotes.)

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Woolly apple Aphid		Assail 30SG	4.0-8.0 oz/A	12	7	[33.1]
	OR	Beleaf 50SG	2.0-2.8 oz/A	12	21	
	OR	*Diazinon 50WP	1 lb/100 gal	96	21	
	OR	Movento	6.0-9.0 fl oz/A	24	7	
	OR	*Thionex 50WP	1 lb/100 gal	24	21	
		or *Thionex 3EC	0.67 qt/100 gal			
Postharvest						
Crown rot (collar rot)		Ridomil Gold 4EC	see comments	12	See comments	[7.2]
Control of Storage Disorders						
Storage rots		Mertect 340F	1 pt/100 gal			[34.1]
		plus Captan 50WP	2.5 lb/100 gal			
		or Captan 80WP	1.6 lb/100 gal			
		or Captec or Captan 4L	1.25 qt/100 gal			
	OR	Scholar 50W	6-8 oz/100 gal			[34.1]
Storage scald		No Scald DPA-23	2.5-5 pt/100 gal			[35.1]
		or Shield Brite DPA				
Senescent break-down (McIntosh)		Dowflake Process Grade	25 lb/100 gal			[36.1]

11.6 Growth Regulator Use In Apples

11.6.1 Chemical Thinning

Fruit thinning is a management practice that reduces yield in the current season but results in increased fruit size and also increased return bloom and yield in the next season. Large fruit size is best obtained with consistent cropload reductions each year through chemical thinning. The use of growth regulating chemicals to thin apple trees is not an exact science and each grower must weigh and evaluate the many factors that affect chemical thinning response in deciding on a thinning program. Although the recommendations in this section are based on research and experience, growers are cautioned that their success with chemical thinning depends on many factors, and they should use these recommendations only as a guide.

11.6.2 Weather Factors that affect Thinning Response

Frost. Frost before application of thinners can greatly increase the amount of thinning obtained from chemical thinners. Frost at bloom can damage fruitlets and reduce seed set, which can result in increased natural drop and greater chemical thinning response. Frost can also damage spur leaves, resulting in greater chemical uptake and reduced photosynthesis, thus greater thinning response. Wherever flowers and leaves have been damaged by frost, extreme caution should be used with chemical thinners. Typically, lower rates would be used in such cases.

Sunlight Levels before Application. The amount of sunlight for the 3–5 days preceding application of chemical thinners has an important effect on chemical uptake and response. Intense cloudy weather before application of thinners can result in increased chemical uptake and greater thinning response, due to greater succulence of the leaves and thinner wax cuticle. This results in increased uptake of thinners thus greater chemical thinning response. Growers may want to reduce the rate of thinner used, if intense cloudy weather precedes application.

Temperature at Time of Application. The uptake of chemical thinners is greater at higher temperatures than at lower temperatures. The optimum is between 70–80° F. Above 80° F, uptake is substantially greater than below 80° F. The time of day applications are made appears to be unimportant. Applications made in the morning or evening when it is cool have a longer drying time on the leaf, resulting in a slow but sustained uptake of chemical, while at higher temperatures during mid-day, drying times are shorter, resulting in a short but rapid uptake of chemical. Thus, the total amount of chemical taken into the plant appears to be very similar regardless of the time of day. Recent research results also indicate that similar thinning is achieved regardless of the time of day applications are made.

Weather After Application. Temperature and sunlight levels for the 5-day period after application of thinners are the predominant weather factors affecting chemical thinning response. The interaction of temperature and sunlight with the chemical thinner creates stress in the tree, which is necessary to make some fruit drop off. Warmer temperatures increase thinning response, while greater light levels decrease thinning response (Fig. 11.6.1).

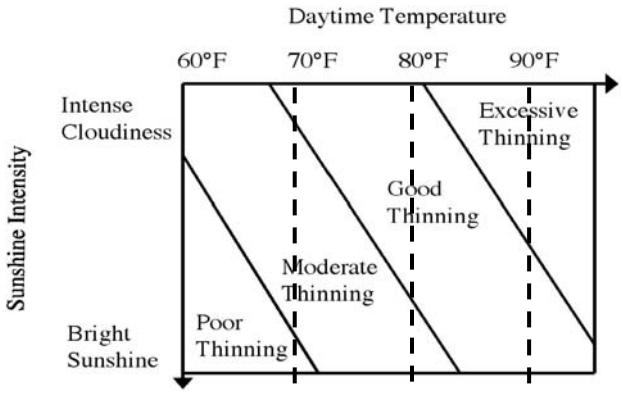


Figure 11.6.1. The interaction of temperature and sunlight intensity on thinner action.

Night temperatures are also an important factor to consider. Warm night temperatures (>60° F) give greater thinning response. With high night temperatures, fruits use up the carbohydrates that were produced during the day at a fast rate, resulting in a deficit of resources for fruit growth and causing the weakest fruits to drop. The greatest thinning can result if warm night temperatures are combined with intense cloudy/warm daytime weather. Under these conditions, the tree produces little reserves during the day and at night the fruits use up all of the reserves produced during the day, making the fruits very susceptible to the stress caused by chemical thinners. Under these conditions, excessive fruit drop can result. The least effective thinning is achieved when bright, warm daytime weather is accompanied by low night temperatures. Under these conditions, the tree produces large amounts of carbohydrates during the day and the fruits use them up at a slow rate during the night. Under these conditions, there is little stress created by chemical thinners and the thinning response is poor. Growers should critically examine the weather forecast for the 3–7-day period following application of thinners and adjust rates of chemical thinners up or down 50% based on forecasted temperatures and sunlight levels. . Further, weather conditions should be a factor in determining whether to use a combination of thinners.

11.6.3 Tree Factors that affect Thinning Response

Pollination. Poor cross-pollination results in low viable seed number per fruit, greater post-bloom fruit drop and greater sensitivity to chemical thinners. In contrast, high seed numbers per fruit result in more difficult-to-thin conditions. In general, if seed numbers are less than 5, thinning rates should be reduced.

Initial Cropload (Fruit Set). A high initial cropload usually results in a relatively high final cropload, regardless of chemical thinning program. Therefore, to achieve a given cropload each year, the initial cropload must be considered when determining the aggressiveness of the thinning program. Growers should use a more aggressive thinning program when initial fruit set is high and a less aggressive thinning program when initial fruit set is lower.

Fruit Size at Time of Application. Fruitlets are more sensitive to NAA and BA at 8-12mm fruit diameter than at smaller or larger sizes. In warm years, when fruit growth rate is rapid, chemical thinners should be applied slightly before fruits reach 10 mm diameter (8-10 mm). In cool years, when fruit growth rate is slow, the application of chemical thinners should be delayed until fruits are 12-15 mm in diameter. Growers should attempt to time chemical thinner application according to a suitable weather window within the preferred fruit size windows. It is generally better to delay application of a thinner until favorable weather if forecast after application than to apply a thinner at the suggested fruit size and have cool weather follow for several days.

Sensitivity of the Tree. The internal physiological status of the tree determines its sensitivity to chemical thinners. Growers should use a less aggressive thinning program under conditions when tree carbohydrate supply for the fruitlets is expected to be low, and a more aggressive thinning program when tree carbohydrate supply is expected to be high. The carbohydrate supply available to the fruitlets is reduced by: 1) heavy croploads the previous year. 2) cloudy weather after application of chemical thinners. 3) heavy insect and disease damage to foliage during the previous season. 4) severe winter temperatures that damage vascular tissues necessary for the transport of reserves from the root to the top in the spring. 5) warm temperatures in late winter and early spring (Feb. 15–April 15), which cause the tree to use its carbohydrate reserves before bloom.

11.6.4 Chemicals Registered for Thinning

Naphthaleneacetic acid (NAA) is an auxin-type growth regulator that induces fruit thinning at rates from 2.5–15 ppm depending on variety. In some years, however, there is very little difference in response between 5 ppm and 10 ppm. NAA has some thinning activity from full bloom until fruits are 15 mm in diameter, with the greatest thinning activity when fruit diameter is between 8-12 mm fruit size. It is sold as either the Sodium salt (Fruitone-N, Fruitone-L) or the Potassium salt (K-Salt Fruit Fix-200 and Fruit Fix-800). The four formulations give very similar thinning responses if used at the same rate of NAA. NAA stimulates ethylene production in the tree and at high concentrations also inhibits photosynthesis and fruit growth rate for a

period of 7–10 days after application. The inhibition of fruit growth rate and photosynthesis results in abscission of the weaker fruit on the tree. At early timings such as full bloom or petal fall, there appears to be little negative impact on fruit growth rate from NAA, as well as more modest thinning than at later timings. In some years and with some varieties like Empire, the temporary inhibition of fruit growth caused by NAA results in little gain in final fruit size at harvest even if thinning is achieved. This negative side effect is most common if NAA is applied at rates greater than 10 ppm, when temperatures are high and at fruit sizes larger than 10 8 mm. High rates of NAA should be avoided on small fruited varieties. High rates of NAA may also cause pygmy fruit with Delicious and Fuji.

Naphthaleneacetamide (NAD or NAAm) is an amide form of NAA but has much lower activity than NAA. As a consequence, it is a mild but safe thinner that is used at rates from 25–50 ppm. Late timings result in pygmy fruit with Delicious, and are ineffective with other varieties. It is often used at petal fall on early ripening varieties and on certain hard-to-thin varieties such as Macoun.

6-Benzyladenine (BA) is a cytokinin-type growth regulator that induces fruit thinning at rates from 35–150 ppm. BA can be used from petal fall to approximately 15 mm fruit size, but the thinning response is poor when applied at petal fall and its effectiveness at larger fruit sizes is diminished unless favorable weather conditions following application. The best response is when fruits are 10–12 mm in diameter. It is most effective when temperatures are warm (70°F) for a 3–5-day period after application. It is sold in three formulations as either Maxcel (1.9% BA), or RiteWay (1.9% BA) or Exilis Plus (2.0% BA). The primary advantage of BA is that it results in larger fruit size than with other thinners due to a stimulation of cell division. The primary disadvantage of BA is that it often does not thin adequately by itself. Where more aggressive thinning is desired, carbaryl should be combined with BA. In some cases, the use of BA alone has resulted in significant fruit size improvement even though there was little thinning.

Carbaryl is a carbamate insecticide that also has moderate thinning action. It is relatively safe and has the added advantage of having good insecticidal properties on leafhoppers and plum curculio. It is relatively rate-insensitive, with similar thinning response from 0.25 lb up to 1.0 lb A.I./100 gallons. One of its best features is that it selectively removes the weaker fruits within the cluster, leaving predominantly one fruit per cluster. Carbaryl has been shown to enhance the effectiveness of NAA or BA when used in a tank mix. It is commonly used in combination with NAA or BA. If there is satisfactory bloom and pollination weather we recommend that a thinning program start with a petal fall spray of carbaryl at a minimum. It is important that bee are removed from the orchard before carbaryl is applied. Recent research indicates that a major mite predator mite in (*Typhlodromus pyri*) has developed resistance to carbaryl. Thus, Carbaryl can be used in N.Y. without disrupting biological mite control programs. Carbaryl is very toxic to bees and the wettable powder particles of Carbaryl, which are similar in size to pollen grains, can be picked up by bees and carried back to the hive. The liquid formulations of carbaryl are not picked up as easily by bees, so their use is much safer. The liquid formulations have made it possible to apply Carbaryl at a wide range of timings from petal fall to 20 mm fruit size. The liquid formulations of carbaryl have significant amounts of added surfactants and thus may have greater thinning activity than the wettable powder formulations. Under cloudy, rainy weather conditions, the liquid formulations may cause fruit skin damage, especially when foliar nutrients or captan are included in the thinning spray. With cloudy, rainy weather, we recommend the wettable powder formulations. With bright sunshine, we recommend the liquid formulations.

Vydate is a broad spectrum carbamate insecticide that also has moderate thinning activity. It is similar to carbaryl in thinning action and is used from 0.25 to 1.0 lb A.I./100 gallons. It is not commonly used in New England for thinning since it is reported to be more toxic to predator mites. However, in pest control programs that do not attempt to conserve predatory mites, Vydate can be useful as both a thinning agent and a broad spectrum insecticide. Like carbaryl, it is usually combined with NAA and BA for greater thinning.

Ethephon (Ethrel) is a growth regulator that stimulates ethylene production by the plant. It can be used to thin apple trees from full bloom to 20 to 25 mm fruit size. It has given unpredictable thinning action. In a few cases it has defruited the trees. Nevertheless, it does have the advantage that it will thin large fruit (up to 25 mm). In general, a rate of 200 to 300 ppm (.66 to 1.0 pt/100 gal tree row volume dilute) is the use range that we suggest. Ethrel also has a significant positive effect on return bloom in addition to the thinning effect. Ethrel can also be used as a return bloom enhancer after the thinning period is over. For this use, it is applied 2 to 4 times at 7 to 10 day intervals after the window for thinning has passed (usually 4-6 weeks after full bloom).

Wilthin is a caustic chemical thinner that works by burning flower parts of unpollinated flowers, thus preventing their pollination and fertilization. It must be applied at a specific timing (50% full bloom) when the king blossoms have been pollinated but the lateral flowers have not. It should also be applied with a spreader/sticker such as Regulaid. The major disadvantage to Wilthin is that it must be applied before the crop is set. However, Wilthin has proven to be a relatively mild and safe thinner, removing only about 10–20% of the crop. With high rates and slow drying conditions, Wilthin can cause fruit injury (marking and russetting), especially on Gala and Fuji.

11.6.5 Chemicals not Registered for Thinning that Influence Cropload

Lime sulfur is a foliar fungicide that, if used during bloom or during the early post-bloom period at rates of 2.5–3 gal/100 gal, will cause significant thinning. Lime sulfur in combination with oil or fish oil is used increasingly in organic apple production systems. Growers who use lime sulfur should account for the thinning action of this material when they develop their thinning programs.

Ammonium Thiosulfate (ATS) is a foliar nitrogen fertilizer that, if used during bloom at rates of 2–4 gal/100 gal, may cause significant thinning. Growers who use ATS should account for the thinning action of this material when they develop their thinning programs.

Oil or Fish oil are foliar insecticides that also significantly enhance chemical thinner response. Combinations of lime sulfur and oil (2%) or carbaryl and oil (0.25%) or BA and carbaryl and oil (0.25%) give greater thinning than either product alone.

11.6.6 Spray Timings

Chemical thinning can be done at various times depending on the chemical used, beginning with full bloom and ending when fruits have reached 20 mm in diameter. The following five timing windows during the growing season should be considered when applying thinners.

50% Bloom. Bloom thinning can be done with caustic thinning chemicals such as Wilthin or ATS or with hormone-type thinners such as NAA. The timing window with caustic thinners is very narrow (1–2 days) since the goal is to allow the king bloom to be pollinated and then apply the chemical to prevent further pollination of other flowers. Thinning response with the caustic blossom thinners is less weather-dependent, but fruit skin injury can occur with high rates and slow drying conditions. Significant phytotoxicity may result if ATS is applied following a period of wet and cloudy weather. Use of NAA at full bloom may give a moderate thinning response.

Petal Fall (1 week after full bloom). Thinning at petal fall has the advantage of allowing some assessment of pollination before making the decision about aggressiveness of thinning. As with bloom thinning, the objective is to remove a portion of the crop before competition between fruits reduces fruit size. In addition, after petals have fallen and bee hives have been removed from the orchard, carbaryl can be used as a thinner. Thinning response with NAA and carbaryl at petal fall is usually moderate, thus the petal fall timing can be viewed as safe. Petal fall sprays alone are unlikely to provide adequately thinning in most years. Petal fall sprays are usually used as part of a multi-spray program, which allows a portion of the crop to be removed at petal fall and the balance of the thinning done 7–10 days later at 10-12 mm fruit diameter.

8–14 mm fruit size (2–3 weeks after full bloom). The traditional time to apply chemical thinners (hormone-type thinners) is when king fruits are 10 mm in diameter. By that time, growers can accurately assess fruit set. Growers should apply chemical thinners anytime when king fruits are between 8 and 13 mm when there is a satisfactory weather window as outlined above. When fruit diameter exceeds 15 mm, the effectiveness of NAA and BA declines rapidly. The major disadvantage of waiting until the 10 mm timing is that this limits growers to only one opportunity to reduce cropload, and if poor weather conditions result in poor thinning, then expensive hand thinning will be required. By using multiple spray timings, a grower has several chances to thin the trees.

15–20 mm fruit size (3–4 weeks after full bloom). Thinning when fruits are larger than 15 mm should be avoided if possible. If the preceding weather has been cool some thinning can be expected using the traditional thinners.. Ethrel with oil or carbaryl with oil as an adjuvant can be used for this purpose although the thinning outcome may be variable.

15-25 mm fruit size. 250 to 300 ppm ethephon plus carbaryl and a surfactant at this time may be used as a 'rescue' thinning treatment if not enough thinning has already been observed. This treatment has had variable results and may not always work – use caution. Hand thinning may be more desirable at this timing. See http://www.umass.edu/fruitadvisor/ factsheets/F-129.pdf for more details.

4-6 weeks after full bloom. With some varieties that are strongly biennial in their cropping pattern, an additional 3 chemical sprays may be useful to enhance repeat bloom the following year without causing additional thinning. This is done once fruitlets have exceeded 20 mm in diameter, when they are less susceptible to chemical thinners. Low doses of Ethephon (Ethrel) or NAA may have a positive effect on repeat bloom without causing additional thinning when used starting at 4-6 weeks after bloom. This treatment is particularly useful on large-fruited varieties that are biennial.

11.6.7 Suggested Strategies For New England Growers

The myriad of possible combinations of chemicals, timings, rates and varieties provides a great number of possible thinning programs for growers. We suggest three basic thinning programs.

1. **Easy-to-thin varieties.** For easy-to-thin varieties like McIntosh, Cortland, Gingergold, Mutsu, Idared and Granny Smith a petal fall application of carbaryl is recommended. This may be all that is required in some circumstances. If additional thinning appears necessary an application at the 8-14 mm fruit stage is appropriate. Our suggested approach is to use carbaryl at 0.5 lb

AI/100 and then add either NAA or BA at a rate that fits the variety, fruit set and environmental conditions. See Table 11.6.2 for specific variety recommendations.

2. **Multiple spray applications.** For hard-to-thin varieties like Empire, Gala, Jonamac, Macoun, Spur Delicious, Golden Delicious, Spur Rome, Fuji etc., we recommend multiple applications. With two or three opportunities to thin the trees, risks associated with over or under thinning are reduced. We suggest growers apply either a Bloom Spray or a Petal Fall Spray and then follow with a second spray at the 8–14 mm stage. A third spray, if needed, could be applied at the 15–20 mm stage. See Table 11.6.2 for specific recommendations.
3. **Single or Multiple Applications followed by repeat bloom enhancer.** This program is used where expected repeat bloom is insufficient. It is useful for easy-to-thin biennial triploid varieties such as Jonagold and Mutsu and it is also useful for hard-to-thin, strongly biennial varieties such as Fuji and Golden Delicious. We suggest applying chemical thinners at the normal timing and then following with 3 weekly sprays of Ethrel or NAA about 4–6 weeks after bloom. See Table 11.6.2 for specific recommendations.

11.6.8 Summary

- The time of day when thinning applications are made has little effect on thinning response, thus, growers should not be too concerned about the temperature at time of application.
- Dark, cloudy weather for 2 or more days after application of thinners may increase thinning response; therefore, growers should reduce the rate of thinner if intense cloudy weather follows application.
- High night temperatures (>60° F) and high day temperatures (>85° F) after application of thinners will increase thinning response; thus, growers should critically examine the weather forecast for the 3–5-day period following application of thinners to adjust rates of chemicals used based on forecasted night and daytime temperatures and sunlight levels.
- High initial fruit set will result in greater final fruit set in most years, despite the application of thinners. A lower initial fruit set will result in lower final fruit numbers; therefore, growers should use a more aggressive thinning program when initial fruit set is high and a less aggressive thinning program when initial fruit set is low.
- Growers should attempt to time chemical thinner applications according to a suitable weather forecast following application.High rates of NAA reduce fruit growth rate and should be avoided on small-fruited varieties such as Empire, Jonamac and Gala.
- BA alone is a mild thinner and should always be used in combination with carbaryl when significant thinning is desired.
- Return bloom may be enhanced by late June and early July applications of Ethrel or NAA.
- To reduce the risk of over thinning or under thinning, a multiple spray program should be employed on hard-to-thin varieties.

Table 11.6.1. Chemicals registered for use in apple thinning in New England.

Timing	Chemical	Commercial Product Name	Typical rates of formulated product/100 gallons based on a full TRV gallonage per acre	Max. rate of formulated product/acre
Bloom	Ammonium Thiosulfate	ATS (foliar nutrient)	2-4 gal	–
Petal Fall	Naphthaleneacetamide	Amid-Thin W	4-8 oz (25-50ppm)	2 lb
	Naphthaleneacetic Acid-Sodium	Fruitone-N, Fruitone-L	2-4 oz (5-10ppm)	16 oz
	Carbaryl	Sevin XLR Plus	0.5-1.5 pt	6 pt
	Carbaryl	Sevin 4F	0.5-1.5 pt	6 pt
8-13mm Fruit Size	Benzyladenine	Maxcel	32-64 fl oz	308 fl oz
	Benzyladenine	Exilis Plus	29-58 fl oz	296 fl oz
	Benzyladenine plus GA 4+7	RiteWay	32-64 fl oz	308 fl oz
	Naphthaleneacetic Acid-Sodium	Fruitone-N, Fruitone-L	2-6 oz (5-15ppm)	24 oz
	Carbaryl	Sevin XLR Plus	0.5-1.5 pt	6 pt
	Carbaryl	Sevin 4F	0.5-1.5 pt	6 pt
	Carbaryl	Sevin 80 WSP	0.3-0.9 lb	3.6 lb
15-20mm Fruit Size	Ethephon	Ethrel	1-1.5 pt (300-450ppm)	6 pt
	Carbaryl	Sevin XLR Plus	0.5-1.5 pt	6 pt
	Carbaryl	Sevin 4F	0.5-1.5 pt	6 pt
	Carbaryl	Sevin 80 WSP	0.3-0.9 lb	3.6 lb
15-25mm Fruit Size	Ethepon plus surfactant	Ethrel	250-300ppm	6 pt

*Tree Row Volume Gallonage (TRV) = (Tree Height X Tree Width X 43,560 X 0.7) / (Between Row Spacing X1,000).

Table 11.6.2. Recommendations for thinning specific apple varieties in New England.

The chemicals and rates suggested in this table are the "best suggestion" of the authors for mature trees with a heavy fruit set and "normal" fruit thinning weather. Our rates should be adjusted up or down by 50% depending on weather conditions, pollination, fruit set and tree sensitivity. Other chemicals, rates, timings and combinations may also work.

	APPLICATION TIMING			
	50% Full Bloom	Petal Fall (1 week after bloom)	8-14 mm fruit size (2-3 weeks after bloom)	Return Bloom Enhancer (4-6 weeks after bloom)
VARIETY	*Rates are per 100 gallons based on a full dilute TRV application**			
Ben Davis			3 oz Fruitone-N* plus 1 pt Sevin	
Cameo		1 pt Sevin	3 oz Fruitone-N plus 1 pt Sevin	
Cortland			2 oz Fruitone-N	
Delicious (Spur Type)	2 gal ATS	1 pt Sevin	64 oz 6-BA plus 1 pt Sevin plus 1 qt Ultrafine spray oil **OR** 3 oz Fruitone-N plus 1 pt Sevin	
Delicious (Non-Spur Type)	2 gal ATS		48 oz 6-BA plus 1 pt Sevin **OR** 2 oz Fruitone-N plus 1 pt Sevin	
Early McIntosh		5 .5 oz Amide Thin plus 1 pt Sevin		
Empire		2 oz Fruitone-N plus 1 pt Sevin	64 oz 6-BA plus 1 pt Sevin **OR** 3 oz Fruitone-N plus 1 pt Sevin	
Fortune		2 oz Fruitone-N plus 1 pt Sevin	3 oz Fruitone-N plus 1 pt Sevin	0.5 pt Ethrel (3 weekly sprays) **OR** 2 oz Fruitone-N (3 weekly sprays)
Fuji	2 gal ATS	1 pt Sevin	64 oz 6-BA plus 1 pt Sevin	0.5 pt Ethrel (3 weekly sprays) **OR** 2 oz Fruitone-N (3 weekly sprays)
Gala	2 gal ATS	1 pt Sevin	64 oz 6-BA plus 1 pt Sevin	
Gingergold			2 oz Fruitone-N plus 1 pt Sevin	
Golden Delicious (without use of Provide)	2 gal ATS	3 oz Fruitone-N plus 1 pt Sevin	64 oz 6-BA plus 1 pt Sevin **OR** 6 oz Fruitone-N plus 1 pt Sevin	0.5 pt Ethrel (3 weekly sprays) **OR** 2 oz Fruitone-N (3 weekly sprays)

Table 11.6.2. Recommendations for thinning specific apple varieties in New England.

The chemicals and rates suggested in this table are the "best suggestion" of the authors for mature trees with a heavy fruit set and "normal" fruit thinning weather. Our rates should be adjusted up or down by 50% depending on weather conditions, pollination, fruit set and tree sensitivity. Other chemicals, rates, timings and combinations may also work.

	APPLICATION TIMING			
	50% Full Bloom	**Petal Fall (1 week after bloom)**	**8-14 mm fruit size (2-3 weeks after bloom)**	**Return Bloom Enhancer (4-6 weeks after bloom)**
VARIETY	***Rates are per 100 gallons based on a full dilute TRV application****			
Golden Delicious (with use of provide)	2 gal ATS	1 pt Sevin	48 oz 6-BA plus 1 pt Sevin **OR** 4 oz Fruitone-N plus 1 pt Sevin	0.5 pt Ethrel (3 weekly sprays) **OR** 2 oz Fruitone-N (3 weekly sprays)
Granny Smith			2 oz Fruitone-N plus 1 pt Sevin	
Honeycrisp	2 gal ATS	2 oz Fruitone-N plus 1 pt Sevin	3 oz Fruitone-N plus 1 pt Sevin	2 oz Fruitone-N (3 weekly sprays)
Idared			2 oz Fruitone-N plus 1 pt Sevin	
Jerseymac		2 oz Fruitone-N plus 1 pt Sevin	3 oz Fruitone-N plus 1 pt Sevin	
Jonagold			3 oz Fruitone-N plus 1 pt Sevin	0.5 pt Ethrel (3 weekly sprays) **OR** 2 oz Fruitone-N (3 weekly sprays)
Jonamac		3 oz Fruitone-N plus 1 pt Sevin	64 oz 6-BA plus 1 pt Sevin **OR** 3 oz Fruitone-N plus 1 pt Sevin	
Jonathan			2 oz Fruitone-N plus 1 pt Sevin	
Lady Apples		2 oz Fruitone-N plus 1 pt Sevin	4 oz Fruitone-N plus 1 pt Sevin	
Liberty		3 oz Fruitone-N plus 1 pt Sevin	64 oz 6-BA plus 1 pt Sevin **OR** **3** oz Fruitone-N Plus 1 pt Sevin	
Lodi		5.5 oz Amide Thin plus 1 pt Sevin		

Table 11.6.2. Recommendations for thinning specific apple varieties in New England.

The chemicals and rates suggested in this table are the "best suggestion" of the authors for mature trees with a heavy fruit set and "normal" fruit thinning weather. Our rates should be adjusted up or down by 50% depending on weather conditions, pollination, fruit set and tree sensitivity. Other chemicals, rates, timings and combinations may also work.

	APPLICATION TIMING			
	50% Full Bloom	**Petal Fall (1 week after bloom)**	**8-14 mm fruit size (2-3 weeks after bloom)**	**Return Bloom Enhancer (4-6 weeks after bloom)**
VARIETY	***Rates are per 100 gallons based on a full dilute TRV application****			
Macoun	2 gal ATS	3 oz Fruitone-N plus 1 pt Sevin	64 oz 6-BA plus 1 pt Sevin **OR** 4 oz Fruitone-N plus 1 pt Sevin	2 oz Fruitone-N (3 weekly sprays)
Milton			2 oz Fruitone-N plus 1 pt Sevin	
McIntosh (Non Spur Type)			2 oz Fruitone-N plus 1 pt Sevin **OR** 40 oz 6-BA plus 1 pt Sevin	
McIntosh (Spur Type)			3 oz Fruitone-N plus 1 pt Sevin OR 48 oz 6-BA plus 1 pt Sevin	
Mutsu (Crispin)			2 oz Fruitone-N plus 1 pt Sevin	0.5 pt Ethrel (3 weekly sprays) **OR** 2 oz Fruitone-N (3 weekly sprays)
Northern Spy			2 oz Fruitone-N plus 1 pt Sevin	0.5 pt Ethrel (3 weekly sprays) **OR** 2 oz Fruitone-N (3 weekly sprays)
NY674		2 oz Fruitone-N plus 1 pt Sevin	3 oz Fruitone-N plus 1 pt Sevin **OR** 64 oz 6-BA plus 1 pt Sevin	
Paulared		2 oz Fruitone-N plus 1 pt Sevin	3 oz Fruitone-N plus 1 pt Sevin	
Quinte		5.5 oz Amide Thin plus 1 pt Sevin		
R.I. Greening			3 oz Fruitone-N plus 1 pt Sevin	

Table 11.6.2. Recommendations for thinning specific apple varieties in New England.

The chemicals and rates suggested in this table are the "best suggestion" of the authors for mature trees with a heavy fruit set and "normal" fruit thinning weather. Our rates should be adjusted up or down by 50% depending on weather conditions, pollination, fruit set and tree sensitivity. Other chemicals, rates, timings and combinations may also work.

	APPLICATION TIMING			
	50% Full Bloom	Petal Fall (1 week after bloom)	8-14 mm fruit size (2-3 weeks after bloom)	Return Bloom Enhancer (4-6 weeks after bloom)
VARIETY	*Rates are per 100 gallons based on a full dilute TRV application**			
Rome Beauty (Non Spur)			2 oz Fruitone-N plus 1 pt Sevin	
Rome Beauty (Spur)		2 oz Fruitone-N plus 1 pt Sevin	3 oz Fruitone-N plus 1 pt Sevin **OR** 64 oz 6-BA plus 1 pt Sevin	
Spartan and Acey Mac		2 oz Fruitone-N plus 1 pt Sevin	3 oz Fruitone-N plus 1 pt Sevin **OR** 64 oz 6-BA plus 1 pt Sevin	
Stayman			2 oz Fruitone-N plus 1 pt Sevin	
Tydeman			2 oz Fruitone-N plus 1 pt Sevin	
Vista Bella			2 oz Fruitone-N plus 1 pt Sevin	
Wealthy			3 oz Fruitone-N plus 1 pt Sevin	
Yellow Newtown			3 oz Fruitone-N plus 1 pt Sevin	
Yellow Transparent		5.5 oz AmideThin plus 1 pt Sevin		

*To convert to alternative formulations of NAA use tables11.6.3-11.6.7. All rates are amounts per 100 gal assuming a full dilute tree row volume (TRV) spray. Rate per acre = amount/hundred gallons X hundreds of gallons per acre TRV dilute. Tree Row Volume dilute gallonage (TRV)= (Tree Height X Tree Width X 43560 X 0.7) / (Between Row Spacing X1000). The rate per acre may safely be concentrated 3X.

Table 11.6.3 Conversion of ppm Maxcel or RiteWay BA thinners to fluid ounces for various TRV gallonages.

Dilute	PPM Maxcel					
Gallonage	25	50	75	100	125	150
per Acre	Fluid ounces per acre[1]					
50	8	16	24	32	40	48
100	16	32	48	64	80	96
150	24	48	72	96	120	144
200	32	64	96	128	160	192
250	40	80	120	160	200	240
300	48	96	144	192	240	288
350	56	112	168	224	280	
400	64	128	192	256		

[1]To convert fluid ounces to milliliters, multiply fluid ounces by 29.57.

Table 11.6.4. Conversion of ppm Exilis Plus to fluid ounces for various TRV gallonages.

Dilute	PPM Maxcel					
Gallonage	25	50	75	100	125	150
per Acre	Fluid ounces per acre[1]					
50	7.5	15	22.5	30	37.5	45
100	15	30	45	60	75	90
150	22.5	45	67.5	90	112.5	135
200	30	60	90	120	150	180
250	37.5	75	112.5	150	187.5	225
300	45	90	135	180	225	270
350	52.5	105	157.5	210	262.5	
400	60	150	180	240		

1To convert fluid ounces to milliliters, multiply fluid ounces by 29.57.

Table 11.6.5. Conversion of ppm Fruitone N to ounces (lb.) for various dilute TRV gallonages.

Dilute	PPM Fruittone N				
Gallonage	2.5	5	7.5	10	12.5
per Acre	Ounces (lb.) per acre*				
50	0.5	1	1.5	2	2.5
100	1	2	3	4	5
150	1.5	3	4.5	6	7.5
200	2	4	6	8	10
250	2.5	5	7.5	10	12.5
300	3	6	9	12	15
350	3.5	7	10.5	14	17.5
400	4	8	12	16	20

*To convert ounces (lb) to grams, multiply fluid ounces by 28.3.

Table 11.6.6. Conversion of ppm of Amide-Thin W to ounces (lb.) for various dilute TRV gallonages.

Dilute	PPM Amide-Thin W				
Gallonage	10	20	30	40	50
per Acre	Ounces (lb.) per acre*				
50	0.8	1.6	2.4	3.2	4
100	1.6	3.2	4.8	6.4	8
150	2.4	4.8	7.2	9.6	12
200	3.2	6.4	9.6	12.8	16
250	4	8	12	16	20
300	4.8	9.6	14.4	19.2	24
350	5.6	11.2	16.8	22.4	28
400	6.4	12.8	19.2	25.6	32

* To convert ounces (lb) to grams multiply, ounces by 28.3.

Table 11.6.7. Conversion of ppm of Ethrel to fluid ounces for various dilute TRV gallonages.

Dilute	PPM Ethrel			
Gallonage	150	300	450	600
per Acre	Fluid ounces per acre*			
50	4	8	12	16
100	8	16	24	32
150	12	24	36	48
200	16	32	48	64
250	20	40	60	80
300	24	48	72	96
350	28	56	84	112
400	32	64	96	128

*To convert fluid ounces to milliliters, multiply fluid ounces by 29.57.

Table 11.6.8. Conversion of lb. a.i. of Sevin XLR Plus or Sevin 4F to fluid ounces for various dilute TRV gallonages.

Dilute	lb. ai. of Sevin XLR Plus or Sevin 4F			
Gallonage	0.25	0.5	0.75	1.0
per Acre	Fluid ounces per acre*			
50	4	8	12	16
100	8	16	24	32
150	12	24	36	48
200	16	32	48	64
250	20	40	60	80
300	24	48	72	96
350	28	56	84	112
400	32	64	96	128

*To convert fluid ounces to milliliters, multiply fluid ounces by 29.57.

11.7 Other Growth Regulator Uses In Apples In New England

In addition to their use in chemical thinning, growth regulating chemicals are also used in apple production to modify tree growth and fruit development. Since growth regulating chemicals are not highly mobile, good spray coverage and good uptake of the chemical are essential for proper response.

11.8 Growth Regulator Chemicals Registered in New England

Apogee (prohexadione-calcium) is a growth regulator that reduces vegetative growth by inhibiting the synthesis of gibberellins, which are naturally occurring plant hormones that control cell elongation. Growers can expect about a 40–50% reduction in terminal growth from Apogee.

Apogee also limits fire blight development in apple shoots but will not protect against blossom blight infection. Although Apogee has no pesticidal activity on the fire blight bacteria itself, it affects the development of the shoot blight by altering the metabolism of the tree and by causing a cessation of shoot growth, which in turn makes the shoots less susceptible to fire blight development. In order to get the maximum benefit in growth reduction and fireblight protection, it is important to make the first application when shoots are 1–3 inches long. This means Apogee must be applied near petal fall to have a large effect on shoot growth. Later applications will be less effective at stopping shoot growth. The onset of shoot growth control and resistance against shoot fire blight infections develops 10 to 14 days after treatment. Thus, apple trees must be treated in a protective manner before shoot blight symptoms develop. After resistance is acquired, it should last from 4–6 weeks. To maintain fire blight protection, a second spray is required if shoots begin to grow again. A low dose provides growth controls for only about 3–4 weeks, while a high dose controls growth for 6–8 weeks. Two to three applications will be required to achieve season-long growth control in most New England orchards.

Apogee-treated apple trees often set more fruit than untreated trees It may also be necessary to adjust thinning strategy to remove more fruit. This may mean using an increased dosage (30–50%) of a chemical thinner, using more aggressive thinner combinations or multiple applications of chemical thinners to achieve desired crop load and fruit size.

Ethephon (Ethrel) is a growth regulator that stimulates ethylene production by the plant. It can be used to thin apple and improve flower bud development when used within a few weeks of bloom, and to improve fruit color and advance fruit maturation when used near harvest. Its use near harvest significantly reduces fruit storage life and shelf life, and can cause excessive fruit drop if fruits are not harvested within 10 days after application

Naphthaleneacetic acid (NAA) is an auxin-type growth regulator that can induce fruit thinning early in the season and reduce fruit drop late in the season. At very high rates, it can stop the development of watersprouts and rootsuckers. Its use as a chemical thinner is described in the thinning section. Its primary use as a growth regulator is to reduce preharvest drop. When it is used to reduce drop, it does not delay ripening, which may result in overripe fruit that have a shorter storage life if harvest is delayed. The level of drop control depends on rate, with 20 ppm giving better control than 10 ppm; however, the higher rate also advances ripening and may shorten fruit storage life.

The use of NAA to control watersprouts and rootsucker is with a formulation that is more active (Tre-Hold) and at rates 1,000 times that of its use as a chemical thinner or for drop control. The Tre-Hold formulation must never be used for thinning or drop control.

BA/GA (Promalin, Perlan, Ritesize or Typy) are growth regulators containing a combination of equal parts of benzyl adenine (a cytokinin) and GA 4+7 (gibberellins). They are used to stimulate growth of fruits and/or lateral branches. Their primary effect on fruit growth is to increase the length:width ratio (typiness) of the fruit. Their primary use is with Delicious, where typiness can be an important marketing advantage. They have their best effect on typiness in a narrow timing window when king blooms are open. At later timings and at high rates, they can cause fruit thinning. The best response is obtained when temperatures are warm (>70° F) and the spray is applied as a fine mist in 50–100 gallons of water.

BA/GA is also used to induce lateral branching of nursery trees and young orchard trees, but at rates of 5–10 times those used to increase typiness. Applications are made on nursery trees when the tree is 26–32” high (mid-June), while on orchard trees, applications are made earlier, when shoots are 1–2” long (near bloom). BA/GA can also be applied at bud break by painting or spraying it on the swollen buds.

GA 4+7 (Provide, Novagib) are commercial formulations of gibberellins A4+7. They are used on apples to reronduce fruit russeting. Russeting is associated with high humidity early in the season and certain strains of yeast. Certain fungicides such as captan and polyram reduce russeting by controlling these strains of yeast, but it is unclear how GA 4+7 reduces russeting. The use of several early season sprays of GA 4+7 beginning at petal fall have been shown to be effective. The most susceptible varieties to russeting are: Golden Delicious, Fuji, Rome, Cortland, Idared, Crispin and Jonagold. The use of GA 4+7 may interact with the use of other growth regulators such as Apogee, since GA 4+7 is a gibberellin and Apogee inhibits synthesis of gibberelins.

ReTain is a commercial formulation of aminoethoxy-vinylglycine (AVG). It is used to reduce preharvest drop and to delay harvest. It acts by inhibiting the synthesis of ethylene in the plant. Since ethylene production by the fruit increases dramatically as fruits ripen, ReTain must be applied before fruits are mature to hold ethylene production in check. The label suggests 3-4 weeks before normal harvest. Application of ReTain 2 weeks before anticipated harvest has the advantage of extending drop control later into the season. Application at this timing is permitted since the preharvest interval is 1 week. It requires 10 to 14 days for ReTain to initiate drop control, so there is the possibility of some drop occurring before drop control can be initiated. ReTain will generally delay harvest and fruit drop by 7–10 days, thus giving growers flexibility with harvest date. ReTain also delays other aspects of fruit ripening such as color development, starch degradation and firmness loss, but if harvest is delayed 7–10 days, ReTain-treated fruits achieve normal color and maturity.

Table 11.8.1. Growth regulator uses in apples.

Timing	Product	Concentration	Rate of Formulated Product
CONTROL OF WATERSPROUTS AROUND PRUNING CUTS			
Dormant	Tre-Hold A112	10,000 ppm	10 fl oz/1 gal
	Tre-Hold RTU (NAA)	1.5% (15,000 ppm) (Do not dilute)	Ready-to-use product
Mix NAA with 2 pt latex paint/gal and apply any time after dormant pruning but before growth begins in spring. Apply with paint brush or cloth pad to thoroughly coat exposed wood and edges of bark around pruning cuts.			
CONTROL OF ROOTSUCKERS			
Dormant or 6-12" Sucker height	Tre-Hold A112	10,000 ppm	8 gal/100 gal
	Tre-Hold RTU (NAA)	1.5% (15,000 ppm) (Do not dilute)	Ready-to-use product
Apply during dormant season after pruning existing suckers and before resprouting, or apply when new sprouts are 6 –12" high. Thorough wetting of stubs or new sprouts is essential.			
IMPROVE SHAPE (TYPINESS) OF DELICIOUS APPLE FRUITS			
Early King Bloom to 50% Bloom	Promalin, Perlan, Typy	25-50 ppm	1-2 pt/100 gal
Apply as a fine mist using 50–100 gallons/acre. Do not apply more than 2 pt/acre. Fruit thinning may occur at high rates. Use of a surfactant increases both typiness and thinning responses.			
INDUCTION OF LATERAL BRANCHING IN YOUNG TREES			
1-2" of Terminal Shoot Growth	Promalin	125-500 ppm	0.25-1 pt/5 gal
Include a non-ionic surfactant and apply as a directed spray to areas where additional branching is desired. This practice is more effective in the second and third growing seasons after planting. Response on weak or low-vigor trees is usually disappointing.			
VEGETATIVE GROWTH CONTROL / FIRE BLIGHT SUPPRESSION			
1-3 inches of new growth (Late bloom-early petal fall	Apogee	62.5-250 ppm	2.75-9 oz (lb)*/100 gal

The first application should be made as soon as shoot growth begins with a second spray 2-3 weeks after the first. In some cases a third application may be required. Unless Apogee is applied for fire blight control, we do not recommend initial application greater than 4 oz/100 gal. of ai. The second and third applications should be at the 2 to 3 oz/100 gal rates. Do not apply more than 48 ounces of Apogee per acre within any 21-day interval, and a max of 99 oz of Apogee per acre per season. Always use a surfactant and a water conditioner such as ammonium sulfate, Choice or Quest (these products control "hard water" deactivation of Apogee). Do not tank-mix with sprays containing calcium. Use of Apogee may necessitate use of increased chemical thinning to achieve desired crop load. Apogee must be applied well in advance of the appearance of fire blight symptoms to be effective for fire blight suppression. To control vigor in only the top of the tree, directed sprays to the top of the tree.

Timing	Product	Concentration Product	Rate of Formulated Product
INDUCTION OF LATERAL BRANCHING IN NURSERY TREES			
When Terminal Shoot is 26-32" long	Promalin	125-500 ppm	0.25-1 pt/5 gal

Include a non-ionic surfactant and apply as a directed spray to areas where additional branching is desired when terminal shoot is at the height where branches are desired.

SUPPRESSION OF "PHYSIOLOGICAL" FRUIT RUSSETING			
Petal Fall	Pro-Vide 2% Liquid	15-20 ppm	10-13 fl oz/acre
	Pro-Vide 10 SG	15-25ppm	60-100 g/acre

Apply 2-4 applications beginning at petal fall and continuing at 7-10 day intervals. Spray at 100 gallons per acre. Max of 40 oz of ProVide per season. Do not use a surfactant when applying Pro-Vide.

REDUCE CRACKING OF STAYMEN APPLES			
July	Pro-Vide	25-50 ppm	8-16 fl oz/100 gal

Apply 3-6 applications every 14-21 days beginning 2-3 weeks before fruit cracking is likely. If used to reduce russetting, it may not be used for cracking control.

INCREASED FLOWER BUD DEVELOPMENT			
NON BEARING TREES **2-4 weeks after full bloom**	Ethrel	300-450 ppm	1-1.5 pt/100 gal
BEARING TREES			
4-6 weeks after full bloom	Ethrel or	150 ppm	1-1.5 pt/100 gal
	NAA	5ppm	2 oz (lb)*/100gal

Spray trees with enough water to uniformly cover the canopy. Apply 3-4 weekly applications. Avoid use of Ethrel on Macoun, Honeycrisp and McIntosh due to advanced ripening.

PREHARVEST FRUIT-DROP CONTROL			
3-4 weeks before anticipated harvest	Re-Tain	130 ppm	0.74 lb/acre or 333g/acre or 1 pouch

Apply in sufficient water to ensure thorough but not excessive coverage. For mature trees, this should be 100 gal/acre. An organosilicone surfactant (12 oz/100 gal) should be used with ReTain. In hot years apply Retain at least 4 weeks before harvest. In cooler years apply ReTain 3 weeks before anticipated harvest. Application 2 weeks before anticipated normal harvest is an option where drop control is desired for an extended period of time.

Drop of first Sound Fruit	Fruitone N	10-20 ppm	4-8 oz (lb)* / 100 gal

Varieties such as McIntosh which are highly prone to preharvest drop require careful monitoring to determine when fruit drop is beginning. Limb-tapping should be used to help determine the onset of drop as fruit near maturity. Approximate duration of drop control varies with dosage: 10 ppm = 6 days; 20 ppm = 10 days. Do not make more than 2 applications. High rates of NAA advance fruit maturity and may shorten fruit storage life.

PROMOTE FRUIT COLORING, PROMOTE UNIFORM RIPENING, ADVANCE FRUIT MATURATION			
2-3 weeks before normal harvest	Ethrel	75-300 ppm	0.25-1 pt / 100 gal

If fruit is to placed in CA storage then harvest should be done 7 days after application. If fruit is to be left on the tree longer than 7 days after application of Ethrel then apply NAA at 10-20 ppm 3 days after Ethrel application to help control preharvest drop. Ethrel will cause excessive fruit preharvest drop about 10 days after application if NAA is not used. Any delay in harvest or cooling of fruit treated with Ethrel will result in unacceptable softening and short storage life.

*To convert ounces (lb) to grams, multiply ounces by 28.3. To convert fluid ounces to milliliters, multiply fluid ounces by 29.57.

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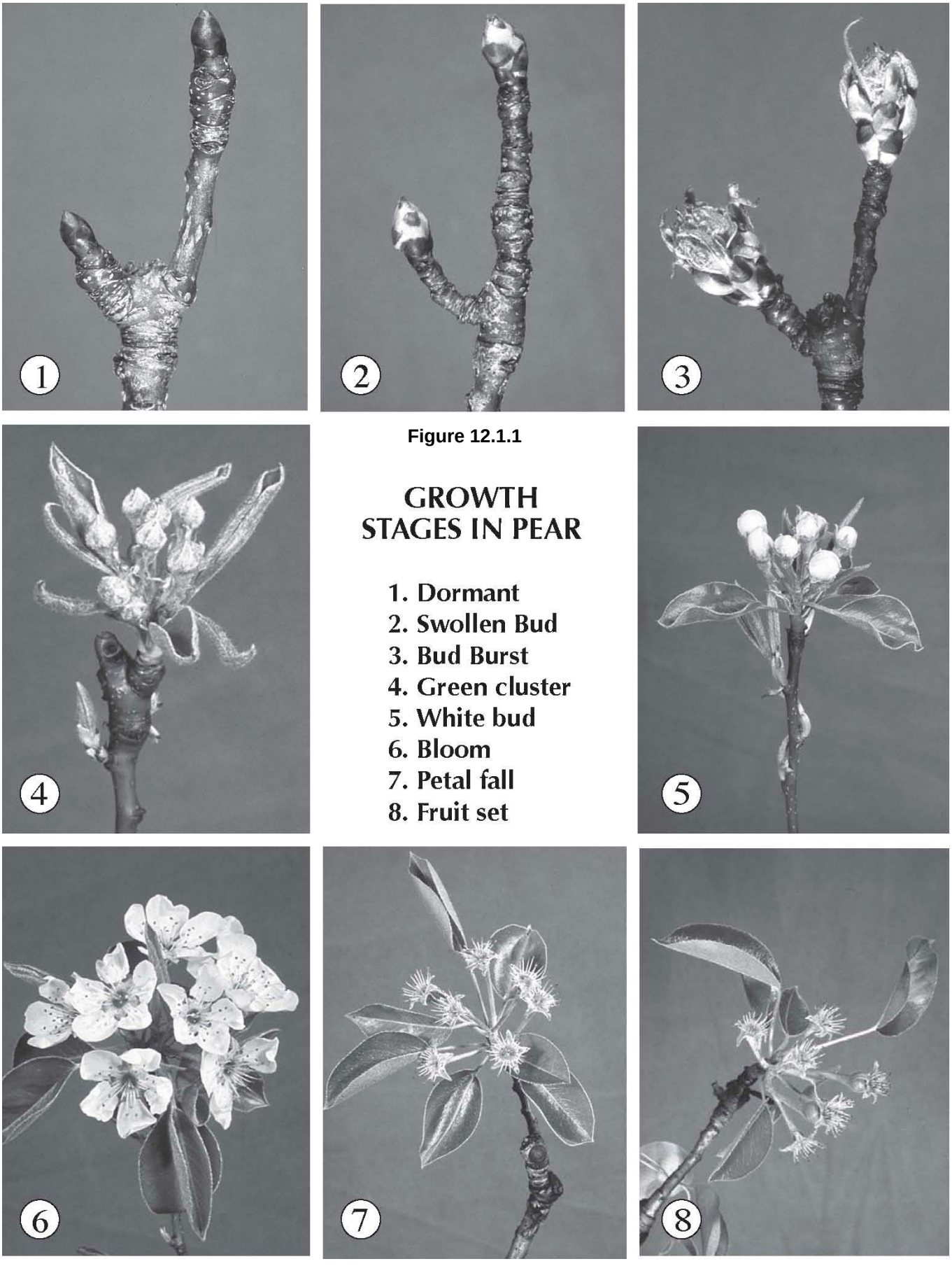
1
2
3
4
GROWTH
STAGES IN PEAR
1. Dormant
2. Swollen Bud
3. Bud Burst
4. Green cluster
5. White bud
6. Bloom
7. Petal fall
8. Fruit set
5
6
7
8

Figure 12.1.1

12 General Pest Management Considerations – Pears

12.1 Diseases

Fabraea Leaf Spot

• Biology & Cultural

[1.1] Bosc and Seckel are much more susceptible than Bartlett.

• Pesticide Application Notes

[1.2] It is important to prevent the establishment of early primary infections. Sprays should start at green cluster if the year is wet and disease was prevalent last year; otherwise, wait until white bud. Continue sprays at 10- to 14-day intervals through 1st or 2nd cover. In orchards with high inoculum, apply a mancozeb spray at 7-day intervals after petal fall until reaching either the 77-day PHI or the limit on the number of sprays per season. A 3-wk summer spray schedule will normally maintain control if early infections have been prevented. Summer applications of Sovran, Flint or Pristine to control scab or sooty blotch should also control Fabraea leaf spot. For resistance management, do not apply more than four applications per year of Sovran (Group 11), Flint (Group 11), Pristine (Group 7+11) or those with similar modes of action. Do not make more than two sequential applications before alternating to a fungicide with another mode of action. Pear psylla may facilitate the spread of leaf spot during summer, so controlling psylla is important in high-pressure orchards. Using summer oils to suppress pear psylla may also suppress spread of Fabraea leaf spot during late summer.

Fire Blight

• Biology & Cultural

[2.1] Fire blight is an even more serious disease on pears than it is on apples. In general, the control strategies recommended for apples apply equally to pears. Bartlett, Bosc, Clapps Favorite, and Gorham are all extremely susceptible varieties. D'Anjou is slightly less susceptible, but comparable to the most highly susceptible apple variety; Seckel is considered moderately susceptible. Refer to the discussion of this disease in the "General Pest Management Considerations for Apples" section.

[2.2] The best program for reducing summer spread of fire blight is good psylla control.

Refer to the reference materials list at the end of this publication for a Fact Sheet containing more details on the biology and management of this pest. Also see Pear Psylla in this section.

• Pesticide Application Notes

[2.3] While specifically labeled for control of pseudomonas blight, a copper spray also will assist with control of fire blight. However, it will not eliminate the need for streptomycin at bloom. It is effective in reducing the population of overwintering fire blight bacteria, and is a useful component in an overall fire blight control program. Thorough coverage of the entire tree is necessary for maximum effectiveness, so high-gallonage sprays are preferred. Leaf burning may occur if applied beyond bud burst, especially under slow drying conditions. The oil should be added at a rate of 1 qt per 100 gal of actual spray solution in the tank (i.e., do not concentrate the oil). If using Bordeaux mix, prepare as described in the "Fungicides"section of "Characteristics of Crop Protectants." Add the oil after adding lime, but before making up to volume. The 1 qt of oil is added to increase the efficiency of the copper compounds and is not sufficient for good psylla control. A separate oil application can be made for psylla, or 3 gal of oil can be used with the copper sprays. Several other commercial copper formulations in addition to those listed are labeled for this use on pears. Although they have not been tested, research on other crops suggests that most copper formulations should give comparable rates of control at comparable rates of metallic copper.

[2.4] Streptomycin is not recommended for routine summer use, but is strongly recommended for use within 24 hr after the start of a hail storm.

Pear Scab

• Biology & Cultural

[3.1] Seckels are very susceptible to scab; Bosc and D'Anjou, somewhat less so; Bartlett is relatively resistant.

• Pesticide Application Notes

[3.2] If scab developed the previous year, sprays should begin at green cluster and continue at 7- to 10-day intervals through 2nd cover. In blocks with little history of scab, applications from white bud through 1st cover should provide sufficient protection. Additional cover sprays will be necessary if scab becomes established and the season remains wet. Use of Topsin M and Thiophanate-methyl should be limited during the early season if substantial use is anticipated later in the season for control of sooty blotch and Fabraea leaf spot. Note: Topsin M and Thiophanate-methyl have a 3-day (72 hr) REI.

[3.3] Mancozeb fungicides are more effective than ferbam or ziram. Mancozeb is labeled for use on pears in one of two different ways: (i) at a rate of 1.5–2 lb/100 gal (maximum 6 lb/A, no more than 24 lb/A per year), not to be applied after bloom; OR (ii) at a reduced rate of 3 lb/A (maximum 21 lb/A per year), which may be applied to within 77 days of harvest.

The latter program is particularly valuable where Fabraea leaf spot and sooty blotch must be controlled in the early summer. It is illegal to combine or integrate the two treatment regimes or to use any mancozeb sprays after bloom if any of the earlier sprays were applied at more than 3 lb/A of formulated product.

[3.4] Sovran and Flint are excellent protectants, and will be most reliable when used in this manner. They

have 48–72 hr post infection activity against pear scab. They significantly reduce spore production from the lesions that develop when the fungicides are applied several days after the start of an infection period. Sovran, Flint and Pristine are not registered for control of Fabraea leaf spot but they should control leaf spot when applied during the summer. They provide good control of black rot on apples, but they are not registered for control of this disease on pears and experience with control of black rot on pears is lacking. The strobilurins are prone to resistance development, and it appears that resistance to one member of this class of materials confers resistance to other products in the class (cross-resistance). The primary strategies for reducing the resistance risk are to: (i) rotate these materials with unrelated fungicides; and (ii) limit the number of seasonal applications of a strobilurin (the labels say limit to four per year).

CAUTION: Sovran has caused moderate to severe phytotoxicity (leaf burning) on several sweet cherry varieties when applied directly onto them at high labeled rates. The *most sensitive varieties are: Somerset, Sweetheart, Valera, Van, and Vandalay;* these varieties might also be injured by spray drift containing Sovran. Minor to moderate injury occurred on Cavalier, Coral Champagne, Emperor Francis, Royalton, Schmidt, Summit, and Viva; there is less danger of injury due to spray drift on these varieties. Many other sweet and sour cherry varieties (including Bing, Brooks, Cashmere, Gold, Hardy Giant, Hartland, Hedelfingen, Hudson, Kristin, Lapins, Lambert, Montmorency, Napoleon, Nelson Black Sweet, Rainier, Royal Ann, Sam, Stark Crimson, Stella, Sue, Tehranivee, Tulare, Ulster, Vega, Vic, Viscount, and Windsor) showed no injury when applied directly with high labeled rates. The Sovran manufacturer recommends: (i) Do not apply Sovran near or allow drift onto cherries in the highly sensitive group (Somerset, etc.); and (ii) thoroughly rinse spray equipment (tanks, hoses, nozzles) after spraying Sovran and before using this equipment on sensitive cherry varieties.

[3.5] Note that Rubigan is not labeled until petal fall (potential fruit shape problems if used earlier). Rubigan has 72–96 hr postinfection activity but limited protectant activity. It should be combined with mancozeb to improve fruit scab control and protect against other diseases such as sooty blotch and Fabraea leaf spot. Note the mancozeb restrictions listed in [3.3].

[3.6] The risk of primary scab is greatly reduced after 1st or 2nd cover. Where scab has been well controlled and there is no history of leaf spot problems, it is possible to extend fungicide spray intervals to 14–21 days after the 3rd cover has been applied. If these diseases have not been controlled, fungicides should be applied at 10- to 14-day intervals throughout the summer, except during drought periods. Observe mancozeb restrictions detailed in [3.3].

Sooty Blotch

• Biology & Cultural

[4.1] Sooty blotch develops gradually during periods of rain, dew, and very high humidity. The disease is favored by frequent showers, poor air circulation, and proximity to sources of inoculum such as woods and brushy hedgerows. Fungicide control programs should begin around 1st cover, depending upon weather and inoculum pressure. Pruning to improve air circulation through the canopy will reduce the total fungicide need in most years. See [3.3] above, and remark [10.1] in the General Pest Management Considerations for Apples section for additional information about sooty blotch.

12.2 Insects and Mites

Aphids, Including Spirea Aphid

• Pesticide Application Notes

[5.1] Do not exceed 2 applications of *Thionex per season.

[5.2] *Calypso applied at petal fall will also control Comstock mealybug.

Codling Moth

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Pesticide Application Notes

[6.1] Summer sprays should be timed to start approximately at the 10% hatch point, 175–200 DD (base 45°F) after the first adult catch of the second brood, with a second application in 10–14 days. Use of a non-ionic surfactant is recommended with Assail. Pyrethroid insecticides applied during summer against pear psylla will control codling moth. If Guthion is applied, the user shall not authorize any person who is not covered by the Worker Protection Standard (WPS), such as members of the general public involved in "pick-your-own," to enter a treated area after application of this product for the entire growing season Suggested action threshold: when commercial trap catch exceeds that in abandoned orchard and night temperature is at least 55°F.

• Biological Control

Carpovirusine and Cyd-X (granulosis virus) registered only in Vermont at this time. Isomate C (pheromone mating disruption) only registered in Vermont and Maine.

Comstock Mealybug

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Pesticide Application Notes

[7.1] Sprays recommended at petal fall and 7d later, against newly emerged crawlers. Research suggests that treatments against 2nd generation crawlers are more

effective, but petal fall sprays may be of use in keeping populations low. Actara and *Calypso will also control plum curculio and pear psylla when applied at petal fall. Do not make more than one application of Actara per season. A maximum of two applications of diazinon are allowed per year: 1) a maximum of one as a dormant application and 2) a maximum of one as an in-season foliar application regardless of target pest.

[7.2] Two sprays recommended for the 2nd generation, 7 days apart, against newly hatched crawlers. Begin approximately Aug. 1. Do not make more than one application of Actara per season. Suggested action threshold: 5% calyx infestation of previous year's crop.

European Red Mite, Twospotted Spider Mite

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Pesticide Application Notes

[8.1] Applications advised as needed in summer. Acramite and Apollo are not effective against rust mite. Kanemite and Portal limited to a maximum of 2 applications per season; not registered for pear rust mite. Use 10.7 oz/A of Nexter if treatment is only for twospotted spider mite; use lower rate for European red mite. Nexter, Savey, Onager, Envidor and Acramite limited to 1 application per season. Pear psylla may also be controlled if Portal is used at the 2 pt/A rate or if Nexter is used at the 6.6 oz/A rate. Suggested action threshold: 6 motile forms/leaf.

Green Fruitworms

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Pesticide Application Notes

[9.1] Growers can usually wait until petal fall to assess the need for treatment. Only 2 applications of *Lannate permitted per season. Lannate cannot be used after a "pick-your-own" site is opened for public entry. It is recommended that pyrethroids not be used more than 1–2 times per season in any orchard. Suggested action threshold: 3 larvae/tree on large trees (27–40 trees/A); 1 larva/tree at density of 140 trees/A.

Obliquebanded Leafroller

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest

• Pesticide Application Notes

[10.1] Spray recommended when last petals are falling. Only 2 applications of *Lannate permitted per season. Lannate cannot be used after a "pick-your-own" site is opened for public entry. Will also help control Comstock mealybug. A pyrethroid applied now against pear psylla will also control obliquebanded leafroller. Suggested action threshold: 5–10% infested clusters.

[10.2] For 1st summer brood in July, begin applications approximately 360 DD [base 43° F] after 1st adult trap catch. Only 2 applications of *Lannate permitted/season. Lannate cannot be used after a "pick-your-own" site is opened for public entry.

Pear Midge

• Pesticide Application Notes

[11.1] Two spray applications between the swollen bud and white bud stages. If Guthion is applied, the user shall not authorize any person who is not covered by the Worker Protection Standard (WPS), such as members of the general public involved in "pick-your-own," to enter a treated area after application of this product for the entire growing season.

Pear Psylla

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Pesticide Application Notes

[12.1] To inhibit egg-laying by psylla, apply oil as soon as first eggs are laid in the spring; timing is especially critical (not effective if >20% of spring oviposition has occurred). Make 2nd application in 7 days if adults are still present. If 2 sprays are anticipated, drop rate to 2 gal for both. The 3 gal rate can also help reduce overwintering populations of European red mite, pearleaf blister mite, and Comstock mealybug. Suggested action threshold for pear psylla: 1 egg in a 3-minute inspection of buds.

[12.2] Apply insecticide from swollen bud through white bud. Pear rust mite may build up with repeated pyrethroid use. Seasonal maximum for *Pounce is 0.8 lb a.i./A; for *Asana, up to 0.2 lb a.i./A during the dormant to white bud stage and up to 0.225 lb a.i./A between bloom and harvest (but no more than 0.375 lb total a.i./A per season). Esteem 35WP may be applied once prebloom at 5 oz/A, or once prebloom and once at petal fall at 4-5 oz/A. Warrior provides suppression only. Improved activity of Delegate may be obtained by addition of an adjuvant such as horticultural mineral oil. Suggested action threshold before white bud: 6–10% of spurs with eggs.

[12.3] M-Pede can provide suppression when used in a seasonal program. Uniform drying conditions are required to prevent droplet residue on fruit; short residual period.

[12.4] One spray of oil at 2 gal rate, or 2 sprays at 1 gal rate, recommended through tight cluster.

[12.5] Nexter limited to a maximum of 1 application per season. Esteem 35WP may be applied once prebloom at 5 oz/A, or once prebloom and once at petal fall at 4-5 oz/A. Suggested action threshold after fruit set: Avg of 1–2 nymphs per terminal leaf. *Agri-Mek can be used anytime from petal fall to about 4 weeks afterward, but is most effective when applied before foliage begins to harden off, generally within the first 2 weeks after petal fall. Should be applied in combination with a horticultural spray oil (not a dormant oil) or other penetrating surfactant. Improved activity of Delegate may be obtained by addition of an adjuvant such as horticultural mineral oil. Actara and *Calypso will also control plum curculio and Comstock mealybug when applied at petal fall. Do not make more than one application of Actara per season.

[12.6] Frequent applications (7–10-day intervals) of Surround and maximal coverage (minimum of 100 gal/A) are advised while there is active foliar growth.

• Pesticide Resistance

[12.7] Variable levels of pear psylla tolerance or resistance to pyrethroids have been seen in New York (and are likely in New England), so growers should alternate use of pyrethroids with other materials to delay the development of resistance in their orchards. The preferred strategy would be to withhold their use until (and unless) needed in the summer.

Pear Rust Mite

• Pesticide Application Notes

[13.1] In blocks with a history of rust mite infestations, a preventive petal fall spray might be advisable. Nexter limited to a maximum of 1 application per season. Also, see [8.1].

Pearleaf Blister Mite

• Pesticide Application Notes

[14.1] A spray of oil plus diazinon or oil plus *Thionex, in the spring, just before the green tissue begins to show. A maximum of two applications of diazinon are allowed per year: a maximum of one as a dormant application and 2) a maximum of one as an in-season foliar application regardless of target pest. See [12.1].

[14.2] A fall application post-harvest, when there is no danger of frost for at least 24-48 hr after the spray.

Plum Curculio

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Pesticide Application Notes

[15.1] Sprays recommended at petal fall and 10 days later. 1st brood codling moth is also controlled by these materials; (see [6.1] for 2nd brood control). Imidan also controls fruit tree leafroller. Actara will also control pear psylla and Comstock mealybug when applied at petal fall. Do not make more than one application of Actara per season.

Redbanded Leafroller

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Pesticide Application Notes

[16.1] Two sprays, from mid-July to early August, for 2nd brood control in problem blocks; note PHI restrictions. If Guthion is applied, the user shall not authorize any person who is not covered by the Worker Protection Standard (WPS), such as members of the general public involved in "pick-your-own," to enter a treated area after application of this product for the entire growing season.

Tarnished Plant Bug, Pear Plant Bug

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Pesticide Application Notes

[17.1] Recommended spray timing is from green cluster to white bud. . If Guthion is applied, the user shall not authorize any person who is not covered by the Worker Protection Standard (WPS), such as members of the general public involved in "pick-your-own," to enter a treated area after application of this product for the entire growing season.

Suggested action threshold: plant bugs—3 bleeding sites/tree, or a cumulative catch of 7 adults by white bud stage (white sticky-board trap). See [12.7].

12.3 Pear Spray Table

Table 12.3.1. Pesticide Spray Table – Pears
Refer to back of book for key to abbreviations and footnotes.

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Dormant						
Fire blight and Pseudomonas spur blight		§Bordeaux mixture, 8-8-100				[2.3]
		(copper sulfate)	8 lb/100 gal	24	BL	
		(spray lime)	8 lb/100 gal			
	plus	§oil	1 qt/100 gal			
	OR	§C-O-C-S	2-4 lb/100 gal	24	BL	
	OR	§Cuprofix Ultra 40 Disperss	7.5 – 10 lb./A	12	GT	
	OR	§Kocide 2000	2-4 lb/100 gal	24	HIG	
		or other coppers	see comments			
Pear psylla, European red mite		§oil	3 gal/100 gal	12	0	[12.1]
Pearleaf blister mite		oil	1-1.5 gal/100 gal			[14.1]
	plus	*Diazinon 50WP	1 lb/100 gal	96	21	
	OR	oil	1-1.5 gal/100 gal			
	plus	*Thionex 50WP	0.5-1 lb/100 gal	96	7	
Swollen Bud						
Pear midge		*Guthion 50WS	0.5-0.75 lb/100gal	14 days (E)	14	[11.1]
Pear psylla		Actara 25WDG	5.5 oz/A	12	35	[12.2]
	OR	*Asana XL 0.66EC	7.3-12.8 fl oz/100 gal	12	28	
	OR	Assail 30SG	4.0-8.0 oz/A	12	7	
	OR	*Calypso 4F	1-2 fl oz/100 gal	12	30	
	OR	*Danitol 2.4EC	16-21.3 fl oz/A	24	14	
	OR	Delegate 25WG	6.0-7.0 oz./A	4	7	[12.2]
	OR	Esteem 35WP	4-5 oz/A	12	45	
	OR	§M-Pede 49L	2 gal/100 gal	12	0	[12.3]
	OR	§oil	1-2 gal/100 gal	12	0	[12.4]
	OR	*Pounce 3.2EC	8-16 fl oz/A	12	PB	
		or *Pounce 25WP	12.8-25.6 oz/A			
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	21	
	OR	§Surround 95WP	50 lb/A	4	0	[12.6]
	OR	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	[12.2]
		or Warrior II 2.08 CS	1.28-2.56 fl. oz/A	24	21	
Green Cluster						
Fabraea leaf spot		Same materials as recommended for pear scab				[1.2]
Pear scab		Topsin M 70WSB	4 oz./100 gal	72	1	[3.2]
		or Thiophanate-methyl 85WDG	3.2 oz./100 gal	72	1	
		or Rubigan 4EC	4 fl oz./100 gal			
		or Procure 50WP	4 oz./100gal			
		or Inspire Super MP				

Table 12.3.1. Pesticide Spray Table – Pears
Refer to back of book for key to abbreviations and footnotes.

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Pear scab *(continued)*	*plus*	Dithane/*Manzate/ Penncozeb 75DF	1 lb/100 gal	24	BL, 77 (A)	[3.3]
	OR	Dithane/*Manzate/ Penncozeb 75DF	1-2 lb/100 gal	24	BL, 77 (A)	[3.3]
	OR	Ziram 76DF	1.5-2 lb/100 gal	48	14	
Pear Midge		*Guthion 50WS	0.5-0.75 lb/100 gal	14 days(E)	14-21(A)	[11.1]
Tarnished plant		*Asana XL 0.66EC	2-5.8 oz/100 gal	12	28	[17.1]
bug, Pear plant bug	*OR*	*Baythroid XL 1E	2.0-2.4 fl oz/A	12	7	
	OR	Beleaf 50SG	2.0-2.8 oz/A	12	21	
	OR	*Brigade 10WS	6.4-32 oz/A	12	14	
	OR	*Danitol 2.4EC	16-21.3 fl oz/A	24	14	
	OR	*Guthion 50WS	0.5-0.75 lb/100 gal	14 days(E)	14-21(A)	
	OR	Leverage2.7SE	3.6-4.4 fl oz/A	12	7	
	OR	*Pounce 3.2E	8-16 fl oz/A	12	PB	
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	21	
	OR	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	
		or Warrior II 2.08 CS	1.28-2.56 fl oz/A	24	21	
White Bud						
Fabraea leaf spot		See Green Cluster sprays				
Pear scab		Choose from materials listed under Green Cluster				
	OR	Flint 50WG	0.67-0.8 oz/100 gal	12	14	[3.4]
	OR	Sovran 50WG	1.0-1.6 oz/100 gal	12	30	
Pear psylla		See Swollen Bud sprays				[12.2, 12.4]
Bloom						
Fire blight		§Agri-mycin 17WP or Streptrol 17WP or Firewall 17WP	0.5 lb/100 gal	12	30	[2.1]
	OR	§Agri-mycin 17WP or Streptrol 17WP or Firewall 17WP	0.25 lb/100 gal	12	30	
	plus	Glycerine (CP or USP grade) or Regulaid	2 qt/100 gal 0.25 pt/100 gal			
Pear scab, Fabraea leaf spot		Choose from materials listed previously				
Petal Fall						
Pear scab,		Choose from materials listed previously				
Fabraea leaf spot	*OR*	Rubigan 1EC	3 fl oz/100 gal	12	30	[3.5]
	plus	Dithane/*Manzate/Penncozeb 75DF	1 lb/100 gal	24	BL/77(A)	[3.3]
Aphids, including		Assail 30SG	2.5-4.0 oz/A	12	7	
spirea aphid	*OR*	§Aza-Direct 1.2L	16-32 fl oz/A	4	0	

Table 12.3.1. Pesticide Spray Table – Pears
Refer to back of book for key to abbreviations and footnotes.

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Aphids, including	*OR*	Beleaf 50SG	2.0-2.8 oz/A	12	21	
spirea aphid	*OR*	*Calypso 4F	1-2 fl oz/100 gal	12	30	[5.2]
(continued)	*OR*	*Dimethoate 4EC	0.5 pt/100 gal	48	28	
	OR	*Leverage 2.7SE	3.6-4.4 fl oz/A	12	7	
	OR	§M-pede 49L	1-2 gal/100gal	12	0	
	OR	*Provado 1.6F	5 fl oz/100 gal	12	7	
	OR	*Thionex 50WP	1 lb/100 gal	96	7	[5.1]
Comstock mealybug		Actara 25WDG	4.5-5.5 oz/A	12	35	[7.1]
	OR	Assail 30SG	4.0-4.8 oz/A	12	7	
	OR	*Calypso 4F	1-2 fl oz/100 gal	12	30	
	OR	*Diazinon 50WP	1 lb/100 gal	96	21	
	OR	*Provado 1.6F	5 fl oz/100 gal	12	7	
Green fruitworms		*Asana XL 0.66EC	2-5.8 fl oz/100 gal	12	28	[9.1]
	OR	*Assail 30SG	4.0-8.0 oz/A	12	7	
	OR	Baythroid XL 1E	1.4-2.0 fl oz/A	12	7	
	OR	*Lannate 2.4L	0.75 pt/100 gal	48-96(E)	7	
	OR	*Leverage 2.7SE	3.0-3.6 fl oz/A	12	7	
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	21	
	OR	*Proclaim 5SG	0.8-1.2 oz/100 gal	12	14	
	OR	*Thionex 50WP	1 lb/100	96	7	
		or Thionex 3EC	21.3 oz/100 gal	48	7	
	OR	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	
		or Warrior II 2.08 CS	1.28-2.56 fl oz/A	24	21	
Pear psylla		Actara 25WDG	5.5 oz/A	12	35	[12.5]
	OR	*Agri-Mek 0.15EC	2.5-5.0 fl oz/100 gal	12	28	[12.5]
	OR	*Asana XL 0.66EC	2.0-5.8 fl oz/100 gal	12	28	
	OR	Assail 30SG	4.0-8.0 oz/A	12	7	
	OR	*Calypso 4F	1-2 fl oz/100 gal	12	30	
	OR	*Danitol 2.4EC	16- 21.3 fl oz/A	24	14	
	OR	Delegate 25WG	6.0-7.0 oz./A	4	7	[12.5]
	OR	Esteem 35WP	4-5 oz/A	12	45	
	OR	§M-Pede 49L	1-2 gal/100 gal	12	0	
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	21	
	OR	*Provado 1.6F	20 fl oz/A	12	7	
	OR	Nexter 75WS	6.6-10.7 oz/A	12	7	
	OR	§Surround 95WP	50 lb/A	4	0	
	OR	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	[12.2]
		or Warrior II 2.08 CS	1.28-2.56 fl oz/A	24	21	
Pear rust mite		*Agri-Mek 0.15EC	2.5-5.0 fl oz/100 gal	12	28	[13.1]
	OR	Nexter 75WS	5.2-10.7 oz/A	12	7	
	OR	*Vendex 50WP	6-8 oz/100 gal	48	14	

Table 12.3.1. Pesticide Spray Table – Pears
Refer to back of book for key to abbreviations and footnotes.

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Plum curculio		Actara 25WDG	4.5-5.5 oz/A	12	35	
	OR	*Asana XL 0.66EC	2.0-5.8 fl oz/100 gal	12	28	
	OR	*Baythroid XL 1E	2.4-2.8 fl oz/A	12	7	
	OR	*Brigade 10WSB	6.4-32 oz/A	12	14	
		or Brigade 2EC	2.6-12.8 fl oz/A	12	14	
	OR	*Guthion 50WS	0.5-0.75 lb/100 gal	14 days (E)	14-21 (A)	
	OR	*Imidan 70WP	0.75-1 lb/100 gal	72	7	
	OR	*Leverage 2.7SE	4.4-5.1 fl oz/A	12	7	
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	21	
	OR	§Surround 95WP	50 lb/A	4	0	[12.6]
	OR	*Warrior 1CS	2.6-5.1 fl oz/A	24	21	
		or Warrior II 2.08 CS	1.28-2.56 fl oz/A	24	21	
Obliquebanded leafroller		§Agree WG 3.8WS	1-2 lb/A	4	0	[10.1]
	OR	§Biobit XL 2.1FC	1.5-5.5 pt/A	4	0	
	OR	Delegate 25WG	4.5-7.0 oz/A	4	7	
	OR	§Deliver 18WG	0.5-2 lb/A	4	0	
	OR	§Dipel 10.3DF	0.5-2 lb/A	4	0	
	OR	Entrust 80WP	0.67-1.0 oz/100 gal	4	7	
	OR	*Intrepid 2F	8-16 fl oz/A	4	14	
	OR	§Javelin 7.5 WDG	0.5-4 lb/A	4	0	
	OR	*Lannate 2.4L	0.75 pt/100 gal	48-96(E)	7	
		or *Lannate 90SP	0.25 lb/100 gal			
	OR	*Proclaim 5SG	0.8-1.2 oz/100 gal	12	14	
	OR	Spintor 2SC	1.25-2.5 fl oz/100 gal	4	7	
Additional Summer Sprays						
Fire blight (ONLY after a hailstorm)		§Agri-mycin 17WP	0.5 lb/100 gal	12	30	[2.4]
		or Streptrol 17WP				
		or Firewall 17WP				
Pear scab, Fabraea leaf spot, Sooty blotch, Black rot		Topsin M 70WSB	4 oz/100 gal	72	1	
	OR	Thiophanate-methyl 85WDG	3.2oz/100 gal	72	1	
	plus	Dithane/*Manzate/Penncozeb as listed for pear scab under Green Cluster		24	BL/77 (A)	[3.6]
	OR	Rubigan 1EC	3 fl oz/100 gal	12	30	
	plus	Dithane/*Manzate/ Penncozeb 75DF	1 lb/100 gal	24	BL/77 (A)	[2.4]
	OR	Flint 50WG	0.67-0.8 oz/100 gal	12	14	[3.4]
	OR	Sovran 50WG	1.0-1.6 oz/100 gal	12	30	
	OR	Pristine 38WG	14.5-18.5 oz/A	12	0	
	OR	Ziram 76DF	1.5-2 lb/100 gal	48	14	
Codling moth		Assail 30SG	4.0-8.0 oz/A	12	7	[6.1]
	OR	*Baythroid XL 1E	2.0-2.4 fl oz/A	12	7	
	OR	§Biobit XL 2.1FC	1.5-5.5 pt/A	4	0	

Table 12.3.1. Pesticide Spray Table – Pears
Refer to back of book for key to abbreviations and footnotes.

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Codling moth *(continued)*	*OR*	*Calypso 4F	1-2 fl oz/100 gal	12	30	
	OR	§Carpovirusine 0.99SC	0.5-1 pt/100 gal	4	0	
	OR	§Cyd-X 0.06SC	1-6 fl oz/A	4	0	
	OR	*Danitol 2.4EC	16-21.3 fl oz/A	24	14	
	OR	Delegate 25WG	4.5-7.0 oz/A	4	7	
	OR	§Deliver 18WG	0.5-2 lb/A	4	0	
	OR	§Dipel 10.3DF	0.5-2 lb/A	4	0	
	OR	§Entrust 80WP	0.67-1.0 oz/100 gal	4	7	
	OR	*Guthion 50WS	0.5-0.75 lb/100 gal	14 days(E)	14-21 (A)	
	OR	*Imidan 70WP	0.75-1 lb/100 gal	72	7	
	OR	§Javelin 7.5WDG	0.5-4 lb/A	4	0	
	OR	*Leverage 2.7SE	3.6-4.4 fl oz/A	12	7	
	OR	Spintor 2SC	1.25-2.5 fl oz/100 gal	4	7	
Comstock mealybug		Actara 25WDG	4.5-5.5 oz/A	12	35	[7.1, 7.2]
	OR	Assail 30SG	4.0-8.0 oz/A	12	7	
	OR	*Calypso 4F	1-2 fl oz/100 gal	12	30	
	OR	*Diazinon 50WP	1 lb/100 gal	96	21	
	OR	*Provado 1.6F	20 fl oz/A	12	7	
European red mite, Twospotted spider mite, Pear rust mite		Acramite 50WS	0.75-1 lb/A	12	7	
	OR	Apollo 4SC	4-8 oz/A	12	21	[8.1, 13.1]
	OR	*Brigade 10WS	12.8-32 oz/A	12	14	
	OR	Envidor 2SC	16-18 fl oz/A	12	7	
	OR	Portal 5EC	1-2 pt/A	12	14	
	OR	Kanemite 15SC	21-31 fl oz/A	12	14	
	OR	Nexter 75WS	4.4-10.7 oz/A	12	7	
	OR	Onager 1EC	12-24 fl oz/A	12	28	
	OR	Savey 50DF	3-6 oz/A	12	28	
	OR	*Vendex 50WP	6-8 oz/100 gal	48	14	
	OR	Zeal 72WS	2-3 oz/A	12	14	
Obliquebanded leafroller		§Agree WG 3.8WS	1-2 lb/A	4	0	[10.2]
	OR	*Baythroid Xl 1E	2.4-2.8 fl oz/A	12	7	
	OR	§Biobit XL 2.1FC	1.5-5.5 pt/A	4	0	
	OR	Delegate 25WG	4.5-7.0 oz/A	4	7	
	OR	§Deliver 18WG	0.5-2 lb/A	4	0	
	OR	§Dipel 10.3DF	0.5-2 lb/A	4	0	
	OR	§Entrust 80WP	0.67-1.0 oz/100 gal	4	7	
	OR	*Intrepid 2F	8-16 fl oz/A	4	0	
	OR	§Javelin 7.5WDG	0.5-4 lb/A	4	0	
	OR	*Lannate 2.4L	0.75 pt/100 gal	48-96(E)	7	

Table 12.3.1. Pesticide Spray Table – Pears
Refer to back of book for key to abbreviations and footnotes.

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Obliquebanded leafroller *(continued)*		or *Lannate 90SP	0.25 lb/100 gal			
	OR	*Leverage 2.7SE	4.4-5.1 fl oz/A	12	7	
	OR	*Proclaim 5SG	0.8-1.2 oz/100 gal	12	14	
	OR	Spintor 2SC	1.25-2.5 fl oz/100 gal	4	7	
Pear psylla		Choose from materials listed under Petal Fall, except for Esteem				[12.5]
Pearleaf blister mite		Sevin XLR Plus, 4F	1.5-3 qt/A	12	3	[14.2]
		or Sevin 80S, *80WS	1.88-3.75 lb/A			
	OR	§oil	1-1.5 gal/100 gal			
	plus	*Diazinon 50WP	1 lb/100 gal	96	21	
	OR	§oil	1-1.5 gal/100 gal			
	plus	*Thionex 50WP	0.5-1 lb/100 gal	96	7	
Redbanded leafroller		§Agree WG 3.8WS	1-2 lb/A	4	0	[16.1]
	OR	*Baythroid XL 1E	2.4-2.8 fl oz/A	12	7	
	OR	§Biobit XL 2.1FC	1.5-5.5 pt/A	4	0	
	OR	Delegate 25WG	4.5-7.0 oz/A	4	7	
	OR	§Deliver 18WG	0.5-2 lb/A	4	0	
	OR	§Dipel 10.3DF	0.5-2 lb/A	4	0	
	OR	*Guthion 50WS	0.5-0.75 lb/100 gal	14 days (E)	14-21 (A)	
	OR	*Imidan 70WP	0.75-1 lb/100 gal	72	7	
	OR	§Javelin 7.5WDG	0.5-4 lb/A	4	0	
	OR	*Leverage 2.7SE	4.4-5.1 fl oz/A	12	7	
	OR	*Proclaim 5SG	0.8-1.2 oz/100 gal	12	14	

Table 12.3.2. Growth Regulator Uses in Pears.
Refer to back of book for key to abbreviations and footnotes.

Timing	Product	Concentration	Rate Of Formulated Product
CHEMICAL THINNING			
Petal Fall to 5-7 days after petal fall	Amide-Thin W (NAD)	25-50 ppm	4-8 oz (lb) / 100 gal
Do not use on Bosc. Apply at petal fall or within 5–7 days after petal fall.			
7-28 days after full bloom	Fruitone-N	10-15 ppm	4-6 oz (lb)/100 gal
Labeled for use on Bartlett, Bosc and Comice. NAA is more effective at early timings and should be applied as soon as fruit set is apparent for greatest success. Late applications may result in reduced fruit size. Do not apply when temperature is below 60°F or above 85°F. NAA will not usually adequately thin Bartlett, but the additon of a surfactant will improve thinning.			
CONTROL OF WATERSPROUTS AROUND PRUNING CUTS			
Dormant	Tre Hold RTU (NAA)	1.5% (15,000 ppm)	Ready-to-use product
Mix NAA with 2 pt latex paint / gal and apply any time after dormant pruning but before growth begins in spring. Apply with paint brush or cloth pad to thoroughly coat exposed wood and edges of bark around pruning cuts.			

Table 12.3.2. Growth Regulator Uses in Pears.
Refer to back of book for key to abbreviations and footnotes.

Timing	Product	Concentration	Rate Of Formulated Product
CONTROL OF ROOTSUCKERS			
Dormant or 6-12" Sucker height	Tre Hold RTU (NAA)	1.5% (15,000 ppm) (Do not dilute)	Ready-to-use product
Apply during dormant season after pruning existing suckers and before resprouting or apply when new sprouts are 6–12" high. Thorough wetting of stubs or new sprouts is essential.			
INDUCTION OF LATERAL BRANCHING IN YOUNG TREES			
1-2" of Terminal Shoot Growth	Promalin, Perlan, Typy	125-1000 ppm	0.25-2 pt / 5 gal
Include a non-ionic surfactant and apply as a directed spray to areas where additional branching is desired. This practice is more effective in the second and third growing seasons after planting. Response on weak or low-vigor trees is usually disappointing. For nursery stock treat after trees have reached a terminal height at which lateral branching is desired.			
PREHARVEST FRUIT-DROP CONTROL			
3 weeks before anticipated harvest	ReTain	132 ppm	0.74 lb / acre or 333 g / acre or (1 pouch)
Apply in sufficient water to ensure thorough but not excessive coverage. An organosilicone surfactant (12 oz / 100 gal) should be used with ReTain.			
5-7 days before harvest	Fruitone-N	10-15ppm	4-6 oz (lb)/100 gal
Apply 7 days before harvest on D'Anjou, Bosc, and Bartlett. Make separate sprays to early and late maturing varieties.			

* To convert ounces to grams multiply ounces by 28.3. To convert fluid ounces to milliliters multiply fluid ounces by 29.57.

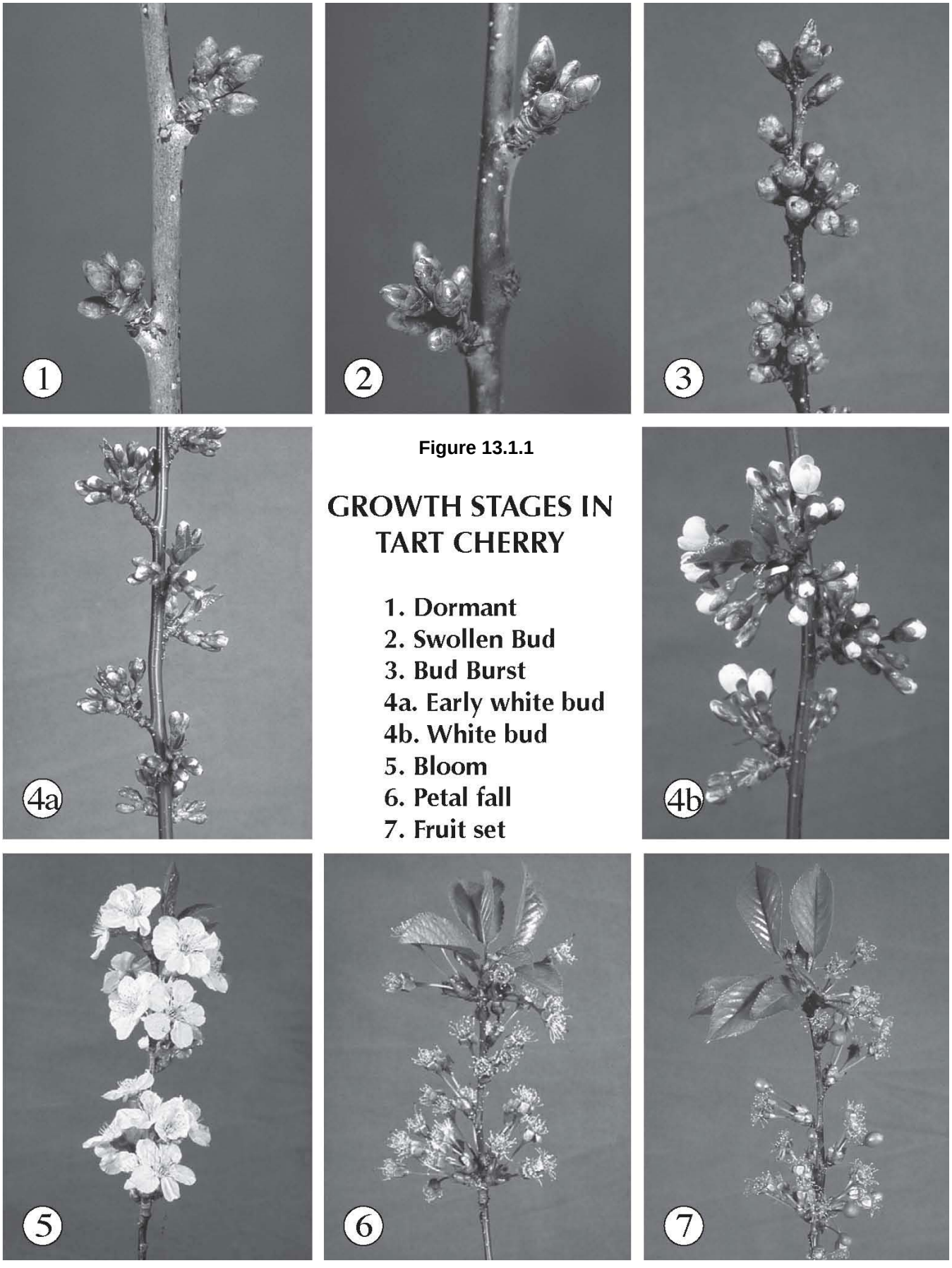

Figure 13.1.1

GROWTH STAGES IN TART CHERRY

1. Dormant
2. Swollen Bud
3. Bud Burst
4a. Early white bud
4b. White bud
5. Bloom
6. Petal fall
7. Fruit set

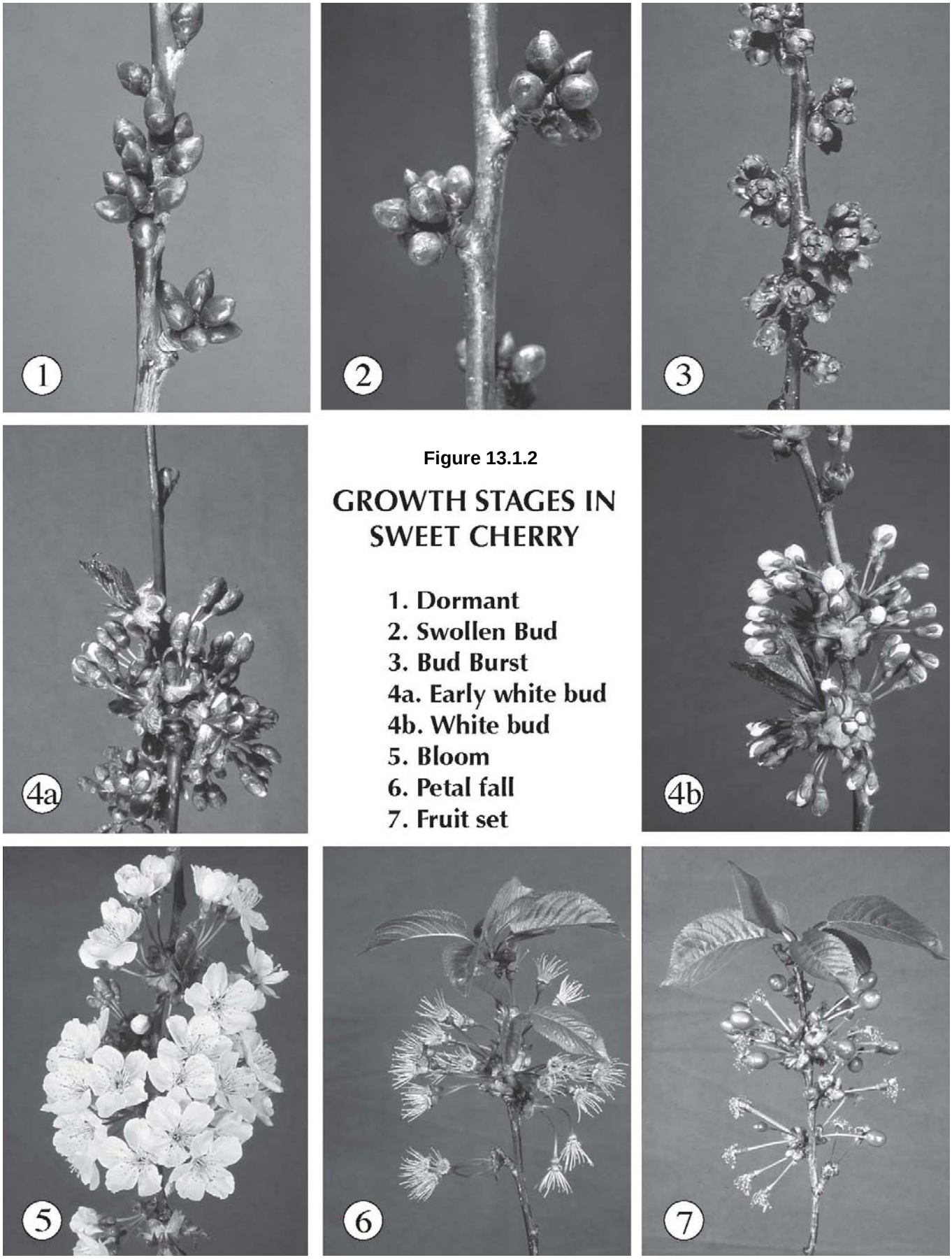
1
2
3
4a
GROWTH STAGES IN SWEET CHERRY
1. Dormant
2. Swollen Bud
3. Bud Burst
4a. Early white bud
4b. White bud
5. Bloom
6. Petal fall
7. Fruit set
4b
5
6
7

Figure 13.1.2

13 General Pest Management Considerations – Cherries

13.1 Diseases

Bacterial Canker *(Pseudomonas syringae)*

• Biology & Cultural

[1.1] The pathogen causing bacterial canker is favored by cool, wet weather (spring and fall). It can invade leaf scars in fall and fresh pruning wounds in spring if pruning is done under cool, wet conditions. When pruning, make sure to leave a 6-inch stub, especially when removing scaffold branches as the bacteria appear to be arrested within the stub. Avoid flush cut pruning.

The optimum timing and effectiveness of copper applications for control of bacterial canker is during the fall (after leaf fall) and spring (before bud burst). Label directions specify one application in the fall "before heavy rains begin" and another at late dormant. A third application before bud burst in the spring is also recommended. (For more information on bacterial canker and control, see the fact sheet at: http://www.fruitadvisor.info/pubs/bacterialcanker.pdf) Several other commercial copper formulations in addition to those listed may be labeled for this use on cherries. Although they have not been tested, research on other crops suggests that most copper formulations should give comparable rates of control at comparable rates of metallic copper.

• Pesticide Application Notes

[1.2] We recommend copper applications at 20% and 80% leaf drop in the fall, and one application in the spring late dormant. Position the two applications around any fall pruning. If you are treating sweet cherries, just make one application at 50% leaf drop. Try to time these applications to a warm, dry period. An additional application is also labeled for use after harvest in orchards where disease is severe, although this application should be avoided on sweet cherries in New York due to the potential for leaf injury. Several other commercial copper formulations in addition to those listed may be labeled for this use on cherries. Although they have not been tested, research on other crops suggests that most copper formulations should give comparable rates of control at comparable rates of metallic copper.

Black Knot

• Biology & Cultural

[2.1] Black knot has become an increasingly important problem on sour cherries in recent years. It is a difficult disease to control completely, but good sanitation—removing and destroying infected (knotted) limbs as they appear (make pruning cuts at least 6-8 in below visible swellings), destroying infected fence row trees and adjacent abandoned orchards (when possible)—is critical. Fungicide sprays are unlikely to provide satisfactory control without good sanitation practices. The most critical time for protecting against infection with fungicides is between white bud and shuck split. Black knot infection periods require rain and temperatures above 55° F; thus, fungicide sprays are most likely to be beneficial under these conditions.

Refer to the reference materials list at the end of this publication for a Fact Sheet containing more details on the biology and management of this disease.

• Pesticide Application Notes

[2.2] Bravo is the most effective fungicide for black knot control. Note that a minimum 10-day re-treatment interval is specified on the label.

Brown Rot (Blossom blight)

• Biology & Cultural

[3.1] Blossom blight is most likely to occur when the weather is warm (above 60° F) and wet during bloom or when large numbers of fruit were not harvested the previous year. Blossom blight may also be serious at lower temperatures if prolonged wetting periods occur. Blossom sprays on tart cherries may often be reduced or eliminated if none of these conditions occur. Blossom blight is much more serious on sweet cherry than on sour cherry.

[3.2] Sweet (but not sour) cherry fruit are very susceptible to brown rot for the first few weeks after they set. Protection is therefore important at this time, particularly in wet weather.

Refer to the reference materials list at the end of this publication for a Fact Sheet containing more details on the biology and management of this disease.

• Pesticide Application Notes

[3.3] When used at a rate of 10 oz/100 gal, Rovral provides 24-48 hr kickback activity against blossom blight infections. Only 2 sprays of Rovral are allowed per season. Indar, Orbit, and Elite also have significant kickback activity. For resistance management purposes, it is recommended that the SI fungicides (Elite, Indar, Orbit, Rally) should not be used routinely throughout the season for BOTH blossom blight AND fruit rot control.

[3.4] More than one blossom blight spray is rarely needed unless disease pressure is extreme.

[3.5] Young sweet cherry fruit are very susceptible to brown rot. Thus, a petal fall spray is recommended on sweet cherries if weather is wet; much less necessary on sour cherries.

[3.6] Do not use chlorothalonil (Bravo, Applause, Concorde, Echo, Equus) after shuck split; may resume use after harvest. Chlorothalonil has much longer residual activity than other fungicides labeled at shuck split, and is recommended if prolonged protection is needed. Indar is the most effective fungicide against brown rot on cherries.

[3.7] Fruit becomes increasingly susceptible to brown rot during the last 3 wk before harvest. It is therefore

recommended that spray intervals be tightened during this period and that superior brown rot fungicides be used if disease pressure is high (warm and wet), especially on sweet cherries.

Indar is the most effective fungicide for control of brown rot under high disease pressure, and provides excellent residual activity. It may be applied at 7–10-day intervals as needed. Orbit, Elite, and Pristine are also excellent brown rot fungicides with no preharvest interval restrictions. Sulfur, captan plus sulfur, and ferbam plus sulfur do not provide adequate control on sweet cherries. The maximum allowable rate of 4 lb/A for captan is inadequate on trees greater than 10 ft tall, particularly on sweet cherries.

Leaf Spot

• Pesticide Application Notes

[4.1] Primary leaf spot infections can occur from petal fall until after harvest; it is, therefore, important to maintain adequate spray deposits prior to infection periods (see Table 11) throughout this time. Chlorothalonil fungicides (Bravo, Applause, Concorde, Echo, Equus) have the longest residual activity. They also provide some control of black knot.

Rubigan, Indar, and Elite have approximately 3 days of after-infection activity, and can be used in this manner when necessary. However, leaf spot has shown resistance to SI fungicides in some orchards in Michigan, and regular use of post-infection timing will spread selection for resistance. Thiophanate-methyl (Topsin M) is no longer recommended for use on cherries because of widespread brown rot resistance and suspected leaf spot resistance. Captan may cause leaf injury on Schmidt, Emperor Francis, and Giant sweet cherries if used between petal fall and harvest. Sulfur has short residual activity and must be reapplied frequently in wet seasons. Syllit has little effect against brown rot.

[4.2] Do not use chlorothalonil (Bravo, Applause, Concorde, Echo, Equus) after shuck split; may resume use after harvest. Chlorothalonil has much longer residual activity than other fungicides labeled at shuck split, and is recommended if prolonged protection is needed.

[4.3] Do not use captan on sensitive sweet cherry varieties in the preharvest sprays. Do not use chlorothalonil between shuck split and harvest.

[4.4] Do not use copper on sweet cherries.

Phytophthora Root, Crown, And Collar Rots

• Biology & Cultural

[5.1] Cherry rootstocks are significantly more susceptible to Phytophthora root, crown, and collar rots than are apples. Mahaleb is more susceptible than Mazzard or Colt. The Gisela rootstocks (G.5, G.6) are not particularly susceptible. The main defenses against these diseases should be providing good soil drainage through proper site selection and physical manipulations such as tiling or planting on berms; in marginal sites or very wet years, berms are much more effective than tiling. Highly susceptible rootstocks (e.g., Mahaleb) also should be avoided on marginal sites. However, Ridomil will provide additional protection in wet years, on marginal sites, or in wetter sections of the orchard. See comment **5.2** about applications.

Refer to the reference materials list at the end of this publication for a Fact Sheet containing more details on the biology and management of this disease.

• Pesticide Application Notes

[5.2] Ridomil applications should be made just before growth starts in the spring and at 2–3-month intervals thereafter if soil conditions are very wet. Apply to the soil beneath the tree canopy in sufficient water to ensure good coverage (material is moved into the soil by subsequent rain or irrigation). Do not apply Ridomil to newly planted trees. See label for further details.

Powdery Mildew

• Pesticide Notes

[6.1] To control mildew, include an appropriate fungicide in each spray from 2nd fruit fly spray through the postharvest application. Nova is most effective.

[6.2] Do not use copper on sweet cherries.

X-Disease

• Pesticide Application Notes

[6.1] Refer to "Early Spring" section in Pesticide Spray Table for Peaches and Nectarines.

13.2 Insects and Mites

American Plum Borer

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Pesticide Application Notes

[8.1] Application recommended against newly emerging adults, shortly after petal fall. If fresh borer activity is noted in early July, follow up with an additional application by mid-July. Apply as a coarse, low-pressure spray to give uniform coverage of tree trunks and lower limbs. *Ambush not labeled for American plum borer. Avoid Lorsban contact with foliage in sweet cherries; 50WS and 75WG formulations not labeled in sweet cherries. Rate of *Baythroid products for lesser peachtree borer: 1.4-2.0 fl oz/A; for American plum borer: 2.4-2.8 fl oz/A.

[8.2] The July and August lesser peachtree borer sprays will additionally provide control of 2nd brood American plum borer. Refer to comment [13.2].

Black Cherry Aphid

• Pesticide Application Notes

[9.1] Prebloom spray recommended, just before blossoms open, and during summer if needed. Because of toxicity to bees, Sevin is not recommended for prebloom aphid treatments. Suggested action threshold: 4 infested terminals/tree.

[9.2] No separate spray recommended at petal fall. See comment [15].

[9.3] Lorsban not labeled for foliar use on sweet cherries.

Black Cherry Fruit Fly, Cherry Fruit Fly

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of these pests.

• Pesticide Application Notes

[10.1] Make 1st spray 7 days after flies emerge (when Early Richmond starts to color); 2nd and 3rd sprays at 7- to 10-day intervals. Sevin is recommended as an emergency treatment near harvest. Imidan is for use on tart cherries only; not registered for black cherry fruit fly.

[10.2] Frequent applications (7–10-day intervals) of Surround and maximal coverage (minimum of 100 gal/A) are advised while there is active foliar growth.

[10.3] Use of *Imidan and Lorsban on tart cherries only.

European Red Mite

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Pesticide Application Notes

[11.1] Apply oil against overwintering eggs.

[11.2] Do not apply Vendex more than 2 times per season.

[11.3] Use lower rate of Nexter for European red mite, higher rate for twospotted spider mite; postharvest use only..

[11.4] Apollo and Savey limited to 1 application per season.

[11.5] Supplemental label must be in possession.

Japanese Beetle

• Biology & Cultural

[12.1] Adults emerge from the soil between early July and mid-August to feed on numerous trees and shrubs. In cherry trees, beetles devour the tissue between the veins, leaving a lace-like skeleton. Severely injured leaves turn brown and often drop. Adults are most active during the warmest parts of the day and prefer to feed on plants that are fully exposed to the sun.

• Pesticide Application Notes

[12.2] Although pheromone traps are available and can be hung in the orchard in early July to detect the beetles' presence, they are generally NOT effective at trapping out the beetles. Fruit and foliage may be protected from damage by applying Sevin, Assail, *Leverage or *Provado; repeated applications may be required.

Lesser Peachtree Borer

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Biological & Non-chemical Control

[13.1] In orchards where lesser peachtree borer is the primary borer pest, hang pheromone ties at 100/acre in late May before flight begins.

• Pesticide Application Notes

[13.2] For Lorsban and pyrethroids, apply as a coarse spray to trunk and lower limbs in up to 3 sprays; June 1-10, July 7-15, and August 1-10. Do not spray fruit; 6-day PHI for *Lorsban 4EC, 21 days for Lorsban 75WG, 14 days for *Asana and *Warrior, 3 days for *Ambush and *Pounce. For *Thionex, a single spray post-harvest. The July and August sprays will additionally provide control of 2nd brood American plum borer.

Obliquebanded Leafroller

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Pesticide Application Notes

[14.1] Apply in early July when larvae are small (approximately 360-450 DD [base 43° F] after 1st trap catch.

[14.2] Lorsban not labeled in sweet cherries.

Plum Curculio

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Pesticide Application Notes

[15.1] Apply sprays when last petals are falling (early fruit set) and at 8- to 10-day intervals. Use 2-4 sprays. Sweet cherrry fruit will incur considerable damage from the early migration of plum curculio if not protected with a recommended insecticide. Imidan is for use on tart cherries only; causes severe foliage injury to sweet cherries. Sevin and Imidan will also control black cherry aphid.

[15.2] Frequent applications (7–10 day intervals) of Surround and maximal coverage (minimum of 100 gal/A) are advised while there is active foliar growth.

[15.3] Not labeled for use on sweet cherries.

Storage Rots

• Pesticide Application Notes

[16.1] A postharvest treatment with Scholar SC via flooders, T-jet, or similar system for control of storage rots is recommended for fruit coming from orchards where sporulating brown rot was observed, or when one hopes keep fruit in cold storage for a few days prior to sale. Holding tanks in postharvest treatment equipment must have excellent agitation to keep fungicides in suspension. Solutions must be replenished regularly as directed on the product label. Never exposed treated fruit to direct sunlight. This will cause the fungicide to break down.

13.3. Cherry Spray Table

Table 13.3.1. Pesticide Spray Table – Cherries

Refer to back of book for key to abbreviations and footnotes.

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Late Dormant						
Bacterial canker (Pseudomonas syringae)		Kocide 40DF or Kocide 50WP	2-4 lb/100 gal (max 12 lb/A)	24	BL, PH (C)	[1.1]
		or §Cuprofix Disperss 40DF	10-16 lb/A	24	BL, PH (C)	24
		or other coppers	see comments			
Phytophthora root, crown and collar rots		Ridomil Gold 4EC	1.5 fl oz/1,000 sq ft treated	12	0	[5.2]
Bud Burst						
European red mite		§oil	2 gal/100 gal	12	0	[11.1]
White Bud						
Brown rot (blossom blight)		Bravo Ultrex 82.5WDG	0.9-1.25 lb/100 gal	12 hr/ 7 days(E)	SS	
		or Bravo Weather Stik 6F	1.0-1.4 pt/100 gal			
		or other chlorothalonil formulations (see labels)				
	OR	Captan 50WP	2 lb/100 gal (max 4 lb/A)	96(E)	0	[3.1, 3.2]
	OR	Echo 6F	1.09-1.4 pt/100 gal	12 hr/ 7 days(E)	SS	
		or Echo 90DF	0.75-1.2 lb/100 gal			
	OR	Elevate 50WDG	0.33-0.5 lb/100 gal (max 6 lb/A)	12	0	
	OR	Elite 45DF	2 oz/100 gal	12	0	[3.3]
	OR	Indar 75WS	0.5-0.8 oz/100 gal (max 2 oz/A)	12	0	
	OR	Orbit 3.6EC	1.0-1.6 fl oz/100 gal (max 4 fl oz/A)	24	0	
	OR	Pristine 38WDG	10.5-14.5 oz/A	12	0	
	OR	Quash	2.5 to 4 oz/A	12	14	
	OR	Rally 40 W/WSP	2.5-6 oz/acre	12	0	
	OR	Rovral 50WP	8-10 oz/100 gal (max 2 lb/A)	24	PF	
		or Rovral 4F	8-10 fl oz/100 gal (max 2 pt/A)			
	OR	§Sulfur 95WP	5 lb/100 gal	24	0	

Table 13.3.1. Pesticide Spray Table – Cherries

Refer to back of book for key to abbreviations and footnotes.

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Late Dormant						
Black cherry aphid		Asana XL 0.66 EC	4.8-14.5 fl oz/acre	12	14	
	OR	Assail 30 SG	2.5-5.3 oz/Acre	12	7	
	OR	§Aza-Direct 1.2L	12.5-42 fl oz/A	4	0	[9.1]
		§Azatin XL Plus 3L	10-21 fl oz/A	4	0	
	OR	or *Baythroid XL 1EC	2.4-2.8 fl oz/A	12	7	
	OR	Beleaf 50 SG	2.0-2.8 oz/acre			
	OR	Leverage 2.7 SE	4.4-5.1 fl oz/acre	12	7	
	OR	or Malathion 57EC	1.5 pt/100 gal	12	3	
	OR	§M-Pede 49L	2 gal/100 gal	12	0	
	OR	§Neemix 4.5L	7-16 fl oz/A	12	0	
	OR	Proaxis 0.5 CS	2.56-5.12 fl oz/acre	24	14	
	OR	*Thionex 3EC	0.67 qt/100 gal	48	21	
		or *Thionex 50WP	1 lb/100 gal	96		
	OR	Movento	6 to 9 oz per Acre	24	7	
	OR	Warrior II	1.28 to 2.56 fl oz/Acre	24	14	
Bloom						
Black knot		Bravo Ultrex 82.5WDG	0.9-1.25 lb/100 gal	12 hr/7 days(E)	SS	[2.1, 2.2]
		or Bravo Weather Stik 6F	1.0-1.4 pr/100 gal			
Brown rot (blossom blight)		See materials listed under White Bud				[3.1], [3.3], [3.4]
Petal Fall						
Black knot		See recommendations under White Bud				[2.1], [2.2]
Brown rot		See recommendations under White Bud				[3.3], [3.5]
Leaf spot		Bravo Ultrex 82.5WDG	0.9-1.25 lb/100 gal	12 hr/7 days(E)	SS, PH	[4.1]
		or Bravo Weather Stik 6F	1.0-1.4 pt/100 gal			
		or other chlorothalonil formulations (see labels)				
	OR	Captan 50WP	1-2 lb/100 gal (max 4 lb/A)	96 (E)	0	
	OR	Captan 50WP *plus* Sulfur 95WP	1-1.5 lb/100 gal 3 lb/100 gal	96 (E)	0	
	OR	Echo 6F	1.0-1.4 pt/100 gal	12 hr/7 days(E)	SS	
		or Echo 90DF	0.75-1.2 lb/100 gal			
	OR	Elite 45DF	2 oz/100 gal	12	0	
	OR	Indar 75WS	0.5-0.8 oz/100 gal (max 2 oz/A)	12	0	
	OR	Orbit 3.6EC	1.0-1.6 fl oz/100 gal (max 4 fl oz/A)	24	0	

Table 13.3.1. Pesticide Spray Table – Cherries

Refer to back of book for key to abbreviations and footnotes.

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Leaf spot	*OR*	Rally 40 W/WSP	2.5-6 oz/acre	12	0	
(continued)	*OR*	Rovral 50WP	8-10 oz/100 gal (max 2 lb/A)	24	PF	
		or Rovral 4F	8-10 fl oz/100 gal (max 2 pt/A)			
	OR	Rubigan 1EC	3 fl oz/110 gal	12	0	
	OR	§Sulfur 95WP	6 lb/100 gal	24	0	
	OR	Syllit 65WP	4 oz/100 gal	48	0	
	OR	Flint 50WDG	2-4 oz/A	12	1	
	OR	Gem 500SC	1.9-3.8 oz/A	12	1	
	OR	Pristine 38WDG	10.5-14.5 oz/A	12	0	
American plum		Ambush 25 WP	6.4-12.8 oz/acre	12	3	[8.1]
borer, Lesser	*OR*	Asana XL 0.66 EC	4.8-15.4 fl oz/acre	12	14	
Peachtree borer		or *Baythroid XL 1EC	[see Comment 8.1]	12	7	
		or Baythroid 2 EC				
	OR	*Lorsban 4EC	1.5-3 qt/100 gal	96	6	
		or Lorsban 50WS	2-3 lb/A	96	14	
		or Lorsban 75WG	1.3-2.0 lb/A	96	21	
	OR	Warrior II	1.28 to 2.56 fl oz/Acre	24	14	
	OR	Pheromone disruption ties:				
		§Isomate-LPTB	100/A			[12.1]
Black cherry aphid		(See comment 9.2)				[9.2]
Plum curculio		*Ambush 25WP	6.4-12.8 oz/100 gal	12	3	[14.1]
	OR	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	14	
	OR	Assail 30SG	5.3-8 oz/Acre	12	7	
	OR	Avaunt 30 WDG	5-6 oz/acre	12	14	
	OR	*Baythroid XL 1EC	2.4-2.8 fl oz/A	12	7	
		or Baythroid 2 EC				
	OR	*Guthion 50WS	0.5 lb/100 gal	15 days(E)		
	OR	*Imidan 70WP	0.75 lb/100 gal	72	7(C)	[14.3]
	OR	Leverage 2.7 SE	4.4-5.1 fl oz/acre	12	7	
	OR	Lorsban 75WG	2 lb/A	96	28	[14.3]
	OR	or *Pounce 25WP	6.4-12.8 oz/100 gal	12	3	
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	14	
	OR	Sevin XLR Plus, 4F	2-3 qt/A	12	3	
		or Sevin 80S, *80WS	2.5-3.75 lb/A			
	OR	§Surround 95WP	50 lb/100 gal	4	0	[14.2]
	OR	*Warrior II	1.28 to 2.56 fl oz/Acre	24	14	

Table 13.3.1. Pesticide Spray Table – Cherries

Refer to back of book for key to abbreviations and footnotes.

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Shuck Split						
Brown rot, Leaf spot		Bravo Ultrex 82.5WDG or Bravo Weather Stik 6F or other chlorothalonil formulations (see labels)	0.9-1.25 lb/100 gal 1.0-1.4 pt/100 gal	12 hr/ 7days (E)	SS	[3.1, 3.2]
	OR	Captan 50WP	1-2 lb/100 gal (max 4 lb/A)	96 (E)	0	
	OR	Captan 50WP *plus* Sulfur 95WP	1 lb/100 gal 3 lb/100 gal	96 (E)	0	
	OR	Echo 6F or Echo 90DF	1.0-1.4 pt/100 gal 0.75-1.2 lb/100 gal	12 hr/ 7 days(E)	SS	
	OR	Ferbam 76WDG	1.5 lb/100 gal	24	0	
	OR	Ferbam 76WDG *plus* Sulfur 95WP	1 lb/100 gal 3 lb/100 gal	24	0	
	OR	Gem 500SC	1.9-3.8 oz/A	12	1	
	OR	Indar 75WS	2 oz/A	12	0	
	OR	Quash	2.5 to 4 oz/A	12	14	
	OR	Rally 40 W/WSP	2.5-6 oz/acre	12	0	
Black knot		Bravo Ultrex 82.5WDG or Bravo Weather Stik 6F or other chlorothalonil formulations (see labels)	0.9-1.25 lb/100 gal 1.0-1.4 pt/100 gal	12 hr/7 days(E)	SS	[2.1, 2.2]
Black cherry aphid		Asana XL 0.66 EC	4.8-14.5 fl oz/acre	12	14	
	OR	Assail 30 SG	2.5-5.3 oz/acre	12	7	
	OR	§Aza-Direct 1.2L	12.5-42 fl oz/A	4	0	[9.1]
	OR	§Azatin XL Plus 3L	10-21 fl oz/A	4	0	
	OR	Assail 30 SG	2.5-5.3 oz/Acre	12	7	
	OR	or *Baythroid XL 1EC or Baythroid 2 EC	2.4-2.8 fl oz/A	12	7	
	OR	Beleaf 50 SG	2.0-2.8 oz/acre	12	14	
	OR	Leverage 2.7 SE	4.4-5.1 fl oz/acre			
	OR	Lorsban 75WG	2 lb/A	96	28	[9.3]
	OR	or Malathion 57EC	1.5 pt/100 gal			
	OR	§M-Pede 49L	2 gal/100 gal	12	0	
	OR	Movento	6 to 9 oz per Acre	24	7	
	OR	§Neemix 4.5L	7-16 fl oz/A	12	0	
	OR	Provado 1.6F	2 oz/100 gal	12	0	
	OR	Sevin XLR Plus, 4F or Sevin 80S, *80WS	2-3 qt/A 2.5-3.75 lb/A	12	3	
	OR	*Thionex 3EC or *Thionex 50WP	0.67 qt/100 gal 1 lb/100 gal	48 96	21	
	OR	Warrior II	1.28 to 2.56 fl oz/Acre	24	14	
Plum curculio		See materials under Petal Fall				[14.1]

Table 13.3.1. Pesticide Spray Table – Cherries

Refer to back of book for key to abbreviations and footnotes.

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Additional Summer Sprays						
Brown rot		Captan 50WP	1-2 lb/100 gal (max 4 lb/A)	96 (E)	0	[3.7]
	OR	Captan 50WP *plus* Sulfur 95WP	1 lb/100 gal 3 lb/100 gal	96 (E)	0	
	OR	Carbamate 76WDG	1.5 lb/100 gal	24	0	
	OR	Carbamate 76WDG *plus* Sulfur 95WP	1.5 lb/100 gal 3 lb/100 gal	24	0	
	OR	Elevate 50WDG	1.0-1.5 lb/A	12	0	
	OR	Elite 45DF	2 oz/100 gal	12	0	
	OR	Indar 75WSP	0.5-0.8 oz/100 gal (max 2 oz/acre)	12	0	
	OR	Orbit 3.6EC	1.0-1.6 fl oz/100 gal (max 4 fl oz/A)	24	0	
	OR	Pristine 38WDG	10.5-14.5 oz/A	12	0	
	OR	Quash	2.5 to 4 oz/Acre	12	14	
	OR	Rally 40 W/WSP	2.5-6 oz/acre	12	0	
Leaf spot		Choose from materials listed at Petal Fall.				[4.3]
Powdery mildew		Elite 45DF	2 oz/100 gal	12	0	[6.1]
	OR	Rally 40 W/WSP	1.25-2 oz/100 gal (max 6 oz/A)	24	0	
	OR	Orbit 3.6EC	1.0-1.6 fl oz/100 gal (max 4 fl oz/A)	24	0	
	OR	Rubigan 1EC	3 fl oz/100 gal	12	0	
	OR	§Sulfur 95WP	3 lb/100 gal	12	0	
	OR	*Procure 50W	10-16 oz/A	12	1	
	OR	Flint 50WDG	2-4 oz/A	12	1	
	OR	Gem 500SC	1.9-3.8 oz/A	12	1	
	OR	Pristine 38WDG	10.5-14.5 oz/A	12	0	
	OR	Quash	2.5 to 4 oz /Acre			
American plum borer		Ambush 25 WP	6.4-12.8 oz/acre	12	3	[8.1]
	OR	Asana XL 0.66 EC	4.8-15.4 fl oz/acre	12	14	
	OR	*Baythroid XL 1EC or Baythroid 2 EC	2.4-2.8 fl oz/A	12	7	
	OR	Leverage 2.7 SE	4.4-5.1 fl oz/acre	12	7	
	OR	*Lorsban 4EC	1.5-3 qt/100 gal	96	0	
		or Lorsban 75WG	2-4 lb/100 gal	96	21	
	OR	Warrior II	1.28 to 2.56 fl oz/Acre	24	14	
Black cherry fruit fly		*Ambush 25WP#	1.6-3.2 oz/100 gal	12	3	[10.1]
Cherry fruit fly	*OR*	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	14	
	OR	Assail 30 SG	2.5-8 oz/Acre	12	7	
	OR	or *Baythroid XL 1EC or Baythroid 2 EC	2.4-2.8 fl oz/A	12	7	

Table 13.3.1. Pesticide Spray Table – Cherries

Refer to back of book for key to abbreviations and footnotes.

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Black cherry fruit fly	*OR*	Delegate 25 WG	4.5-7.0 oz/acre	4	7	
Cherry fruit fly	*OR*	*Diazinon 50WP#	1 lb/100 gal	24	21	
(continued)	*OR*	*Guthion 50WS	0.5 lb/100 gal	15 days (E)	15	
	OR	*Imidan 70WP	0.75 lb/100 gal	72	7(c)	
	OR	Lorsban 50WS	2-3 lb/A	96	21	[10.3]
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	14	
	OR	Sevin XLR Plus, 4F	2-3 qt/A	12	3	
		or Sevin 80S, *80WS	2.5-3.75 lb/A			
	OR	§Surround 95WP	50 lb/100 gal	4	0	[10.2]
	OR	*Warrior II	1.28 to 2.56 fl oz/Acre	24	14	
European red mite, Twospotted spider mite		Apollo 4SC	2-8 oz/A	12	21	[11.4]
	OR	Onager 1 EC	12-24 fl oz/acre	12	28	
	OR	Nexter 75WS	4.4-10.7 oz/A	12	300(PH)	
	OR	Savey 50DF	3-6 oz/A	12	28	[11.4]
	OR	*Vendex 50WP	4-8 oz/100 gal	48	14	[11.2]
	OR	Envidor	16-18 oz/A	12	7	
	OR	Portal	1-2 pt/A	12	365	[11.3]
	OR	Zeal 72 WS	2 to 3 oz/Acre	12	7	[11.5]
Japanese beetle		Assail 30 SG	5.3-8 oz/acre	12	7	12.2
	OR	Leverage 2.7 SE	3.6-4.4 fl oz/acre	12	7	
	OR	Provado 1.6 F	4.0-8.0 fl oz/acre	12	7	
	OR	Sevin XLR Plus, 4F	see label	2-3 qt/A	12	3
		or Sevin 80S, *80WS	see label	2.5-3.75 lb/A		
Lesser peachtree borer		Pheromone disruption ties: §Isomate-LPTB	100/A			[13.1]
	OR	*Ambush 25WP	6.4-12.8 oz/A	12	3	[13.2]
		or *Ambush 2EC	6.4-12.8 fl oz/A			
	OR	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	14	
	OR	Lorsban 4EC	1.5-3 qt/100 gal	96		
		or Lorsban 75WG	1.3-2 lb/A	96	21	
	OR	*Pounce 25WP	6.4-12.8 oz/A	12	3	
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	14	
	OR	*Thionex 3EC	1 qt/100 gal	48	21	
		or *Thionex 50WP	2.6-5.1 fl oz/100 gal	96		
	OR	*Warrior II	1.28 to 2.56 fl oz/Acre	24	14	
Obliquebanded leafroller		*Baythroid XL 1EC	2.4-2.8 fl oz/A	12	7	
		or Baythroid 2 EC				
	OR	§Biobit XL 2.1FC	1.5-5.5 pt/A	4	0	[14.1]
	OR	Delegate 25 WG	4.5-7.0 oz/acre	4	7	
	OR	§Deliver 18WG	0.5-2 lb/A	4	0	
	OR	§Entrust 80WP	1.25-2.5 oz/A	4	7	

Table 13.3.1. Pesticide Spray Table – Cherries

Refer to back of book for key to abbreviations and footnotes.

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Obliquebanded leafroller ***(continued)***	*OR*	§Javelin 7.5 WDG	0.25-4 lb/A	4	0	
	OR	Lorsban 50WS	2 lb/A	96	21	[13.2]
	OR	Leverage 2.7 SE	4.4-5.1 fl oz/acre	12	7	
	OR	Lorsban 75WG	1.3-2 lb/A	96	21	
	OR	Spin Tor 2SC	8 fl oz/A	4	7	
	OR	Belt	3 to 4 oz/Acre	12	7	
Postharvest						
Leaf spot		Bravo Ultrex 82.5 WDG or Bravo Weather Stik 6F	0.9-1.25 lb/100 gal 1.0-1.4 pt/100 gal	12 hr/ 7days(E)	SS	
	OR	Captan 50WP	1-2 lb/100 gal (max 4 lb/A)	96 (E)	0	
	OR	C-O-C-S *plus* hydrated lime	1.5 lb/100 gal 3 lb/100 gal	24	PH(C)	[4.4]
	OR	Echo 6F or Echo 90DF	1.0-1.4 pt/100 gal 0.75-1.2 lb/100 gal	12 hr/ 7days(E)	SS	
	OR	Rally 40WP	1.25-2 oz/100 gal	24	0	
	OR	Rubigan 1EC	3 fl oz/100 gal	12	0	
	OR	Syllit 65WP	0.5 lb/100 gal	48	0	
	OR	Flint 50WDG	2-4 oz/A	12	1	
	OR	Gem 500SC	1.9-3.8 oz/A	12	1	
	OR	Pristine 38WDG	10.5-14.5 oz/A	12	0	
Powdery mildew		C-O-C-S *plus* hydrated lime	1.5 lb/100 gal 3 lb/100 gal	24	PF, PH(C)	[4.4]
	OR	Rally 40WP	1.25-2 oz/100 gal	24	0	
	OR	Rubigan 1EC	3 fl oz/100 gal	12	0	
	OR	§Sulfur 95WP	3 lb/100 gal	12	0	
	OR	*Procure 50W	10-16 oz/A	12	1	
	OR	Flint 50WDG	2-4 oz/A	12	1	
	OR	Gem 500SC	1.9-3.8 oz/A	12	1	
	OR	Pristine 38WDG	10.5-14.5 oz/A	12	0	
	OR	Quash	2.5 to 4 oz/Acre	12	14	
European red mite, Twospotted spider mite		Nexter 75WS	4.4-10.7 oz/A	12	300(PH)	
Storage rots		Scholar SC	32 fl oz/100 gal (see comments & label)			[15.1]
Autumn						
Bacterial canker (Pseudomonas syringae)		Kocide 40DF	2-4 lb/100 gal	24	BL, PH (C)	[1.1]
		or Kocide 50WP	(max 12 lb/A)	24	BL, PH (C)	
		or §Cuprofix Ultra Disperss 40DF	10-16 lb/A			
		or other coppers	(see comments)			

Table 13.3.2. Growth Regulator Uses in Cherries

Refer to back of book for key to abbreviations and footnotes.

Timing	Product	Concentration Product	Rate of Formulated
PROMOTE LATERAL BRANCHING IN TART CHERRY: *(to counteract the adverse effects of tart cherry yellows virus on formation of vegetative buds)*			
14-21 days	Pro-Gibb 4%, Falgro 4L	10-15 ppm	4-6 fl oz/100 gal
after petal fall	Pro-Gibb Plus 2X, Falgro 20SP	10-15 ppm	0.67-1 oz (lb)/100 gal
Apply at the 3-5 leaf stage or 1-3 inches of terminal extension on bearing trees. Apply with a nonionic surfactant as a dilute spray using 200–300 gal/acre. Use low rate on vigorous trees and high rate on low vigor trees.			
PROMOTE VEGETATIVE GROWTH OF YOUNG NON-BEARING TREES			
2-4 weeks	Pro-Gibb 4%, Falgro 4L	50-100 ppm	20-40 fl oz/100 gal
after bloom	Pro-Gibb Plus 2X, Falgro 20SP	50-100 ppm	3.34-6.67 oz (lb)/100 gal
Apply at the 5-7 leaf stage. Reduces crop in year after treatment. Do not spray first year trees. For low vigor trees make two applications no closer than 7 days apart.			
INDUCTION OF LATERAL BRANCHING IN NURSERY TREES			
SWEET CHERRIES			
When terminal shoot is 26-32" long	Promalin, Perlan, Typy	250-1,000 ppm	0.5-2 qt/5 gal
Include a non-ionic surfactant and apply as a directed spray to top part of tree after trees have reached a terminal height at which lateral branching is desired.			
INDUCTION OF LATERAL BRANCHING IN YOUNG NON-BEARING TREES			
SWEET CHERRIES			
Bud Swell	Promalin, Perlan, Typy	5,000-7,500 ppm	3.2-5.3 fl oz/1pt latex paint
Mix with latex paint and paint on buds. Do not apply the Promalin-latex paint mixture after bud break which may cause some injury to tender shoot tips. The best results are obtained by scoring above the bud and then painting the cut and the bud with the Promalin-latex paint mixture.			
DELAY HARVEST AND INCREASE FIRMNESS AND SIZE OF SWEET CHERRIES			
Fruit is light green to straw color(about 3-4 weeks before harvest)	Pro-Gibb 4%, Falgro 4L	10-30 ppm	16-48 fl oz/acre
	Pro-Gibb Plus 2X, Falgro 20SP	10-30 ppm	80-240g/acre
	Pro-Gibb 40%	10-15ppm	40-120g/acre
High rates may delay fruit color development but give the maximum delay in harvest. Apply lower rates for less delay in ripening and less inhibition of color. Do not apply within 1 week of harvest			
PROMOTE FRUIT LOOSENING FOR MECHANICAL HARVESTING			
TART CHERRIES			
7-14 days before anticipated harvest	Ethrel	150 ppm	0.5 pt/100 gal
Apply with a nonionic surfactant. Do not apply to weak trees or trees under heat or moisture stress.			
SWEET CHERRIES			
7-14 days before anticipated harvest	Ethrel	300-450 ppm	1-1.5 pt/100 gal
Apply with a nonionic surfactant. Do not apply to weak trees or trees under heat or moisture stress.			

* To convert ounces (lb) to grams multiply ounces by 28.3. To convert fluid ounces to milliliters multiply fluid ounces by 29.57.

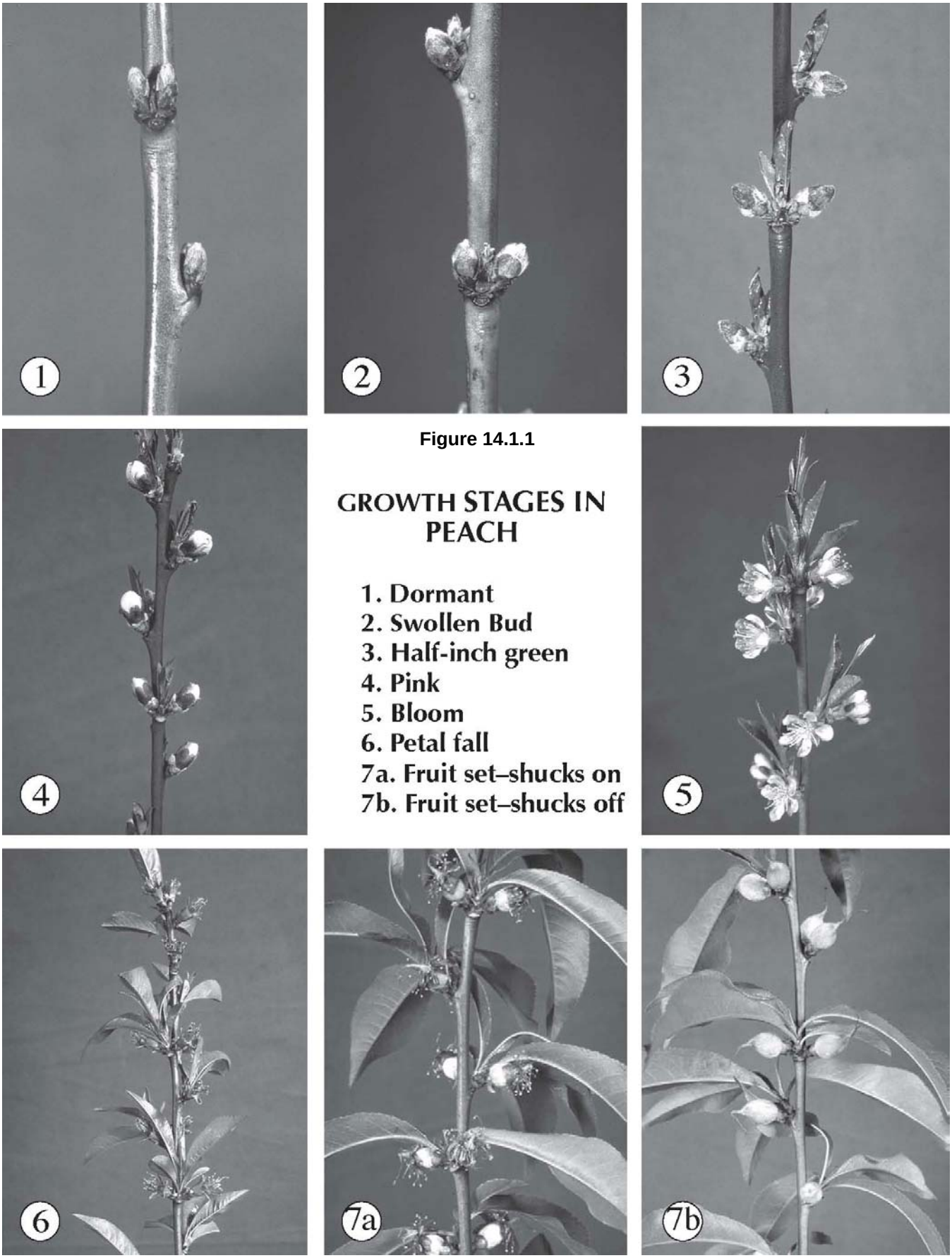
1
2
3
4
GROWTH STAGES IN PEACH
1. Dormant
2. Swollen Bud
3. Half-inch green
4. Pink
5. Bloom
6. Petal fall
7a. Fruit set–shucks on
7b. Fruit set–shucks off
5
6
7a
7b

Figure 14.1.1

14 General Pest Management Considerations – Peaches and Nectarines

14.1 Diseases

Bacterial Spot

• Biology & Cultural

[1.1] Bacterial spot is a devastating disease of peaches and nectarines as well as plums, prunes and apricots. This disease is most likely to be a problem on susceptible varieties (e.g., Autumnglo, Babygold 5, Redhaven, California white-fleshed varieties, nectarines). Any variety developed in drier climates and then grown in the more humid climate of New England has a strong likely hood of being susceptible. Also, this disease will be more severe in the warmer southern portions of New England, in wet years, in orchards with lighter (sandy) soils, and in windy orchard sites. The bacterial spot pathogen, *Xanthomonas arboricola* pv. *pruni* infects leaf scars at leaf drop and overwinters in infected twigs. Bacteria populations subsequently multiply during warm weather and ooze out during spring rains. Immature tissues are less susceptible to the bacterial infection, and as such, infections will not begin until petal fall/shuck split. Early season copper applications are quite effective for controlling the bacterial populations, but are also likely to induce phytotoxicity if one is not careful. Moreover, copper phytotoxicity can cause symptoms similar to that of bacterial spot. Do not plant susceptible peach varieties near plums, prunes, or apricots. Prunes, plum, and apricots are also susceptible to bacterial spot, and no materials are registered for use on bacterial spot of prunes, plum, and apricots.

• Pesticide Application Notes

[1.2] Where susceptible varieties are planted, a delayed dormant application of copper my help reduce bacterial spot disease pressure for the season. Along these lines, if applications of copper were made to manage peach leaf curl, these applications will substitute for those needed for bacterial spot. Apply copper with caution. Peaches are very susceptible to copper injury, especially after bud break. Copper phytotoxicity will be exacerbated by cool wet weather and environmental acidity.

[1.3] Where control is needed, apply sprays of Mycoshield or Flameout every 7-–10 days from shuck split until 3 wk before harvest. The sprays immediately after shuck split are the most important for protecting the fruit. Thorough coverage is essential. Copper sprays applied for peach leaf curl at leaf drop should also aid in bacterial spot control.

[1.4] Low rates of copper can be applied post-bloom at 7-14 day intervals to reduce harvest damage and build of bacterial populations in susceptible varieties. Do not make more than six such applications. Take caution with post-bloom copper applications. These copper applications may result in phytotoxicity if no rains occur between applications. If copper sprays are applied under acidic conditions (e.g., with LI-700 or other acidifiers) these may be more phytotoxic than copper applied alone.

Brown Rot (Blossom Blight)

• Biology & Cultural

[2.1] Blossom blight is most likely to occur when the weather is warm (above 60° F) and wet during bloom or when significant numbers of fruit were left unharvested the previous year. Blossom blight may also be serious at lower temperatures if prolonged wetting periods occur. However, blossom sprays on peaches may often be reduced or eliminated if these conditions do not occur. Nectarines are more susceptible to brown rot than most peach cultivars.

[2.2] Good insect control is important to prevent formation of entry points for the brown rot fungus. Pay special attention to control of plum curculio, oriental fruit moth, and tarnished plant bug. Fruits thinned after pit hardening are likely to become infected on the orchard floor and provide a source of inoculum for spread to ripening fruits in the tree; in contrast, fruits thinned prior to pit hardening are much less likely to do so.

Refer to the reference materials list at the end of this publication for a Fact Sheet containing more details on the biology and management of this disease.

• Pesticide Application Notes

[2.3] When used at a rate of 10 oz/100 gal dilute, Rovral provides 24–48 hr kickback activity against blossom blight infections at 68° F. Only 2 applications of Rovral are allowed per year. Orbit, Indar, and Elite also have significant kickback activity. Also, note that Thiram Granuflo is not labeled for use on nectarines

[2.4] More than one blossom blight spray is rarely needed unless disease pressure is extreme.

[2.5] If a previous brown rot spray was applied, a petal fall application is necessary on peaches only if warm and wet weather persists.

[2.6] Fruit are very susceptible to infection for the first 3 wk after shuck split; therefore, the shuck split and 1st cover sprays are important for controlling brown rot, particularly in wet weather. Chlorothalonil (Bravo, Echo) has longer residual activity than captan or sulfur, but do not use Chlorothalonil after shuck split. Indar is also highly effective.

[2.7] Elite, Indar and Orbit are not registered for use until 3 wk before harvest. Fruit becomes increasingly susceptible to infection the last 3 wk before harvest. It is therefore suggested that spray intervals be tightened up during this period and that Elite, Indar, or Orbit be used if disease pressure is high.

• Pesticide Resistance

[2.8] For resistance management purposes, the SI fungicides (Indar, Elite, Orbit, and Rally) should not be used routinely throughout the season for BOTH blossom blight AND fruit rot control. Where peaches within the same block ripen over an extended season, continued use of SI fungicides as preharvest sprays for successive varieties will also create selection pressure for fungicide resistance. Use captan or Pristine to break the string of preharvest SI fungicides applied to varieties with varied ripening or harvest dates.

Peach Leaf Curl

• Pesticide Application Notes

[3.1] Leaf curl sprays are especially important in years following crop failures because inoculum can build in orchards that do not receive brown rot sprays. Leaf curl sprays can be applied anytime between leaf fall and bud swell. Treatment applied after bud swell may not provide 100% control. Fixed copper compounds applied at leaf fall should also improve bacterial spot control by reducing the inoculum that overwinters in leaf scars. Several other commercial copper formulations in addition to those listed may be labeled for this use on peaches. Most copper formulations should give comparable rates of control at comparable rates of metallic copper.

Peach Scab

• Biology & Cultural

[4.1] Most likely to develop if weather is warm and wet the first several weeks following shuck split. Generally more of a problem downstate, on later varieties, and following a year when spring frosts destroyed the crop and no fungicides were applied.

• Pesticide Application Notes

[4.2] Where control is needed, apply sprays at 10- to 14-day intervals beginning at shuck split and continuing until 6 wk before harvest. Spray intervals can be lengthened during extended periods of dry weather. Bravo or Echo applied at shuck split will provide at least 14 days of protection for young fruits.

Perennial (Cytospora, Valsa) Canker

• Biology & Cultural

[5.1] Perennial canker is the most destructive disease of peach trees in New England and other cold-climate regions. Infections usually become established in pruning wounds or winter-injured tissue, from which they slowly expand and girdle the infected trunk or limbs. The most common point of entry is small, weak shoots that develop in the centers of the trees, then become killed during the winter. Thus, the most effective means of controlling this disease is to prune trees so that their centers are open. Other control practices include establishing new plantings at a distance from old, cankered blocks; training to promote wide crotch angles (reduced breakage and winter injury); delaying annual pruning until bloom or later, to allow pruning cuts to "heal" quickly; and standard horticultural practices to promote winter hardiness, such as the application of white trunk paint. Some fungicides applied for brown rot control after pruning may help protect these wounds from infection, but such benefits are unproven and likely to be minor. *This disease is controlled almost entirely through horticultural practices!!!*

Refer to the reference materials list at the end of this publication for a Fact Sheet containing more details on the biology and management of this disease.

Phytophthora Root, Crown, and Collar Rots

• Biology & Cultural

[6.1] Peach rootstocks are significantly more susceptible to Phytophthora root, crown, and collar rots than are apples (peach is similar to cherry in susceptibility). The main defense against these diseases should be providing good soil drainage through proper site selection and physical manipulations such as tiling or planting on berms; in marginal sites or very wet years, berms are much more effective than tiling. Ridomil will provide additional protection in wet years, on marginal sites, or in wetter sections of the orchard. See comment about application.

Refer to the reference materials list at the end of this publication for a Fact Sheet containing more details on the biology and management of this pest.

• Pesticide Application Notes

[6.2] Applications should be made just before growth starts in the spring and at 2–3-month intervals thereafter if soil conditions are very wet. Apply to the soil beneath the tree canopy in sufficient water to assure good coverage (material is moved into the soil by subsequent rain or irrigation). See label for further details.

Powdery Mildew (Rusty Spot)

• Biology & Cultural

[7.1] Only a problem on certain susceptible varieties (e.g., Rio-Oso-Gem, Redskin). Can be particularly severe if peaches are planted adjacent to mildew-susceptible apple cultivars.

• Pesticide Application Notes

[7.2] Where disease has been a problem, add sulfur to each spray from petal fall through pit hardening. This rate of sulfur may be combined with 1 lb captan/100 gal in the early cover sprays for brown rot protection. When applied for brown rot control, the SI fungicides (Elite, Indar, Orbit) also should provide control of powdery mildew.

Prunus Stem Pitting Virus

• Biology & Cultural

[8.1] Prunus stem pitting virus is spread from broadleaf weed species to trees by the dagger nematode. The virus is seed-transmitted and enters orchards via windblown seeds from infected weed species. Broadleaf weeds in the sodded row middles should be controlled annually using 2,4-D after harvest to minimize the potential sources of virus in the orchard.

X-Disease

• Biology & Cultural

[9.1] The only effective control for X-disease of peach, nectarine, and cherry is the destruction of infected host plants within a 500-ft radius of the orchard. Chokecherry (*Prunus virginianae*) and wild sweet cherry seedlings are the wild hosts that provide most of the inoculum for leafhopper vectors of this disease. Wild black cherry (*Prunus serotina*) is not a host for X-disease. Infected sweet and tart cherry trees (particularly those on Mazzard rootstock) and wild sweet cherry seedlings can also serve as inoculum sources, but leafhoppers cannot acquire the disease from infected peach or nectarine trees. Where X-disease is a concern, new peach and nectarine plantings should be isolated from plantings of sweet cherries that might harbor X-disease.

All chokecherry and wild sweet cherry seedlings within 500 ft of peach, nectarine, and cherry orchards should be eradicated either by physically removing the plants or through use of brush killers. Chokecherries often grow in hedgerows, along fences and property lines, along the margins of woodlots, and in overgrown meadows where they can be managed with brush killers. DO NOT USE BRUSH KILLERS WITHIN THE ORCHARD. Where chokecherries have been removed or treated with brush killers, check for regrowth of chokecherry sprouts during the season following treatment. Some broadleaf weeds can also harbor the X-disease pathogen, and weeds encourage high populations of X-disease vectors. To minimize risks of X-disease, stone fruit orchards should be treated annually (in autumn) with 2,4-D herbicide to eliminate broadleaf weeds in the grass ground cover.

• Pesticide Application Notes

[9.2] Method of Hyvar application: Spread granules around the base of the stump or brush clump. Hyvar is a soil sterilant. Growth of most vegetation will be prevented in the treated area for several years. Do not apply near ditches or where surface water may carry the material to desirable plants.

[9.3] To increase activity of Krenite, add one quart of spray oil/100 gallons. Krenite will not affect current season's foliage, but it will prevent the treated plants from breaking bud in the spring. DO NOT ALLOW KRENITE TO DRIFT ONTO CROP PLANTS. Krenite affects only woody plants, and only those parts of the plant that are sprayed. Thus, it acts like a "chemical pruner." It is not active in soil.

[9.4] Peach and nectarine trees with X-disease can be treated therapeutically by injecting trees with oxytetracycline (an antibiotic) in the fall after harvest. Oxytetracycline kills or suppresses the pathogen in the tree phloem and prolongs the life and productivity of infected trees. Infected trees usually require annual treatment to maintain disease suppression, but some trees recover completely after two successive years of treatment. Peach and nectarine trees in later stages of decline (i.e., X-disease symptoms throughout the canopy) will not recover and should not be treated. Oxytetracycline has not been proven effective for treating cherry trees. Oxytetracycline should only be applied to peach and nectarine trees that have symptoms of X-disease; it should never be applied to healthy trees or used as a preventive for X-disease.

14.2 Insects and Mites

American Plum Borer

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Pesticide Application Notes

[10.1] Apply spray against newly emerging adults, shortly after petal fall. Apply as a coarse, low-pressure spray to give uniform coverage of tree trunks and lower limbs. Particularly a problem in trees with split trunks from Cytospora canker or winter injury. Will also contribute to control of peachtree borer and lesser peachtree borer; see comment [17.3]. Only 1 application of Lorsban permitted per season.

[10.2] Rate of Baythroid products for lesser peachtree borer: 1.4-2.0 fl oz/A; for American plum borer: 2.4-2.8 fl oz/A. Rate of *Leverage for lesser peachtree borer: 3.0-3.6 fl oz/A; for American plum borer: 4.4-5.1 fl oz/A. *Baythroid and *Leverage not labeled for peachtree borer.

Cottony Peach Scale, European Fruit Lecanium Scale

• Pesticide Application Notes

[11.1] Low rate of oil during dormant period for European fruit lecanium, high rate for cottony peach scale.

European Red Mite

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Pesticide Application Notes

[12.1] High rate of oil during dormant period.

[12.2] Apply as mites appear in summer; use lower rate of Nexter for European red mite, higher rate for

twospotted spider mite. Acramite, Savey and Apollo limited to 1 application per season.

[12.3] Non-bearing trees only.

Green Peach Aphid

• Pesticide Application Notes

[13.1] Apply spray postbloom, before excessive leaf curling occurs.

Japanese Beetle

• Biology & Cultural

14.1] Adults emerge from the soil between early July and mid-August to feed on numerous trees and shrubs. In peach trees, beetles devour the tissue between the veins, leaving a lace-like skeleton, and also feed on the surface of the fruit. Severely injured leaves turn brown and often drop. Adults are most active during the warmest parts of the day and prefer to feed on plants that are fully exposed to the sun.

• Pesticide Application Notes

[14.2] Although pheromone traps are available and can be hung in the orchard in early July to detect the beetles' presence, they are generally NOT effective at trapping out the beetles. Fruit and foliage may be protected from damage by applying Sevin, Assail, *Leverage or *Provado; repeated applications may be required.

Obliquebanded Leafroller

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Pesticide Application Notes

[15.1] 3 sprays: end of May (shuck split), 1st hatch (mid-late June: 360 DD43 after 1st trap catch), and 2 wk later. Best results obtained if materials are alternated.

Oriental Fruit Moth

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Biological & Non-chemical Control

[16.1] Pheromone disruption is economically justified if 2–3 sprays are normally applied, and if no other insecticide sprays are routinely needed for other pests after petal fall. For this reason, disruption may not be economical for the 1st brood, as plum curculio sprays at this time normally would also control oriental fruit moth. Pheromones should be applied in mid-June before initiation of the 2nd flight; the need for re-application depends on residual field life of specific formulations: Isomate-M 100, 90 days; Checkmate Sprayable, 14 days. Border insecticide sprays may be needed in orchards adjacent to sources of adult immigration or in other high pressure situations.

• Pesticide Application Notes

[16.2] Against adults, beginning at petal fall. Use 2 applications at a 10-14-day interval. Pyrethroids will also control plum curculio, lesser peachtree borer, and tarnished plant bug. Avaunt will provide suppression of oriental fruit moth and control of plum curculio. Sevin will not control lesser peachtree borer. *Imidan and Avaunt not registered for lesser peachtree borer.

[16.3] Summer sprays should be timed to start approximately at the 10% hatch point, 175-200 DD (base 45° F) after the first adult catch of the second brood, with a second application in 10-14 days. In high pressure blocks, a final spray should be applied 2 wk before harvest to control late season larvae. Suggested action threshold: Avg. of >10 adults/week caught per pheromone trap.

Peachtree Borers (Including Lesser Peachtree Borer)

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Biological & Non-chemical Control

[17.1] Hang pheromone ties at 100/acre in late May before flight begins. If a significant part of the population is (greater) peachtree borer, increase rate to 200-250/acre.

• Pesticide Application Notes

[17.2] Against adults, when first shucks start to split. Will also control plum curculio, oriental fruit moth, and tarnished plant bug. Sevin will not control lesser peachtree borer. *Imidan, Avaunt and Assail not registered for lesser peachtree borer.

[17.3] 3 sprays of pyrethroids to trunk and scaffold limbs against larvae: June 1–10, July 7–15, and August 1–10. 1 application of Lorsban or *Thionex, from July 20 to Aug. 1 OR immediately after harvest, may be substituted for the 3rd spray; do not apply either material to fruit. Only 1 application of Lorsban permitted per season. *Baythroid not labeled for peachtree borer. Suggested action threshold: 1st emergence of adults plus 8 days or 1–2 larvae/tree. Note: Preplant dipping of roots and crowns of peach tree seedlings before planting has given complete control of the peachtree borer for the 1st growing season and has reduced borers during the 2nd season. *Thionex, 2 2/3 qt of 3EC formulation/40 gal, is preferred because it stays in suspension and eliminates the need for constant agitation during treatment. SPECIAL PRECAUTIONS: Wear full PPE to avoid exposing skin to insecticide. Dispose of excess material with extreme care. *Thionex is extremely toxic to fish and wildlife.

Plum Curculio

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Pesticide Application Notes

[18.1] Against adults, when first shucks start to split; continue at 7- to 10-day intervals. Use 2–3 applications. Pyrethroids will also control oriental fruit moth, lesser peachtree borer, and tarnished plant bug.

[18.2] Frequent applications (7–10-day intervals) of Surround and maximal coverage (minimum of 100 gal/A) are advised while there is active foliar growth.

Tarnished Plant Bug, Stink Bug

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest. Satisfactory control requires adequate management of orchard weeds that attract this pest and act as alternate hosts.

• Monitoring & Forecasting

[19.1] Apply spray as insects appear. Suggested action threshold: At pink, 3 bleeding sites/tree or cumulative capture of 7 adults by late pink stage (white sticky-board trap); at petal fall, 3 bleeding sites/tree.

[19.2] Most catfacing injury is caused before shuck split. Later season feeding generally results in only minor surface scarring.

• Pesticide Application Notes

[19.3]At 10-day intervals as needed in July and August. Suggested action threshold: 3 bleeding sites/tree.

Western Flower Thrips

• Biology & Cultural

Drought conditions and high temperatures may encourage damaging populations in nectarines, although it has not been a particular problem in New England. Adults move from alternate weed or crop hosts to fruit just prior to and during harvest, feed on the fruit surface in protected sites, such as in the stem end, the suture, under leaves and branches, and between fruit. Feeding results in silver stipling or patches; injury is particularly obvious on highly colored varieties.

• Pesticide Application Notes

[20.1] In orchards with severe infestations, a petal fall application may be warranted against thrips feeding in fruit clusters. Control using SpinTor or Delegate may be improved by addition of an adjuvant. Carzol labeled for nectarines only.

[20.2] An application after the first harvest may prevent subsequent losses; however, an additional application may be needed if pressure is severe. Control may be improved by addition of an adjuvant. PHI is 14 days for peaches, 1 day for nectarines.

14.3 Peach and Nectarine Spray Table

Table 14.3.1. Pesticide Spray Table - Peaches and Nectarines.

Refer to back of book for key to abbreviations and footnotes.
Refer to label for registration status before applying any pesticide to nectarines.

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Dormant						
Bacterial Spot		C-O-C-S	4.0 to 5.0 lb/acre	24	BL	[1.2]
		Kocide 2000	5.7 to 7.1 lb/acre	24	21	
		or other copper formulations (see label)				
Peach leaf curl		Bravo Ultrex 82.5WDG	0.9-1.25 lb/100 gal	12 hr/ 7days (E)	SS	[3.1]
		or Bravo Weather Stik 6F	1.0-1.4 pt/100 gal			
		or other chlorothalonil formulations (see labels)				
	OR	§C-O-C-S	4 lb/100 gal	24	BL	
	OR	other copper formulations; see labels				
	OR	Echo 6F	1.0-1.4 pt/100 gal	12 hr/ 7days (E)	SS	
		or Echo 90DF	0.75-1.2 lb/100 gal			
	OR	Ferbam 76 WDG	1 1/2 lb/100 gal	24	24	
	OR	§Kocide	4 lb/100 gal			
	OR	Thiram Granuflo	3.9 to 5.1 lb per acre	24	7	
	OR	Ziram 76DF, 76WDG	1 1/2 lb/100 gal	48	14	
Phytophthora root, crown, and collar rots		Ridomil Gold 4EC	2 qt per acre	48	0	[6.2]
Cottony peach scale, European fruit lecanium, European red mite		§oil	2-3 gal/100 gal	12	0	[11.1] [11.1] [12.1]
Early Spring						
X-Disease		Hyvar X-L	1 tbsp/stump or brush clump			[9.1, 9.2]
Pink						
Brown rot (blossom blight)		Bravo Ultrex 82.5WDG	0.9-1.25 lb/100 gal	12 hr/ 7days (E)	SS	
		or Bravo Weather Stik 6F	1.0-1.4 pt/100 gal			
		or other chlorothalonil formulations (see labels)				
	OR	Captan 50WP	1 1/2 lb/100 gal	96 (E)	0	
		or Captan 4L	1 pt/100 gal	24 (E)		
	OR	Echo 6F	1.0-1.4 pt/100 gal	12 hr/ 7days(E)	SS	
		or Echo 90DF	0.75-1.2 lb/100 gal			
	OR	Elevate 50WDG	0.33-0.5 lb/100 gal	12	0	
	OR	Elite 45DF	2 oz/100 gal	12	0	[2.8]
	OR	Indar 75WS	0.8 oz/100 gal	12	0	[2.8]
	OR	Orbit 3.6EC	1.6 floz/100 gal	24	0	[2.8]
	OR	Rally 40WSP	2.5 to 6 oz per acre	12	0	
	OR	Rovral 50WP	8-10 oz/100 gal (max 2 lb/A)	24	PF	[2.3]
		or Rovral 4F	8-10 floz/100 gal	24	PF	[2.3]
	OR	§Sulfur 95WP	5 lb/100 gal	24	0	

Table 14.3.1. Pesticide Spray Table - Peaches and Nectarines.

Refer to back of book for key to abbreviations and footnotes.

Refer to label for registration status before applying any pesticide to nectarines.

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Brown rot (blossom blight) *(continued)*	*OR*	Quash	2.5 to 4 oz/Acre	12	14	
	OR	Vangard 75WG	5 oz/A	12	BL	
	OR	Scala 600SC	9-18 fl oz/A	12	2	
	OR	Pristine 38WDG	10.5-14.5 oz/A	12	0	
	OR	Thiram Granuflo	3.9 to 5.1 lb/acre	24	7	
Tarnished plant bug		*Ambush 25WP	6.4-19.2 oz/100 gal	12	14	[19.1]
	OR	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	14	
	OR	*Carzol 92SP	4 oz/100 gal	4-16 days(E)	PF	
	OR	Assail 30SG	5.3 to 8 oz/acre	12	7	
	OR	Beleaf 50SG	2 to 2.8 oz/acre	12	14	
	OR	*Baythroid 2EC	2.0-2.4 fl oz/A	12	7	
		or *Baythroid XL 1EC	2.0-2.4 fl oz/A	12	7	
		Leverage 2.7SE	3.6 to 6.4 fl oz per acre	12	7	
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	14	
	OR	*Pounce 3.2EC	4-12 fl oz/A	12	14	
		or *Pounce 25WP	6.4-19.2 oz/A	12	14	
	OR	*Warrior II	2.6-5.1 fl oz/A	24	14	
Bloom						
Brown rot (blossom blight)		See materials listed under Pink				
Oriental fruit moth		See comments [16.1] regarding pheromone disruption				
Petal Fall						
Brown rot (blossom blight)		See materials listed under Pink				
American plum borer, Peachtree borer, Lesser peachtree borer		*Baythroid XL 1EC				[10.2]
		or *Baythroid 2EC				
	OR	Leverage 2.7SE	[see Comment]			[10.2]
	OR	*Lorsban 4EC	3 qt/100 gal	96	14	[10.1]
	OR	Pheromone disruption ties:				
		§Isomate-LPTB	100/acre			[17.1]
Green peach aphid		Assail 30SG	2.5 to 5.3 oz per acre	12	7	
	OR	Beleaf 50SG	2 to 2.8 oz per acre	12	14	
		*Lannate 2.4L	3/4-1 1/2 pt/100 gal	48-96 (E)	4	[13.1]
		or *Lannate 90SP	1/4-1/2 lb/100 gal			
	OR	*Thionex 3EC	2/3 qt/100 gal	48	21/30(A)	
		or *Thionex 50WP	1 lb/100 gal	96	21	
Oriental fruit moth		See materials listed under Shuck Split				
Tarnished plant bug		See materials listed under Pink				[19.1]
Western flower thrips		*Carzol 92SP	4 oz/100 gal	4-16 days(E)	PF	
	OR	SpinTor 2SC	4-8 fl oz/A	4	14	
		or §Entrust 80WP	1.25-2.5 oz/A			

Table 14.3.1. Pesticide Spray Table - Peaches and Nectarines.

Refer to back of book for key to abbreviations and footnotes.

Refer to label for registration status before applying any pesticide to nectarines.

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Shuck Split						
Brown rot (**blossom blight**)		Bravo Ultrex 82.5WDG or Bravo WeatherStik 6F or Bravo Weather Stik 6F or other chlorothalonil formulations (see labels)	0.9-1.25 lb/100 gal 3.125 to 4.125 pt/acre 1.0-1.4 pt/100 gal	12hr/ 7days(E)	SS	[3.1]
	OR	Captan 50WP	1 1/2 lb/100 gal	96 (E)	0	
	OR	Indar 75WS	0.8 oz/100 gal	12	0	[2.8]
	OR	Echo 6F or Echo 90DF	1.0-1.4 pt/100 gal 0.75-1.2 lb/100 gal	12hr/ 7days(E)	SS	
	OR	Elevate 50WDG	0.33-0.5 lb/100 gal	12	0	
	OR	Orbit 3.6EC	4 fl oz per acre	12	0	
	OR	Pristine 38WDG	10.5-14.5 oz/A	12	0	
	OR	Quash	2.5 to 4 oz/acre	12	14	
	OR	Rally 40WSP	2.5 to 6 oz per acre	12	0	
	OR	§Sulfur 95WP	5 lb/100 gal	24	0	[2.6]
	OR	Thiram Granuflo	3.9 to 5.1 lb per acre	24	7	
Bacterial spot		§Mycoshield 17WP	12 oz/100 gal	96(E)	21	[1.2]
	OR	Flameout 17WP	12 oz/100 gal	12	21	
Peach scab		Abound	4-5 fl oz/100 gal	4	0	
	OR	Bravo Ultrex 82.5WDG or Bravo Weather Stik 6F or other chlorothalonil formulations (see labels)	0.9-1.25 lb/100 gal 1.0-1.4 pt/100 gal	12 hr/ 7days (E)	SS	[4.2]
	OR	Echo 6F or Echo 90DF	1.0-1.4 pt/100 gal 0.75-1.2 lb/100 gal	12hr/ 7days (E)	SS	
	OR	Captan 50WP or Captan 4L	2 lb/100 gal 1 1/2-2 pt/100 gal	96 (E) 24 (E)	0	
	OR	Gem 500SC	1.9-3.8 oz/A	12	1	
	OR	Indar 75WS	0.8 oz/100 gal (max 2 oz/A)			
	OR	§Sulfur 95WP	5 lb/100 gal	24	0	
	OR	Quash	2.5 to 4 oz/acre	12	14	
	OR	Thiram Granuflo	3.9 to 5.1 lb per acre			
	OR	Topsin M 70WSB *plus* Captan 50WP	6 oz/100 gal 1 lb/100 gal	96(E)	1	
Obliquebanded leafroller		*Baythroid 2E or *Baythroid XL 1L	2.4-2.8 fl oz/A 2.4-2.8 fl oz/A	12 12	7 7	[15.1]
	OR	Belt	3 to 4 oz/acre	12	7	
	OR	§Biobit XL2.1FC	1.5-5.5 pt/A	4	0	
	OR	§Deliver 18WG	1/2-2 lb/A	4	0	
	OR	Delegate WG	4.5 to 7 oz/acre	4	14 (1)	

Table 14.3.1. Pesticide Spray Table - Peaches and Nectarines.

Refer to back of book for key to abbreviations and footnotes.

Refer to label for registration status before applying any pesticide to nectarines.

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Obliquebanded	*OR*	§Dipel DF 10.3DF	1/2-2 lb/A	4	0	
leafroller	*OR*	SpinTor 2SC	4-8 fl oz/A	4	14	
(continued)		or §Entrust 80WP	1.25-2.5 oz/A			
Oriental fruit moth,		*Ambush 25WP	6.4-19.2 oz/A	12	14	[16.2]
Lesser peachtree	*OR*	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	14	
borer, Plum curculio	*OR*	Assail 30SG	5.3 to 8 oz per acre	12	7	
	OR	Avaunt 30WDG	5 to 6 oz per acre	12	14	
	OR	§Aza-Direct 1.2L	12.5-42 fl oz/A	4	0	[9.1]
	OR	§Azatin XL Plus 3L	10-21 fl oz/A	4	0	
	OR	*Baythroid 2EC, or *Baythroid XL 1EC				
		for lesser peachtree borer:	1.4-2.0 fl oz/A	12	7	
		for oriental fruit moth:	2.0-2.4 fl oz/A	12	7	
		for plum curculio:	2.4-2.8 fl oz/A	12	7	
	OR	Delegate 25WG	6 to 7 oz per acre	4	1/14	
	OR	*Imidan 70WP	3/4 lb/100 gal	72	14	
	OR	Leverage 2.7SE	3 to 5.1 fl oz per acre			
	OR	§Neemix 4.5L	7-16 fl oz/A	12	0	
	OR	*Pounce 25WP	6.4-19.2 oz/A			
	OR	Proaxis 0.5CS	2.6-5.1 fl oz/A	24	14	
	OR	Sevin XLR Plus, 4F	2-3 qt/A	12	3	
		or *Sevin 80WS	2.5-3.75 lb/A			
	OR	§Surround 95WP	50 lb/100 gal	12	3	[18.2]
	OR	*Warrior II	1.28 to 2.56 fl oz/acre	24	14	
	OR	Pheromone disruption:				
		or §Checkmate OFM-F	1.32-2.93 fl oz/A			[16.1]
		or §Isomate-M 100	100 ties/A			[16.1]
		§Isomate-LPTB	100 ties/A			[17.1]
Scale		Centaur	34.5 oz/A	12	14	
Additional Summer Sprays						
Bacterial spot		§Mycoshield 17WP	12 oz/100 gal	12	21	[2.7]
	OR	Flameout 17WP	12 oz/100 gal	12	21	
Brown rot		Captan 50WP	2 lb/100 gal	96 (E)	0	[2.7]
(**Blossom blight**)		or Captan 4L	1 1/2-2 pt/100 gal	24 (E)		
	OR	Elevate 50WDG	0.33-0.5 lb/100 gal	12	0	
	OR	Elite 45DF	2 oz/100 gal	12	0	
	OR	Indar 75WS	0.8 oz/100 gal (max 2 oz/A)	12	0	
	OR	Orbit 3.6EC	1.6 fl oz/100 gal (max 4 fl oz/A)	24	0	
	OR	Pristine 38WDG	10.5-14.5 oz/A)	12	0	
	OR	Quash	2.5 to 4 oz/acre	12	14	
	OR	Rally 40WSP	2.5 to 6 oz per acre	12	0	
	OR	Thiram Granuflo	3.9 to 5.1 lb per acre	24	7	
	OR	§Sulfur 95WP	5 lb/100 gal	24	0	
Peach scab		Captan 50WP	2 lb/100 gal	96 (E)	0	[4.2]
		or Captan 4L	1 1/2-2 pt/100 gal	24 (E)		

Table 14.3.1. Pesticide Spray Table - Peaches and Nectarines.

Refer to back of book for key to abbreviations and footnotes.

Refer to label for registration status before applying any pesticide to nectarines.

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Peach scab *(continued)*	*OR*	Gem 500SC	1.9-3.8 oz/A	12	1	
	OR	Pristine 38WDG	10.5-14.5 oz/A)	12	0	
	OR	§Sulfur 95WP	5 lb/100 gal	24	0	
	OR	Thiram Granuflo	3.9 to 5.1 lb per acre			
	OR	Topsin M 70WSB *plus* Captan 50WP	6 oz/100 gal 1 lb/100 gal	96(E)	1	
Powdery mildew (rusty spot)		§Sulfur 95WP	3 lb/100 gal	24	0	[7.2]
European red mite, Twospotted spider mite		Acramite 50WS	0.75-1.0 lb/A	12	3	[12.2]
	OR	Apollo 4SC	2-8 oz/A	12	21	
	OR	Nexter 75WS	4.4-10.7 oz/A	12	7	
	OR	Onager 1EC	12 to 24 fl oz per acre	12	28	
	OR	Savey 50DF	3-6 oz/A	12	28	
	OR	*Vendex 50WP	1-2 lb/A	48	14	
	OR	Envidor	16-18 oz/A	12	7	
	OR	Portal	1-2 pt/A	12	365	[12.3]
Green peach aphid		Assail 30SG	2.5 to 5.3 oz per acre	12	7	
	OR	Beleaf 50SG	2 to 2.8 oz per acre	12	14	
	OR	*Lannate 2.4L or *Lannate 90SP	3/4-1 1/2 pt/100 gal 1/4-1/2 lb/100 gal	48-96 (E)	4	[13.1]
	OR	Movento	6 to 9 fl oz/acre	24	7	
	OR	*Provado 1.6F	2 oz/100 gal	12	0	
	OR	*Thionex 3EC or *Thionex 50WP	2/3 qt/100 gal 1 lb/100 gal	48 96	21/30(A) 21	
Japanese beetle		Assail 30SG	5.3 to 8 oz per acre	12	7	
	OR	Leverage 2.7SE	3.6 to 4.4 fl oz per acre	12	7	
		*Provado 1.6F	2 fl oz/100 gal	12	0	
	OR	Sevin XLR Plus, 4F or Sevin 80S, *80WS	2-3 qt/A 2.5-3.75 lb/A	12	3	
Oriental fruit moth		Pheromone disruption: §Checkmate OFM-F or §Isomate-M 100	 1.32-2.93 fl oz/A 100 ties/A			
	OR	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	14	[16.3]
	OR	Assail 30SG	5.3 to 8 oz per acre	12	7	
	OR	*Baythroid 2E or *Baythroid XL 1L	2.0-2.4 fl oz/A 2.0-2.4 fl oz/A	12 12	7 7	
	OR	Proaxis 0.5CS	2.6-5.1 fl oz/A	24	14	
	OR	Delegate 25WG	6 to 7 oz per acre	4	1/14	
	OR	Sevin XLR Plus, 4F or Sevin 80S, *80WS	2-3 qt/A 2.5-3.75 lb/A	12	3	
	OR	*Warrior II	1.28 to 2.56 fl oz/acre	24	14	
Peachtree borers (including Lesser Peachtree borer)		*Ambush 25WP	6.4-19.2 oz/A	12	14	[17.3]
	OR	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	14	
	OR	*Baythroid XL 1EC or *Baythroid 2EC	1.4 to 2 fl oz per acre	12	7	
	OR	Lorsban 4EC	1.5-3 qt/100 gal	96	14	
	OR	*Pounce 25WP	6.4-19.2 oz/A			

Table 14.3.1. Pesticide Spray Table - Peaches and Nectarines.

Refer to back of book for key to abbreviations and footnotes.
Refer to label for registration status before applying any pesticide to nectarines.

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Peachtree borers (including Lesser Peachtree borer) *(continued)*	*OR*	Proaxis 0.5CS	2.6-5.1 fl oz/A	24	14	
	OR	*Thionex 3EC	1 qt/100 gal	48	21/30(A)	
		or *Thionex 50WP	1.5 lb/100 gal	96	21	
	OR	*Warrior II	1.28 to 2.56 fl oz/acre	24	14	
Tarnished plant bug,		*Ambush 25WP	6.4-19.2 oz/A	12	3	[19.3]
	OR	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	14	
	OR	Assail 30SG				
	OR	*Baythroid 2E	2.0-2.4 fl oz/A	12	7	
		or *Baythroid XL 1L	2.0-2.4 fl oz/A	12	7	
	OR	Beleaf 50SG	2 to 2.8 oz per acre			
	OR	Leverage 50SG	3 to 5.1 fl oz/acre			
	OR	*Pounce 25WP	6.4-19.2 oz/A			
	OR	Proaxis 0.5CS	2.6-5.1 fl oz/A	24	14	
	OR	*Warrior II	1.28 to 2.56 fl oz/acre	24	14	
Western flower thrips		SpinTor 2SC	4-8 fl oz/A	4	14	[20.2]
		or Entrust 80WP	1.25-2.5 oz/A			
	OR	Delegate WG	4.5 to 7 oz/acre			
After Harvest, Before Leaf Drop						
Prunus stem pitting virus		Product 2,4-D as described in the weed control section for "Dandelion and other broadleaf weeds in sod cover"				
X-Disease		§Tree Tech OTC (oxytetracycline)	Tree injection: See label instructions			[9.4]
	OR	Mycoject	Tree injection: See label instructions			

Table 14.3.2. Growth Regulator Uses in Peaches and Nectarines.

Refer to back of book for key to abbreviations and footnotes.
Refer to label for registration status before applying any pesticide to nectarines.

Timing	Product	Concentration	Rate of Formulated Product	Comments
CHEMICAL THINNING				
50–80% Bloom	ATS (foliar nutrient)		4-6 gal/100 gal	Apply 100 gal/acre.
PREHARVEST FRUIT DROP CONTROL				
1-2 weeks before anticipated harvest	ReTain	132 ppm	333 g/acre (1 pouch)	Apply in sufficient water to ensure thorough but not excessive coverage. An organosilicone surfactant (12 oz/100 gal) should be used with ReTain.

15 General Pest Management Considerations – Apricots

15.1 Diseases

Bacterial Canker (Pseudomonas syringae)

• Biology & Cultural

See the description of pathogen biology and copper spray timing for this disease under "Cherries—Diseases." No recent research has been done on bacterial canker in apricots under east coast conditions. However, this pathogen is probably responsible for much of the early tree death that follows limb die-back and trunk cankers that commonly develop in young apricot plantings. *P. syringae* can also cause a severe blossom blast on apricots if pathogen populations are high when a bloom-time frost occurs. Blossom blast can kill most of the spurs on affected trees.

When pruning, make sure to leave a 6-inch stub, especially when removing scaffold branches as the bacteria appear to be arrested within the stub. Avoid flush cut pruning.

To minimize the potential for severe losses from bacterial canker, apricot plantings should not be located adjacent to old sweet cherry orchards nor close to hedgerows or woodlots that contain wild Prunus (especially wild black cherry, *Prunus serotina*). Copper sprays should be applied in spring and fall as for sweet cherries. The spring copper spray may be even more important on apricot than on sweet cherry because apricots appear more sensitive to blossom blast. Entry of the pathogen through pruning wounds can be minimized if pruning is done during hot, dry weather after bloom or after harvest, because *P. syringae* is suppressed by hot weather. Trunks and scaffolds on apricot trees should be painted with white latex paint in autumn to reduce the potential for winter injury, as *P. syringae* can also enter where bark is injured during winter.

• Pesticide Application Notes

[1.1] Optimum timing and effectiveness of copper applications for control of bacterial canker and blossom blast of apricots has not been determined under eastern conditions. However, applying copper at the maximum labeled rates at the late dormant stage should increase the likelihood that effective copper residues will remain on the trees throughout the bloom period. Copper applications are especially important on young trees because trees less than five years old can be killed by bacterial canker if infections reach the main trunk.

Bacterial Spot (Xanthomonas arboricola pv. pruni)

• Biology & Cultural

Bacterial spot can be devastating to apricots. Apricot varieties developed in drier climates and then grown in the more humid climate of NY are the most likely to be susceptible. This disease will be more severe in the warmer southern portions of NY, in wet years, in orchards with lighter (sandy) soils, and in windy orchard sites. The bacterial spot pathogen, *Xanthomonas arboricola* pv. *pruni* infects leaf scars at leaf drop and overwinters in infected twigs. Bacteria populations subsequently multiply during warm weather and ooze out during spring rains. Immature tissues are less susceptible to the bacterial infection, and as such, infections will not begin until petal fall/shuck split. Early season copper applications applied to manage bacterial canker are quite effective for controlling the bacterial spot populations, but also likely to induce phytotoxicity if one is not careful.

• Pesticide Application Notes

Unfortunately, there are no materials registered for bacterial spot on apricots. Despite the effectiveness, do not make a dormant copper application for bacterial spot. Copper applications to manage bacterial canker and bacterial blast are still allowed whether or not the planting has bacterial spot.

Brown Rot

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this disease.

• Pesticide Application Notes

[2.1] Apricots are much more susceptible to blossom blight than any other stone-fruit species. At least 1 protective spray should be applied each year; repeat at full bloom and/or petal fall if wet weather prevails during bloom. Pristine, Indar, and Orbit are generally more effective than captan or Bravo. When used at a rate of 10 oz/100 gal dilute, Rovral provides 24–48 hr kickback activity against blossom blight infections at 68° F; Indar and Orbit also have significant kickback activity. Scala, Vangard, and Elevate have not been tested on apricots, but they have been effective for blossom blight on peaches.

[2.2] The shuck split application is an important spray. Chlorothalonil (Bravo, Echo) provides a longer period of protection than either captan or sulfur, but do not use Chlorothalonil after shuck split.

[2.3] Fruit are very susceptible to brown rot prior to pit hardening and the last 3 wk before harvest. It is recommended that spray intervals be shortened during the preharvest period and that Indar, Orbit, or Pristine be used if disease pressure is high (warm, wet). Indar and Orbit are registered for use beginning 3 weeks before harvest. Of these materials, Indar has the longest residual activity.

• Pesticide Resistance

[2.4] For resistance management purposes, the SI fungicides (Indar & Orbit) should not be used routinely throughout the season for BOTH blossom blight AND fruit

rot control. Where peaches within the same block ripen over an extended season, continued use of SI fungicides as preharvest sprays for successive varieties will also create selection pressure for fungicide resistance. Use captan or Pristine to break the string of preharvest SI fungicides applied to varieties with varied ripening or harvest dates.

Peach Scab

• Biology & Cultural

Peach scab can severely damage apricot if spring weather is warm and wet and no fungicides are applied at shuck split and first cover. The disease is more common following a year when spring frosts caused a crop failure, because trees grown for an entire summer without fungicides are more likely to carry peach scab infections the following year.

• Pesticide Application Notes

[3.1] Apply 2 or 3 sprays at 10–14-day intervals beginning at shuck split. Under light disease pressure, a single application of Bravo or Echo applied at shuck split may provide season-long control. Bravo and Echo cannot be applied after shuck split.

Perennial (Cytospora, Valsa) Canker

• Biology & Cultural

[4.1] See discussion of this disease under Peaches. Also, refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this disease.

Phytophthora Root, Crown, and Collar Rots

• Biology & Cultural

[5.1] Apricot rootstocks are perhaps more susceptible to Phytophthora root, crown, and collar rots than any other fruit tree rootstock grown in New England. The main defenses against these diseases should be providing good soil drainage through proper site selection and physical manipulations such as tiling or planting on berms. In general, berms are much more effective than tiling. See comment [5.2] about pesticide applications.

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this disease.

• Pesticide Application Notes

[5.2] In addition to the cultural practices noted in comment [5.1], Ridomil will provide additional protection in wet years, on marginal sites, or in wetter sections of the orchard. Applications should be made just before growth starts in the spring and at 2–3 month intervals thereafter if soil conditions are very wet. Apply to the soil beneath the tree canopy in sufficient water to assure good coverage (material is moved into the soil by subsequent rain or irrigation). See label for further details.

15.2 Insects and Mites

European Red Mite, Twospotted Spider Mite

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Pesticide Application Notes

[6.1] Apply as mites appear in a minimum of 50 gal/A. Limited to 1 application per season.

[6.2] Use lower rate of Nexter for European red mite, and higher rate of Nexter, for twospotted spider mite.

[6.3] Non-bearing trees only.

Oriental Fruit Moth

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Biological & Non-chemical Control

[7.1] Pheromone disruption is economically justified if 2–3 sprays are normally applied, and if no other insecticide sprays are routinely needed for other pests after petal fall. For this reason, disruption may not be economical for the 1st brood, as plum curculio sprays at this time normally would also control oriental fruit moth. Pheromones should be applied in mid-June before initiation of the 2nd flight; the need for re-application depends on residual field life of specific formulations: Isomate-M 100, 90 days; Checkmate and 3M SprayableOFM-F, 14 days. The residual lifeInsecticide sprays or a double rate of the 3M sprayable deposit can be extended by the additionpheromone may be needed in border rows of a spreader-sticker such as Nu-Film-17 at 1 pt/A. Border insecticide sprays may be needed in orchards adjacent to sources of adult immigration or in other high pressure situations.

• Pesticide Application Notes

[7.2] Summer sprays should be timed to start approximately at the 10% hatch point, 175-200 DD (base 45° F) after the first adult catch of the second brood, with a second application in 10-14 days. In high pressure blocks, a final spray should be applied 2 wk before harvest to control late season larvae. Suggested action threshold: Avg. of >10 adults/ week caught per pheromone trap.

Peachtree Borers (including Lesser peachtree borer)

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Biological & Non-chemical Control

[8.1] Hang pheromone ties at 100/acre in late May before lesser peachtree borer flight begins; use 200-250 peracre if population is predominantly peachtree borer.

• Pesticide Application Notes

[8.2] Up to 3 sprays of pyrethroids to trunk and scaffold limbs against larvae: June 1-10, July 7-15, and August 1-10 (do not spray fruit). OR 1 application of *Thionex immediately after harvest; do not spray fruit. *Baythroid and *Leverage not labeled for peachtree borer. Suggested action threshold: 1st emergence of adults plus 8 days (in blocks with a history of damage), or 1-2 larvae/tree.

Plum Curculio

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Pesticide Application Notes

[9.1] 2–3 applications. Begin at fruit set (shucks on) and follow at 8–10-day (for Sevin) or 10–14-day (for other products) intervals.

[9.2] Frequent applications (7–10-day intervals) of Surround and maximal coverage (minimum of 100 gal/A) are advised while there is active foliar growth.

Tarnished Plant Bug

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest. Satisfactory control requires adequate management of orchard weeds that attract this pest and act as alternate hosts.

• Monitoring & Forecasting

[10.1] Most catfacing injury is caused before shuck split. Later season feeding generally results in only minor surface scarring.

[10.2] Apply spray as insects or damage appears. Suggested action threshold: 3 bleeding sites/tree.

• Pesticide Application Notes

[10.3]At 10–14-day intervals as needed in midsummer. Suggested action threshold: 3 bleeding sites/tree.

Western Flower Thrips

• Biology & Cultural

Drought conditions and high temperatures may encourage damaging populations. Adults move from alternate weed or crop hosts to fruit just prior to and during harvest, feed on the fruit surface in protected sites, such as in the stem end, the suture, under leaves and branches, and between fruit. Feeding results in silver stipling or patches; injury is particularly obvious on highly colored varieties.

• Pesticide Application Notes

[11.1] In orchards with severe infestations, a petal fall application may be warranted against thrips feeding in fruit clusters. Control may be improved by addition of an adjuvant.

[11.2] An application immediately after harvest may prevent subsequent losses; however, an additional application may be needed if pressure is severe. Control may be improved by addition of an adjuvant. Note 14 day pre-harvest-interval.

Storage Rots

• Pesticide Application Notes

[12.1] A postharvest treatment with Scholar SC via dipping, flooders, T-jet, or similar system for control of storage rots is recommended for fruit coming from orchards where sporulating brown rot was observed, or when one hopes keep fruit in cold storage for a few days prior to sale. Holding tanks in postharvest treatment equipment must have excellent agitation to keep fungicides in suspension. Solutions must be replenished regularly as directed on the product label. Never exposed treated fruit to direct sunlight. This will cause the fungicide to break down.

15.3 Apricot Spray Tables

Table 15.3.1. Pesticide Spray Table -- Apricots.

Refer to inside back cover for key to abbreviations and footnotes.

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Late Dormant						
Phytophthora root, crown and collar rots		Ridomil Gold 4EC	2 qt per acre	48	0	[5.1]
Bacterial canker (*Pseudomonas syringae*)		Kocide 40DF	12 lb per acre	24	BL,PH(C)	[1.1]
		or Kocide 50WP				
		or §Cuprofix Ultra 40 Disperss	5.8 lb/A	12	BL,PH(C)	
		other coppers	See comments			
Popcorn						
Brown rot (Blossom blight)		Bravo Ultrex 82.5WDG	0.9-1.25 lb/100 gal	12hr/7days (E)	SS	
		or Bravo Weather Stik 6F	1.0-1.4 pt/100 gal			
		or other chlorothalonil formulations (see labels)				
		Captan 50WP	2 lb/100 gal	96 (E)	0	[2.1]
		or Captan 4L	1 qt/100 gal	24 (E)		
	OR	Echo 6F	1.0-1.4 pt/100 gal	12 hr/7days(E)	SS	
		or Echo 90DF	0.75-1.2 lb/100 gal			
	OR	Elevate 50WDG	0.33-0.5 lb/100 gal (max 6 lb/A)	12	0	
	OR	Indar 75WS	0.8 oz/100 gal (max 2 oz/A)	12	0	
	OR	Orbit 3.6EC	1.6 fl oz/100 gal (max 4 fl oz/A)	24	0	
	OR	Rally 40 WSP	2.5 to 6 oz per acre			
	OR	Rovral 50WP	8-10 oz/100 gal (max 2 lb/A)	24	PF	
		or Rovral 4F	8-10 fl oz/100 gal			
	OR	Pristine 38WDG	10.5-14.5 oz/A	12	0	
	OR	Quash	2.5 to 4 oz/acre	12	14	
	OR	Scala 600SC	9-18 fl oz/A	12	2	
	OR	Vangard 75WG	5 oz/A	12	BL	
Tarnished plant bug		See materials listed under Petal Fall.				[10.1]
Bloom						
Brown rot (blossom blight)		See materials and comments listed under Popcorn.				
Petal Fall						
Brown rot (Blossom blight)		See materials and comments listed under Popcorn, except Vangard, which cannot be used after bloom.				
Plum curculio		Assail 30SG	5.3-8 oz/Acre	12	7	
	OR	Avaunt 30 WDG	5 to 6 oz per acre			
	OR	*Imidan 70WP	3/4-1 lb/100 gal	72	14	[9.1]
	OR	*Baythroid 2EC	2.4-2.8 fl oz/A	12	7	
		or *Baythroid XL 1EC	2.4-2.8 fl oz/A	12	7	
	OR	Leverage 2.7 SE	3 to 5.1 fl oz per acre			

Table 15.3.1. Pesticide Spray Table -- Apricots.
Refer to inside back cover for key to abbreviations and footnotes.

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Plum curculio *(continued)*	*OR*	Sevin XLR Plus, 4F	2-3 qt/A	12	3	
		or Sevin 80, *80WS	2.5-3.75 lb/A	12	3	
	OR	§Surround 95WP	50 lb/100 gal	4	0	[9.2]
Peachtree borers (including Lesser peachtree borer)		Pheromone disruption ties: §Isomate-LPTB	100 ties per acre			[8.1]
Tarnished plant bug		*Asana XL 0.66EC	2-5.8 oz/100 gal	12	14	[10.2]
	OR	Assail 30SG	5.3-8 oz/Acre	12	7	
	OR	*Baythroid 2EC	2.0-2.4 fl oz/A	12	7	
		or *Baythroid XL 1EC	2.0-2.4 fl oz/A	12	7	
		*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	14	
	OR	*Warrior II	1.28 to 2.56 fl oz/acre	24	14	
Western flower thrips		SpinTor 2SC	4-8 fl oz/A	4	14	[20.2]
		or §Entrust 80WP	1.25-2.5 oz/A			
	OR	Delegate WG	4.5 to 7 oz/acre	4	14	
Shuck Split						
Brown rot (Blossom blight)		Bravo Ultrex 82.5WDG	0.9-1.25 lb/100 gal	12hr/ 7days(E)	SS	
		or Bravo Weather Stik 6F	1.0-1.4 pt/100 gal			
		or other chlorothalonil formulations (see labels)				
	OR	Captan 50WP	2 lb/100 gal	96 (E)	0	[2.2]
		or Captan 4L	1 qt/100 gal	24 (E)		
	OR	Echo 6F	1.0-1.4 pt/100 gal	12hr/ 7days(E)	SS	
		or Echo 90DF	0.75-1.2 lb/100 gal			
	OR	Pristine 38WDG	10.5-14.5 oz/A)	12	0	
	OR	Quash	2.5 to 4 oz/acre	12	14	
	OR	Rally 40 WSP	2.5 to 6 oz per acre	12	0	
	OR	§Sulfur 95WP	5 lb/100 gal	24	0	
Peach Scab		Any of the products listed above (except Quash) for brown rot at shuck split.				[3.1]
	OR	Gem 500SC	1.9-3.8 oz/A	12	1	
Additional Summer Sprays						
Brown rot (Blossom blight)		Captan 50WP	2 lb/100 gal (max 5 lb/A)	96 (E)	0	[2.3]
		or Captan 4L	1 qt/100 gal (max 5 qt/A)	24 (E)		
	OR	Elevate 50WDG	0.33-0.5 lb/100 gal (max 6 lb/A)	12	0	
	OR	Indar 75WS	0.8 oz/100 gal (max 2 oz/A)	12	0	
	OR	Orbit 3.6EC	1.6 floz/100 gal (max 4 fl oz/A)	24	0	
	OR	Pristine 38WDG	10.5-14.5 oz/A)	12	0	
	OR	Quash	2.5 to 4 oz/acre			
	OR	Rally 40 WSP	2.5 to 6 oz per acre	12	0	
	OR	§Sulfur 95WP	5 lb/100 gal	24	0	

Table 15.3.1. Pesticide Spray Table -- Apricots.
Refer to inside back cover for key to abbreviations and footnotes.

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
European red mite,		Apollo 4SC	2-8 oz/A	12	21	[6.1]
Twospotted spider	*OR*	§Nexter 75WS	4.4-10.7 oz/A	12	300(PH)	[6.2]
mite	*OR*	Onager 1 EC	12 to 24 fl oz per acre	12	28	
	OR	Savey 50DF	3-6 oz/A	12	28	
Oriental fruit moth		Pheromone disruption ties:				
		§Checkmate OFM-F	1.32-2.93 fl oz/A			
		§Isomate-M 100	100 ties/A			
	OR	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	14	[7.2]
	OR	Assail 30SG	5.3-8 oz/Acre	12	7	
	OR	*Baythroid 2EC	2.0-2.4 fl oz/A	12	7	
		or *Baythroid XL 1EC	2.0-2.4 fl oz/A	12	7	
	OR	Delegate 25 WG	6 to 7 oz per acre	4	14	
	OR	Leverage	3 to 5.1 fl oz per acre			
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	14	
	OR	Sevin XLR Plus, 4F	2-3 qt/A	12	3	
		or Sevin 80S, *80WS	2.5-3.75 lb/A			
	OR	*Warrior II	1.28 to 2.56 fl oz/acre	24	14	
Peachtree borers		*Asana XL 0.66EC	2-5.8 oz/100 gal	12	14	[8.2]
(including Lessser	*OR*	*Baythroid 2EC	1.4-2.0 fl oz/A	12	7	
peachtree borer)		or *Baythroid XL 1EC	1.4-2.0 fl oz/A	12	7	
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	14	
	OR	*Thionex 3EC	1 qt/100 gal	48	21/30(A)	
		or *Thionex 50WP	1.5 lb/100 gal	96		
	OR	*Warrior II	1.28 to 2.56 fl oz/acre	24	14	
Tarnished plant bug		*Asana XL 0.66EC	2-5.8 oz/100 gal	12	14	[10.3]
Stink bug	*OR*	Assail 30SG	5.3-8 oz/Acre	12	7	
	OR	*Baythroid 2EC	2.0-2.4 fl oz/A	12	7	
		or *Baythroid XL 1EC	2.0-2.4 fl oz/A	12	7	
	OR	Beleaf 50 SG	2 to 2.8 oz per acre	12	14	
	OR	Leverage	3.6 to 4.4 oz per acre	12	7	
	OR	*Warrior II	1.28 to 2.56 fl oz/acre	24	14	
Western flower thrips		SpinTor 2SC	4-8 fl oz/A	4	14	[11.2]
		or §Entrust 80WP	1.25-2.5 oz/A			
	OR	Delegate WG	4.5 to 7 oz/acre	4	14	
Postharvest						
European red mite, Twospotted spider mite		Nexter 75WS	4.4-10.7 oz/A	12	300(PH)	[6.2]
Peachtree borers		*Thionex 50WP	1.5 lb/100 gal	96	21	[8.2]
		or *Thionex 3EC	1 qt/100 gal	48		
Control of Storage Disorders						
Storage rots		Scholar SC	16 to 32 fl oz per 100 gal (see comments and label)			[12.1]

Table 15.3.1. Pesticide Spray Table -- Apricots.

Refer to inside back cover for key to abbreviations and footnotes.

Pest	Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Autumn					
Bacterial canker *(Pseudomonas syringae)*	Kocide 40DF	2-4 lb/100 gal (max 12 lb/A)	24	BL,PH(C)	[1.1]
	or Kocide 50WP or §Cuprofix Ultra 40 Disperss	10-16 lb/A	12	BL,PH(C)	
	or other coppers	See comments			

Table 15.3.2. Plant Growth Regulator Use in Apricots

Refer to inside back cover for key to abbreviations and footnotes.

Timing	Product	Concentration	Rate of Formulated Product	Comments
PREHARVEST FRUIT DROP CONTROL				
1-2 weeks before anticipated harvest	ReTain	132 ppm	0.74 lb/acre or 333 g/acre (1 pouch)	Apply in sufficient water to ensure thorough but not excessive coverage. An organosilicone surfactant (12 oz/100 gal) should be used with ReTain.

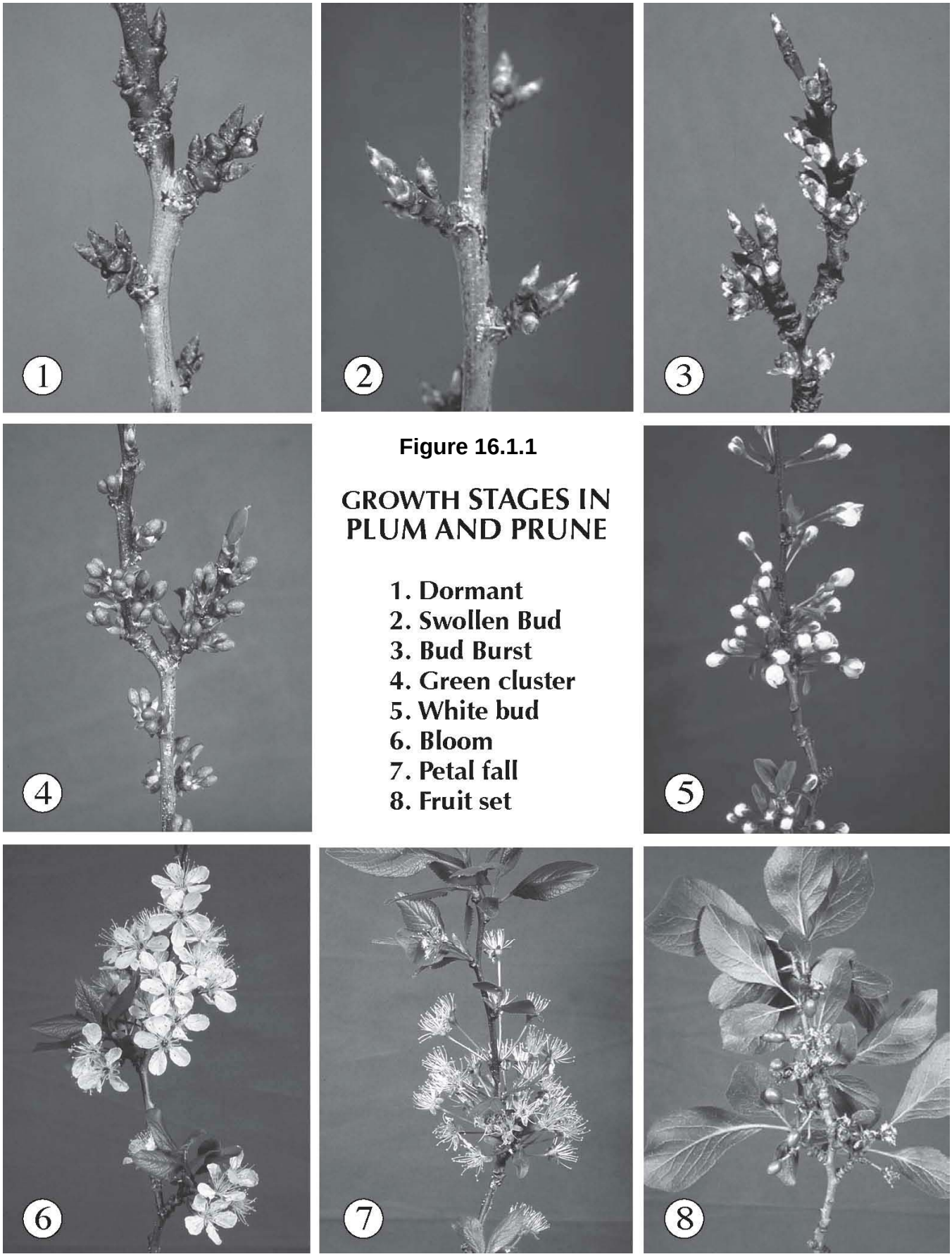

Figure 16.1.1

GROWTH STAGES IN PLUM AND PRUNE

1. Dormant
2. Swollen Bud
3. Bud Burst
4. Green cluster
5. White bud
6. Bloom
7. Petal fall
8. Fruit set

16 General Pest Management Considerations - Plums and Prunes

16.1 Diseases

Bacterial Spot (Xanthomonas arboricola pv. pruni)

• Biology & Cultural

Bacterial spot can be devastating to plums and prunes. Plum or prune varieties developed in drier climates and then grown in the more humid climate of NY are the most likely to be susceptible. This disease will be more severe in the warmer southern portions of NY, in wet years, in orchards with lighter (sandy) soils, and in windy orchard sites. The bacterial spot pathogen, *Xanthomonas arboricola* pv. *pruni* infects leaf scars at leaf drop and overwinters in infected twigs. Bacteria populations subsequently multiply during warm weather and ooze out during spring rains. Immature tissues are less susceptible to the bacterial infection, and as such, infections will not begin until petal fall/shuck split. Early season copper applications applied to manage bacterial blast are quite effective for controlling the bacterial spot populations, but also likely to induce phytotoxicity if one is not careful.

• Pesticide Application Notes

Unfortunately, there are no materials registered for bacterial spot on prunes and plums. Despite the effectiveness, do not make a dormant copper application for bacterial spot. Copper applications to manage bacterial blast are still allowed whether or not the planting has bacterial spot.

Black Knot

• Biology & Cultural

[1.1] Fungicide sprays will be relatively ineffective in controlling black knot unless old knots are pruned and removed or burned, preferably before bud break. Make pruning cuts at least 6–8 inches below visible swellings. Destroy wild plum and cherry trees along fence rows, for these are major sources of black knot inoculum.

[1.2] The most important period for black knot sprays is from white bud through shuck split. Black knot infection periods require rain and are most likely at temperatures above 55° F; thus, sprays are most likely to be beneficial under these conditions.

Refer to the reference materials list at the end of this publication for a Fact Sheet containing more details on the biology and management of this disease.

• Pesticide Application Notes

[1.3] Captan may cause injury on Stanley and Japanese-type plums if used repeatedly in early season sprays.

[1.4] Bravo and Echo are the most effective fungicides for black knot control. Topsin M is only moderately effective. Bravo and Echo are not labeled for use on plums after shuck split.

[1.5] If leaf spot has been a problem in previous years, include captan, sulfur, or Topsin M in each spray from petal fall until terminal growth stops. Pristine also controls leaf spot. A petal fall spray of Bravo or Echo is recommended if wet weather and inoculum availability favor black knot infection. This spray will also protect against early season brown rot infections of the green fruit.

[1.6] If black knot is present in the orchard or nearby, apply an appropriate fungicide in the first 2 cover sprays if weather conditions are favorable for infection (wet).

[1.7] Vangard may not be applied after bloom.

Brown Rot

• Biology & Cultural

[2.1] Blossom blight is most likely to be a problem when the weather is warm (above 60° F) and wet or when large numbers of fruit were not harvested the previous year. Blossom blight may also be a problem at lower temperatures if prolonged wetting periods occur. If these conditions do not occur, it is recommended that the white bud, bloom, and petal fall sprays be directed primarily at black knot. Bravo and Echo give superior control of black knot and will also control blossom blight.

Refer to the reference materials list at the end of this publication for a Fact Sheet containing more details on the biology and management of this disease.

• Pesticide Application Notes

[2.2] Captan may cause injury on Stanley and Japanese-type plums if used repeatedly in early season sprays.

[2.3] Some plum cultivars are very susceptible to brown rot for the first few wk after setting; therefore, the shuck split and first cover sprays are important for control of this disease unless the weather is very dry. Do not apply Topsin M without captan.

[2.4] Spray intervals should be shortened during wet periods and the last 3 wk before harvest, because this is when fruit are most susceptible to infection. Pristine and Orbit are the best materials for brown rot control if high disease pressure develops near harvest, because of their partially systemic and antisporulant activities. Orbit is labeled for use beginning 3 wk before harvest.

[2.5] Note the label warning that Orbit may affect the size and shape of "Stanley" plums.

Peach Scab

• Biology & Cultural

Peach scab can infect Japanese plum fruit in southern New England if spring weather is warm and wet and no fungicides are applied at shuck split and first cover. The disease is more common following a year when spring frosts caused a crop failure, because trees grown for an entire summer without fungicides are more likely to carry peach scab infections the following year. Fungicides applied to control black knot are usually sufficient to control peach scab.

• Pesticide Application Notes

[3.1] Apply 2 or 3 sprays at 10–14-day intervals beginning at shuck split. Under light disease pressure, a single application of Bravo or Echo applied at shuck split may provide season-long control. Bravo and Echo cannot be applied after shuck split.

Perennial (cytospora, valsa) Canker

• Biology & Control

[4.1] Perennial canker can be serious on Japanese-type plums and some prune cultivars. Refer to the discussion on this disease under Peaches. Also, refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this disease.

Phytophthora Root and Crown Rots

• Biology & Control

[5.1] Although plum rootstocks are relatively resistant to these diseases, Japanese-type plums that are planted on peach rootstocks are at the same risk as peach and apricot trees. Refer to the section on this disease under Peaches.

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this disease.

16.2 Insects and Mites

Apple Maggot

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Monitoring

[6.1] Suggested action threshold: 1 adult capture on yellow board or red sphere trap.

• Pesticide Application Notes

[6.2] Up to 3 sprays at 10-day intervals, beginning app. July 1 in southern New England.

European Fruit Lecanium Scale

• Monitoring

[7.1] 1 spray at the end of crawler hatch (mid-June), about 16–20 days after the 2nd plum curculio spray.

European Red Mite, Twospotted Spider Mite

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Monitoring

[8.1] Suggested action thresholds:
Bud Burst—10% of spurs with eggs
Shuck Split and later—6 motile forms/leaf.

• Pesticide Application Notes

[8.2] Apply acaricides when mites first surpass threshold; do not apply Acramite or Savey more than once, or Nexter or *Vendex more than 2 times per season. Use lower rate of Nexter for European red mite, higher rate for twospotted spider mite. Fujimite for non-bearing trees only.

Lesser Peachtree Borer, Peachtree Borer, American Plum Borer

• Biology & Cultural

Refer to the reference materials list at the end of this publication for Fact Sheets containing details on the biology and management of these pests. American plum borer can be a problem particularly in orchards adjacent to other stone fruit plantings.

• Biological & Non-chemical Control

[9.1] In orchards where lesser peachtree borer is the primary borer pest, hang pheromone ties at 100/acre in late May before flight begins. If population is predominantly peachtree borer, increase to 200-250acre.

• Pesticide Application Notes

[9.2] A single postharvest application of *Thionex or 3 sprays of *Asana or *Warrior to trunk and scaffold limbs against larvae: June 1–10, July 7–15, and August 1–10. *Baythroid and *Leverage not labeled for peachtree borer.

Oriental Fruit Moth

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Biological & Non-chemical Control

[10.1] Pheromone disruption is economically justified if 2–3 sprays are normally applied, and if no other insecticide sprays are routinely needed for other pests after

petal fall. For this reason, disruption may not be economical for the 1st brood, as plum curculio sprays at this time normally would also control oriental fruit moth. Pheromones should be applied in mid-June before initiation of the 2nd flight; the need for re-application depends on residual field life of specific formulations: Isomate-M 100, 90 days; Checkmate, OFM-F, 14 days. Insecticide sprays or a double rate of the 3M sprayable deposit can be extended by the additionpheromones may be needed in border rows of a spreader-sticker such as Nu-Film-17 at 1 pt/A. Border insecticide sprays may be needed in orchards adjacent to sources of adult immigration or in other high pressure situations.

• Pesticide Application Notes

[10.2] Summer sprays should be timed to start approximately at the 10% hatch point, 175-200 DD (base 45° F) after the first adult catch of the second brood, with a second application in 10-14 days. In high pressure blocks, a final spray should be applied 2 wk before harvest to control late season larvae. Avaunt will provide suppression only. Suggested action threshold: Avg. of >10 adults/week caught per pheromone trap.

Plum Curculio

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Pesticide Application Notes

[11.1] Also effective against and redbanded leafroller.

[11.2] Frequent applications (7–10-day intervals) of Surround and maximal coverage (minimum of 100 gal/A) are advised while there is active foliar growth.

Redbanded Leafroller

• Biology & Cultural

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

• Monitoring

[12.1] Suggested action threshold: 10% infested terminals from petal fall to shucks off; 5% infested terminals in late August.

• Pesticide Application Notes

[12.2] Imidan applied as the 2nd plum curculio spray controls this pest. May also need a spray 3 wk before harvest.

16.3 Storage Rots

[13.1] A postharvest treatment with Scholar SC via dipping, flooders, T-jet, or similar system for control of storage rots is recommended for fruit coming from orchards where sporulating brown rot was observed, or when one hopes keep fruit in cold storage for a few days prior to sale. Holding tanks in postharvest treatment equipment must have excellent agitation to keep fungicides in suspension. Solutions must be replenished regularly as directed on the product label. Never exposed treated fruit to direct sunlight. This will cause the fungicide to break down.

16.4 Plum and Prune Spray Tables

Table 16.4.1 Pesticide Spray Table – Plums and Prunes.

Refer to inside back cover for key to abbreviations and footnotes

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
Bud Burst						
European red mite		§oil	2 gal/100 gal	12	NA	[8.1]
White bud to Petal Fall						
Black knot		Bravo Ultrex 82.5 WDG	0.9-1.25 lb/100 gal	12 hr/ 7days(E)	SS	[1.1, 1.2]
		or Bravo Weather Stik 6F	1.0-1.4 pt/100 gal			[1.4]
		or other chlorothalonil formulations (see labels)				
	OR	Captan 50WP#	2 lb/100 gal	96(E)	0	[1.3]
		or Captan 80WP	1.25 lb/100 gal			
		or Captan 4L	1 qt/100 gal	24(E)		
	OR	Topsin M 70WP	4 oz/100 gal	96(E)	1	[1.4]
		or Topsin M 4.5F	10 fl oz/100 gal			
		plus Sulfur 95WP#	3 lb/100 gal			
Brown rot (blossom blight)		Bravo Ultrex 82.5WDG	0.9-1.25 lb/100 gal	12 hr/ 7days(E)	SS	
		or Bravo Weather Stik 6F	1.0-1.4 pt/100 gal			
		or other chlorothalonil formulations (see labels)				
	OR	Captan 50WP#	2 lb/100 gal	96(E)	0	[2.2]
		or Captan 80WP	1.25 lb/100 gal			
		or Captan 4L	1 qt/100 gal	24 (E)		
	OR	Echo 6F	1.0-1.4 pt/100 gal	12hr/ 7days(E)	SS	
		or Echo 90DF	0.75-1.2 lb/100 gal			
	OR	Elevate 50WDG	0.33-0.5 lb/100 gal	12	0	
	OR	Orbit 3.6EC	1.6 fl oz/100 gal (max 4 fl oz/A)	24	0	[2.5]
	OR	Pristine 38WDG	10.5-14.5 oz/A	12	0	[1.7]
	OR	Rally 40 W/WSP	2.5 – 6 oz/acre	12	0	
	OR	Quash 50 WDG	2.5 – 3.5 oz/acre	12	14	
	OR	Scala 600SC	9-18 fl oz/A	12	2	
	OR	Vangard 75WG	5 oz/A	12	BL	
	OR	§Sulfur 95WP	5 lb/100 gal	24	0	
Leaf spot		(See comments)				[1.5]
Shuck Split						
Brown rot, Black knot, Peach Scab		Bravo Ultrex 82.5WDG	0.9-1.25 lb/100 gal	12 hr/ 7days(E)	SS	[2.3, 3.1]
		or Bravo Weather Stik 6F	1.0-1.4 pt/100 gal			
		or other chlorothalonil formulations (see labels)				
	OR	Captan 50WP	2 lb/100 gal	96(E)	0	
		or Captan 4L	1 qt/100 gal	24 (E)		
	OR	Topsin M 70WP	4 oz/100 gal	96(E)	1	
		or Topsin M 4.5F	5 fl oz/100 gal			
		plus Captan 50WP	1.5 lb/100 gal			
		or Captan 4L	1.5 pt/100 gal	24 (E)		

Table 16.4.1 Pesticide Spray Table – Plums and Prunes.
Refer to inside back cover for key to abbreviations and footnotes

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
European red mite,		Acramite 50 WS	0.75 – 1.0 lb/acre	12	3	[8.2]
Twospotted spider mite	*OR*	*Agri-Mek 0.15EC *plus* oil	10 – 20 fl oz/acre	12	21	
	OR	Nexter 75WS	4.4-10.7 oz/A	12	7	
	OR	Onager 1 EC	12 – 24 fl oz/acre	12	28	
	OR	Savey 50DF	3-6 oz/A	12	28	
	OR	*Vendex 50WP	1-2 lb/A	48	14	
Oriental fruit moth,		*Asana 0.66EC	2-5.8 oz/100 gal	12	14	[10.2]
Plum curculio	*OR*	Assail 30 SG	5.3 – 8 oz/acre	12	7	
	OR	Avaunt 30 WDG	5 – 6 oz/acre	12	14	
	OR	§Aza-Direct 1.2L	12.5-42 fl oz/A	4	0	
		§Azatin XL Plus 3L	10-21 fl oz/A	40	0	
	OR	*Baythroid XL 1EC or *Baythroid 2 EC				
		for oriental fruit moth:	2.0-2.4 fl oz/A	12	7	
		for plum curculio:	2.4-2.8 fl oz/A	12	7	
	OR	*Imidan 70WP	3/4 lb/100 gal	72	7	[11.1]
	OR	Leverage 2.7 SE	3.0 – 5.1 fl oz/acre			
	OR	§Neemix 4.5L	4-7 fl oz/A	12	0	
	OR	Sevin XLR Plus, 4F	2-3 qt/A	12	3	
		or Sevin 80WS, *80WS	2.5-3.75 lb/A			
	OR	§Surround 95WP	50 lb/100 gal	4	0	[11.2]
	OR	Pheromone disruption:				
		or §Checkmate OFM-F	1.32-2.93 fl oz/A			[10.1]
		or §Isomate-M 100	100 ties/A			
Additional Summer Sprays						
Black knot		Captan 50WP#	2 lb/100 gal	96(E)	0	[1.6]
		or Captan 4L	1 qt/100 gal	24 (E)		
	OR	Topsin M 70WP	4 oz/100 gal	96(E)		
		or Topsin M 4.5F	5 fl oz/100 gal			
Brown rot (Blossom blight)		Captan 50WP	2 lb/100 gal	96(E)	0	[2.4]
		or Captan 4L	1 qt/100 gal			
	OR	Elevate 50WDG	0.33-0.5 lb/100 gal	12	0	
	OR	Orbit 3.6EC	1.6 fl oz/100 gal	24	0	[2.5]
	OR	Pristine 38WDG	10.5-14.5 oz/A	12	0	
	OR	Rally 40 W/WSP	2.5 – 6.0 oz/acre			
	OR	§Sulfur 95WP	5 lb/100 gal	24	0	
Apple maggot, European fruit lecanium scale		*Imidan 70WP	3/4 lb/100 gal	72	7	[6.2, 7.1]
European red mite,		Acramite 50WS	0.75-1.0 lb/A	12	3	[8.2]
Twospotted spider	*OR*	Nexter 75WS	4.4-10.7 oz/A	12	7	
mite	*OR*	Onager 1 EC	12 – 24 fl oz/acre	12	28	

Table 16.4.1 Pesticide Spray Table – Plums and Prunes.
Refer to inside back cover for key to abbreviations and footnotes

Pest		Product	Rate	REI (hrs)	PHI (days)	Comments (see text)
European red mite, Twospotted spider Mite *(continued)*	*OR*	Savey 50DF	3-6 oz/A	12	28	
	OR	*Vendex 50WP	1-2 lb/A	48	14	
	OR	Envidor	16-18 oz/A	12	7	
	OR	Portal	1-2 pt/A	12	365	
Lesser peachtree borer, Peachtree borer, American plum borer		*Asana 0.66EC	2-5.8 oz/100 gal	12	14	[9.2]
	OR	*Baythroid 2EC, or *Baythroid XL 1EC				
		for lesser peachtree borer:	1.4-2.0 fl oz/A	12	7	
		for American plum borer:	2.4-2.8 fl oz/A	12	7	
	OR	*Thionex 3EC	1 qt/100 gal	48	7	
		or *Thionex 50WP	1.5 lb/100 gal	96		
	OR	Pheromone disruption:				
		§Isomate-LPTB	100-250 ties/acre			[9.1]
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	14	
	OR	*Warrior II	1.28 – 2.56 fl oz/A	24	14	
Oriental fruit moth		Pheromone disruption:				
		or §Checkmate OFM-F	1.32-2.93 fl oz/A			
		or §Isomate-M 100	100 ties/A			
	OR	*Asana XL 0.66EC	2-5.8 oz/100 gal	12	14	[10.2]
	OR	Assail 30SG	5.3-8 oz/Acre	12	7	
	OR	*Baythroid 2EC	2.0-2.4 fl oz/A	12	7	
		or *Baythroid XL 1EC	2.0-2.4 fl oz/A	12	7	
	OR	Delegate 25 WG	6.0-7.0 oz/acre	4	7	
	OR	*Leverage 2.7 SE	3.0-5.1 fl oz/acre	12	7	
	OR	*Proaxis 0.5CS	2.6-5.1 fl oz/A	24	14	
	OR	Sevin XLR Plus, 4F	2-3 qt/A	12	3	
		or Sevin 80WS, *80WS	2.5-3.75 lb/A			
	OR	*Warrior II	1.28-2.56 fl oz/acre	24	14	
Redbanded leafroller		*Baythroid XL 1EC	2.4-2.8 fl oz/A	12	7	[11.1, 12.2]
		or *Baythroid 2 EC				
	OR	Delegate 25 WG	6.0-7.0 oz/acre	4	7	
	OR	SpinTor 2SC	4-8 fl oz/A	4	7	
		or §Entrust 80WP	1.25-2.5 oz/A			
Control of Storage Disorders						
Storage rots		Scholar SC	16-32 fl oz/100 gal			[13.1]

Table 16.4.2. Plant Growth Regulator Use in Plums and Prunes
Refer to inside back cover for key to abbreviations and footnotes.

Timing	Product	Concentration	Rate of Formulated Product	Comments
PREHARVEST FRUIT DROP CONTROL				
1-2 weeks before anticipated harvest	ReTain	132 ppm	333 g/acre (1 pouch) (12 oz/100 gal)	Apply in sufficient water to ensure thorough but not excessive coverage. An organosilicone surfactant (12 oz/100gal) should be used with ReTain.

17 Weed Control Guidelines

17.1 Apples

Table 17.1.1. Weed control guidelines for APPLES.

Weeds Controlled	Materials	Active Ingredient (lb)/A	Formulated Product/A	REI (hrs)
Year of Planting				
Annual grasses and broadleaf weeds				
Apply as soon as soil has settled and no cracks are present.				
	oxyfluorfen	1.6-2.0		
	(Goal 2XL, Galigan 2E)		3-4 qt	24
Oxyfluorfen applications limited to dormant trees (before buds on trees begin to grow).				
plus either	napropamide	4.0		
	(Devrinol 50DF)		8 lb	12
or	pendimethalin	4.0		
	(Prowl H2O)		2-4 qt	24
or	oryzalin	3.0-6.0		
	(Surflan AS)		2-4 qt	24
Additional measures may be needed to control later emerging weeds. Add *paraquat to help control established perennial grasses and weeds.				
	*paraquat	0.63-1.0		
	(*Gramoxone Max)		1.7-2.7 pt	12
Apply to emerged weeds as needed. Avoid contact of *paraquat with foliage or trunks of trees. SEE LABEL FOR WORKER SAFETY CAUTIONS.				
	Chateau (flumioxazin)		6-12 oz	12
Protect trees from spray contact by non-porous wraps, grow tubes, or waxed containers.				
	glyphosate	1.0-3.0		
	(Roundup, etc.)		1-4 qt	12
Apply to emerged weeds as needed. Avoid contact of glyphosate with foliage, branches, suckers or trunks of trees.				
	carfentrazone-ethyl	0.03		
	(Aim EW,EC)		1.9 oz	12
Apply in tank mix with paraquat or glyphosate for broadleaf and grass control, but avoid contact with green bark and foliage.				
Annual or perennial grasses				
	fluazifop	0.25-0.375		12
	(Fusilade DX)		1-1.5 pt	
Apply as separate spray when grass is 2-8 in tall. Repeat in 2-3 wk or before regrowth is 10 in tall. Add surfactant or crop-oil concentrate (see label). NONBEARING TREES ONLY.				
	sethoxydim	0.28-0.47		
	(Poast)		1.5-2.5 pt	12
Apply to actively growing grass before tillering or seedhead formation. Use with crop-oil concentrate (see label).				
Trees Established in Orchard for at Least One Full Year				
Materials as listed for year of planting				
or				
Annual grasses and broadleaf weeds				
	simazine	1.0-2.0		

Table 17.1.1. Weed control guidelines for APPLES.

Weeds Controlled	Materials	Active Ingredient (lb)/A	Formulated Product/A	REI (hrs)
Annual grasses and broadleaf weeds *(continued)*				
	(Simazine 90DF)		1.1-2.2 lb	
	(Caliber 90)		1.125-2.25 lb	
	(Princep 4L)		1-2 qt	12
	(Princep 90 WG)		2.2-4.4 lb	
plus	norflurazon	2.0-2.4		
	(Solicam 80DF)		2.5-3.0 lb	12
	Rimsulfuron		4 oz	
	(Matrix 25 DF use in tank mix with other herbicides)			
Apply early spring before weeds emerge. See soil-texture rate limitations for simazine and norflurazon. Add *paraquat to help control established weeds. Addition of napropamide, pendimethalin, or oryzalin have improved late-season annual grass and broadleaf control.				
or				
	simazine	1.0-2.0		
	(Simazine 90DF)		1.1-2.2 lb	
	(Caliber 90)		1.125-2.25 lb	
	(Princep 4L)		1-2 qt	12
plus	diuron	1.0-2.0		
	(Karmex 80DF, Diuron 80DF)		1.25-2.5 lb	12
Apply early spring before weeds emerge. See labels for soil-texture rate limitations for simazine and diuron. Add *paraquat to help control established weeds. Additions of napropamide or oryzalin have improved late-season annual grass and broadleaf weed control.				
or				
	diuron	1.0-2.0		
	(Karmex 80DF)		1.25-2.5 lb	12
plus	norflurazon	2.0-2.4		
	(Solicam 80DF)		2.5-3.0 lb	12
Apply early spring before weeds emerge. See soil-texture rate limitations for diuron and norflurazon. Add *paraquat to help control established weeds. Additions of napropamide, pendimethalin, or oryzalin have improved late-season annual grass and broadleaf weed control.				
	dichlobenil	4.0-6.0		
	(Casoron 4G)		100-150 lb	12 (E)
November to March when soil temp is below 45˚. Controls many annual and perennial grasses and weeds.				
	Chateau (flumioxazin)		6.0-12.0	12
Chateau should be tank mixed with labeled burndown herbicide (glyphosate, paraquat, 2,4-D, Rely 200) for control of emerged weeds. May be tank mixed with Surflan, simazine or diuron for additional residual weed control. Use 6.0 oz. rate on sandy soils and/or where trees are less than three years old.				
Established perennial grasses				
	*pronamide	2.0-4.0		
	(*Kerb 50WP)		4.0-8.0 lb	24
Apply late fall before soil freezes. Spring-planted trees must be established at least 6 mo; fall-planted trees at least 1 yr. Use other materials for broadleafs and late-summer annual grasses.				

Table 17.1.1. Weed control guidelines for APPLES.

Weeds Controlled	Materials	Active Ingredient (lb)/A	Formulated Product/A	REI (hrs)
Broadleaf weeds				
	2,4-D	1.4		
	(*Weedar 64; *Unison; *2,4-D Amine)		3 pt	48
Trees Established in Orchard at Least Two Full Years				
Materials as listed for younger trees				
or				
Annual grasses and broadleaf weeds				
	diuron	0.8-1.6		
	(Karmex 80DF)		1.0-2.0 lb	12
plus	terbacil	0.8-1.6		
	(Sinbar 80WP)		1.0-2.0 lb	12
	simazine	1.6-2.0		
	(Simazine 90DF)		1.8-2.2 lb	
	(Caliber 90)		1.75-2.25 lb	
	(Princep 4L)		1.6-2.0 qt	12
plus	terbacil	0.8-1.6		
	(Sinbar 80WP)		1.0-2.0 lb	12
Apply early spring before weeds emerge. See label for soil-texture rate limitations for diuron, simazine, and terbacil. Add *paraquat if emerged weeds are present. Second *paraquat application may be needed.				
Trees Established in Orchard at Least Three Full Years				
Materials as listed for younger trees				
or				
Annual grasses and broadleaf weeds				
	diuron	2.0-2.4		
	(Karmex 80DF)		2.5-3.0 lb	12
plus	simazine	2.0-2.4		
	(Simazine 90DF)		2.25-2.66 lb	
	(Caliber 90)		2.25-2.66 lb	
	(Princep 4L)		2-2.4 qt	12
Apply late fall or early spring before weeds emerge. See label for soil-texture rate limitations for simazine and terbacil. Add *paraquat to help control established weeds.				
or				
	simazine	2.0-2.4		
	(Simazine 90DF)		2.25-2.66 lb	
	(Caliber 90)		2.25-2.66 lb	
	(Princep 4L)		2-2.4 qt	12
plus	terbacil	2.0-2.4		
	(Sinbar 80WP)		0.6-1.2 lb lb	12
Apply late fall or early spring before weeds emerge. See label for soil-texture rate limitations for simazine and terbacil. Add *paraquat to help control established weeds.				

Table 17.1.1. Weed control guidelines for APPLES.

Weeds Controlled	Materials	Active Ingredient (lb)/A	Formulated Product/A	REI (hrs)
Established Orchards				
Established perennials, woody brush and vines				
	glyphosate	2.0-4.0		
	(Roundup/Roundup WeatherMax, Touchdown)		2-3 qt	12/4
Best timing varies with weed type. See label. Avoid contact of glyphosate with foliage, branches or trunks of trees less than 3 yr old.				
or	*Weedar 64; *2,4-D Amine; *Unison	2-3 pt		48
plus	glyphosate	2.0-3.0		
	(Roundup, etc.)		2-3 qt	12

***Restricted-use pesticide;** may be purchased and used only by certified applicators or used by someone under the supervision of a certified applicator. Refer to inside back cover for key to abbreviations and footnotes.*

17.2 Pears

Table 17.2.1. Weed control guidelines for PEARS.

Weeds Controlled	Materials	Active Ingredient (lb)/A	Formulated Product/A	REI (hrs)
Year of Planting				
Annual grasses and broadleaf weeds				
Apply as soon as soil has settled and no cracks are present.				
	oxyfluorfen	1.2-2.0		
	(Goal 2XL)		2.4-4 qt	24
Oxyfluorfen applications limited to dormant trees (before buds on trees begin to grow).				
plus either	napropamide	4.0		
	(Devrinol DF)		8 lb	12
or	pendimethalin	4.0		
	(Prowl 3.3EC, Prowl H2O)		4-8 qt	24
or	oryzalin	3.0-6.0		
	(Surflan AS)		3-6 qt	24
Add *paraquat to help control established perennial grasses and weeds.				
	Chateau (flumioxazin)		6.0	12
Protect trees from spray contact by non-porous wraps, grow tubes, or waxed containers.				
	*paraquat	0.63-1.0		
	(*Gramaxone Max)		1.7-2.7 pt	12
Apply to emerged weeds as needed. Avoid contact of *paraquat with foliage or trunks of trees. SEE LABEL FOR WORKER SAFETY CAUTIONS.				
	glyphosate	1.0-3.0		
	(Roundup, etc.)		1-3 qt	12
Apply to emerged weeds as needed. Avoid contact of glyphosate with foliage, branches, suckers or trunks of trees.				

Table 17.2.1. Weed control guidelines for PEARS.

Weeds Controlled	Materials	Active Ingredient (lb)/A	Formulated Product/A	REI (hrs)
Annual grasses and broadleaf weeds *(continued)*				
	carfentrazone-ethyl	0.03		
	(Aim EW, EC)		1.9 oz	12
Apply in tank mix with paraquat or glyphosate for broadleaf and grass control, but avoid contact with green bark and foliage.				
Annual or perennial grasses				
	fluazifop	0.25-0.375		
	(Fusilade DX)		1-1.5 pt	12
Apply when grass is 2-8 in. tall. Repeat in 2-3 wk or before regrowths is 10 in. tall. Apply as separate spray. Add surfactant or crop-oil concentrate (see label). NONBEARING TREES ONLY.				
	sethoxydim	0.28-0.47		
	(Poast)		1.5-2.0 pt	12
Apply to actively growing grass before tillering or seedhead formation. Use with crop-oil concentrate (see label).				
Trees Established in Orchard at Least One Full Year				
Materials as listed for year of planting				
or				
Annual grasses and broadleaf weeds				
	simazine	1.0-2.0		
	(Simazine 90DF)		1.1-2.2 lb	12
	(Caliber 90)		1.125-2.25 lb	12
	(Princep 4L)		1-2 qt	12
plus	norflurazon	2.0-2.4		
	(Solicam 80D)		2.5-3.0 lb	12
Apply early spring before weeds emerge. See soil-texture rate limitations for simazine and norflurazon. Add *paraquat to help control established weeds. Additions of napropamide, pendimethalin, or oryzalin have improved late-season annual grass & broadleaf weed control.				
or				
	simazine	1.0-2.0		
	(Simazine 90DF)		1.1-2.2 lb	12
	(Caliber 90)		1.125-2.25 lb	12
	(Princep 4L)		1-2 qt	12
plus	diuron	1.0-2.0		
	(Karmex 80DF)		1.25-2.5 lb	12
	rimsulofuron		4 oz	
	(Matrix 25 DF use in tank mix with other herbicides)			
Apply early spring before weeds emerge. See labels for soil-texture rate limitations. Add *paraquat to help control established weeds. Additions of napropamide, pendimethalin, or oryzalin have improved late-season annual grass & broadleaf control.				

Table 17.2.1. Weed control guidelines for PEARS.

Weeds Controlled	Materials	Active Ingredient (lb)/A	Formulated Product/A	REI (hrs)
Trees Established in Orchard at Least One Full Year *(continued)*				
or				
	diuron	1.0-2.0		
	(Karmex 80DF)		1.25-2.5 lb	12
plus	norflurazon	2.0-2.4		
	(Solicam 80DF)		2.5-3.0 lb	12
Apply early spring before weeds emerge. See labels for soil-texture rate limitations for diuron and norflurazon. Add *paraquat to help control established weeds. Additions of napropamide, pendimethalin, or oryzalin have improved late-season annual grass & broadleaf control.				
or				
	dichlobenil	4.0-6.0		
	(Casoron 4G)		100-150 lb	12(E)
November to March when soil temp is below 45˚F. Controls many annual and perennial grasses and weeds.				
	Chateau (flumioxazin)		6.0-12.0	12
Chateau should be tank mixed with labeled burndown herbicide (glyphosate, paraquat, 2,4-D, Rely 200) for control of emerged weeds. May be tank mixed with Surflan, simazine or diuron for additional residual weed control. Use 6.0 oz. rate on sandy soils and/or where trees are less than three years old. Do not apply to pears after bloom.				
Established perennial grasses				
	*pronamide	2.0-4.0		
	(*Kerb 50WP)		4.0-8.0 lb	24
Apply late fall before soil freezes. Use other materials for broadleafs.				
Broadleaf weeds				
	2,4-D	1.4		
	(*Weedar 64; *Unison; *2,4-D Amine)		3 pt	48
Trees Established in Orchard at Least Three Full Years				
Materials as listed for younger trees				
or				
Annual grasses and broadleaf weeds				
	diuron	2.0-2.4		
	(Karmex 80DF)		2.5-3.0 lb	12
plus	simazine	2.0-2.4		
	(Simazine 90DF)		2.2-2.7 lb	12
	(Caliber 90)		2.2-2.7 lb	12
	(Princep 4L)		2-2.4 qt	12
Apply late fall or early spring before weeds emerge. See labels for soil-texture rate limitations for simazine and diuron. Add *paraquat to help control established weeds.				
Established Orchards				
Established perennials, woody brush and vines				
	glyphosate	2.0-4.0		
	(Roundup, Touchdown)		2-3 qt	12
Best timing varies with weed type. See label. Avoid contact of glyphosate with foliage, branches or trunks of trees less than 3 yr old.				

Table 17.2.1. Weed control guidelines for PEARS.

Weeds Controlled	Materials	Active Ingredient (lb)/A	Formulated Product/A	REI (hrs)
Established Orchards *(continued)*				
	*Weedar 64; *2,4-D Amine; *Unison		2-3 pt	48
plus	glyphosate	2.0-3.0		
	(Roundup, etc.)	2-3 qt		

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17.3 Cherries

Table 17.3.1. Weed control guidelines for CHERRIES.

Weeds Controlled	Materials	Active Ingredient (lb)/A	Formulated Product/A	REI (hrs)
Year of Planting				
Annual grasses and broadleaf weeds				
Apply as soon as soil has settled and no cracks are present.				
	oxyfluorfen	1.2-2.0		
	(Goal 2XL)			
Oxyfluorfen applications limited to dormant trees (apply before buds begin to grow).				
plus either	napropamide	4.0		
	(Devrinol 50DF)		8 lb	12
or	pendimethalin	4.0		
	(Prowl 3.3EC, Prowl H2O)		4.8 qt	24
or	oryzalin	3.0-6.0		
	(Surflan AS)		3-6 qt	24
	Chateau (flumioxazin)		6.0	12
Protect trees from spray contact by non-porous wraps, grow tubes, or waxed containers.				
	*paraquat	0.63-1.0		
	(*Gramaxone Max)		1.7-2.7 pt	12
Apply *paraquat to emerged weeds as needed. Avoid contact with foliage or trunks of trees. SEE LABEL FOR WORKER SAFETY CAUTIONS.				
	carfentrazone-ethyl	0.03		
	(Aim EW, EC)		1.9 oz	12
Apply in tank mix with paraquat for broadleaf and grass control, but avoid contact with green bark and foliage.				
Annual and perennial grasses				
	fluazifop	0.25-0.375		
	(Fusilade DX)		1-1.5 pt	12
Apply fluazifop when grasses are 2-8 in tall. Repeat before regrowth is 10 in tall. Use surfactant or crop oil according to label directions.				

Table 17.3.1. Weed control guidelines for CHERRIES.

Weeds Controlled	Materials	Active Ingredient (lb)/A	Formulated Product/A	REI (hrs)
Annual and perennial grasses *(continued)*				
	sethoxydim	0.28-0.47		
	(Poast)		1.5-2.0 pt	12
Apply sethoxydim to actively growing grasses before tillering or seedhead formation. Use surfactant or crop oil according to label directions. Apply as a separate spray.				
Established perennial grasses				
	*pronamide	2.0-4.0		
	(*Kerb 50WP)		4-8 lb	24
Late fall but before soil freeze-up (November). Spring-planted trees must be established at least 6 mo., fall-planted trees at least 1 yr. Effective on quackgrass.				
Annual and perennial grasses and broadleaf weeds				
	dichlobenil	4.0-6.0		
	(Casoron 4G)		100-150 lb	12(E)
Apply Nov. to Mar. when soil temp is below 45˚F. Do not apply within 4 mo after planting.				
Trees Established in Orchard at Least One Full Year				
Materials as listed for year of planting				
or				
Annual grasses and broadleaf weeds				
	norflurazon	2.0-2.4		
	(Solicam 80DF)		2.5-3.0 lb	12
plus either	napropamide	4.0		
	(Devrinol 50DF)		8 lb	12
or	pendimethalin	4.0		
	(Prowl 3.3EC)		4.8 qt	24
or	oryzalin	3.0-4.0		
	(Surflan AS)		3-4 qt	24
or	norflurazon	2.0-2.4		
	(Solicam 80DF)		2.5-3.0 lb	12
plus	simazine	1.0-2.0		
	(Simazine 90DF)		1.1-2.2 lb	12
	(Caliber 90)		1.125-2.25 lb	12
	(Princep 4L)		1-2 qt	12
plus either	napropamide	4.0		
	(Devrinol 50DF)		8 lb	12
or	pendimethalin	4.0		
	(Prowl 3.3EC, Prowl H2O)		4.8 qt	24
or	oryzalin	3.0-6.0		
	(Surflan AS)		3-4 qt	24
Apply late fall or early spring before weeds emerge. Will not control established perennial grasses or weeds.				

Table 17.3.1. Weed control guidelines for CHERRIES.

Weeds Controlled	Materials	Active Ingredient (lb)/A	Formulated Product/A	REI (hrs)
Annual grasses and broadleaf weeds *(continued)*				
	Chateau (flumioxazin)		6.0-12.0	12
	rimsulfuron			
	(Matrix 25 DF use in tank mix with other herbicides)		4 oz	
Chateau should be tank mixed with labeled burndown herbicide (glyphosate, paraquat, 2,4-D, Rely 200) for control of emerged weeds. May be tank mixed with Surflan, simazine or diuron for additional residual weed control. Use 6.0 oz. rate on sandy soils and/or where trees are less than three years old.				
Dandelion and other broadleaf weeds in sod cover				
	2,4-D	1.4		
	(*2,4-D Amine)		3.0 pt	48
	(*Weedar 64; *Unison)		3.0 pt	48
Apply in the fall (best) or early spring BEFORE TREES OR DANDELIONS BEGIN TO BLOOM. Yearly application is needed to control dandelions. Avoid contact with fruit, foliage, stems, or limbs of trees. (Unison not a vaporizer)				
Newly Planted or Established Orchards				
Annual grasses and broadleaved weeds, perennial weeds, woody brush and vines				
	glyphosate	1.0-4.0		
	(Roundup, etc.)		1.0-4.0 qt	12
or	2 % solution for spot treatment		2 qt/25 gal	
Best timing varies with weed type; see label for specific directions. Avoid contact with foliage, branches, or trunks of trees less than 3 yr old. Does not provide residual weed control. See labels for tank-mix combinations.				
Established perennial broadleaf weeds				
	*Clopyralid	0.12-0.24		
	(*Stinger)		1/3-2/3 pt	12
Apply for post-emergence control of specific problem weeds such as Canada thistle, clover, vetch, dandelion, in row and row middles. Not to exceed 2/3 pt/A/year.				

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17.4 Peaches

Table 17.4.1. Weed control guidelines for PEACHES.

Weeds Controlled	Materials	Active Ingredient (lb)/A	Formulated Product/A	REI (hrs)
Year of Planting				
Annual grasses and broadleaf weeds				
Apply as soon as soil has settled and no cracks are present				
	oxyfluorfen	1.2-2.0		
	(Goal 2XL)		2.4-4 qt	24
Oxyfluorfen applications limited to dormant trees (before buds on trees begin to grow)				
plus either	napropamide	4.0		
	(Devrinol 50DF)		8 lb	12

Table 17.4.1. Weed control guidelines for PEACHES.

Weeds Controlled	Materials	Active Ingredient (lb)/A	Formulated Product/A	REI (hrs)
Annual grasses and broadleaf weeds *(continued)*				
or	pendimethalin	4.0		
	(Prowl 3.3EC, Prowl H2O)		4.8 qt	24
or	oryzalin	3.0-6.0		
	*Surflan AS)		3-6 qt	24
	*paraquat	0.63-1.0		
	(*Gramaxone Inteon)		1.7-2.7 pt	
Apply to emerged weeds as needed. Avoid contact of *paraquat with foliage or trunks of trees. SEE LABEL FOR WORKER SAFETY CAUTIONS.				
	carfentrazone-ethyl	0.03		
	(Aim EW, EC)		1.9 oz	12
Apply in tank mix with paraquat for broadleaf and grass control, but avoid contact with green bark and foliage.				
	Chateau (flumioxazin)		6.0	12
Protect trees from spray contact by non-porous wraps, grow tubes, or waxed containers.				
Annual and perennial grasses				
	fluazifop	0.25-0.375		
	(Fusilade DX)		1-1.5 pt	12
Grasses 2-8 in tall. Repeat before regrowth is 10 in tall. Use surfactant or crop oil according to label directions.				
	sethoxydim	0.28-0.47		
	(Poast)		1.5-2.0 pt	12
Apply to actively growing grasses before tillering or seedhead formation. Use surfactant or crop oil according to label directions. Apply as a separate spray.				
Established perennial grasses				
	*pronamide	2.0-4.0		
	(*Kerb 50WP)		4-8 lb	24
Apply late fall before soil freeze-up (November). Spring-planted trees must be established at least 6 mo, fall-planted trees at least 1 yr. Effective on quackgrass.				
Refer to label for registration status before applying any pesticide to nectarines.				
Trees Established in Orchard at Least One Full Year				
Materials as listed for Year of Planting				
or				
Annual grasses and broadleaf weeds				
	norflurazon	2.0-2.4		
	(Solicam 80DF)		2.5-3.0 lb	12
plus either	napropamide	4.0		
	(Devrinol 50DF)		8 lb	12
or	pendimethalin	4.0		
	(Prowl 3.3EC, Prowl H2O)		4.8 qt	24
or	oryzalin	3.0-4.0		
	(Surflan AS)		3-4 qt	24
Apply late fall or early spring before weed emergence. Will not control emerged weeds. Will not control established perennial grasses or weeds. Add *paraquat to help control emerged weeds.				

Table 17.4.1. Weed control guidelines for PEACHES.

Weeds Controlled	Materials	Active Ingredient (lb)/A	Formulated Product/A	REI (hrs)
Annual grasses and broadleaf weeds *(continued)*				
	simazine	1.0-2.0		
	(Simazine 90DF)		1.125-2.25 lb	12
	(Caliber 90)		1.125-2.25 lb	12
	(Princep 4L)		1-2 qt	12
plus	norflurazon	2.0-2.4		
	(Solicam 80DF)		2.5-3.0 lb	12
plus either	napropamide	4.0		
	(Devrinol 50DF)		8 lb	12
or	pendimethalin	4.0		
	(Prowl 3.3EC)		4.8 qt	24
Pendimethalin use limited to NONBEARING TREES ONLY.				
or	oryzalin	3.0-4.0		
	(Surflan AS)		3-4 qt	24
Apply late fall or early spring before weed emergence. Will not control established perennial grasses or weeds. Add *paraquat to help control emerged weeds.				
	Chateau (flumioxazin)		6.0-12.0	12
	rimsulfuron		4 oz	
	(Matrix 25 DF use in tank mix with other herbicides)			
Chateau should be tank mixed with labeled burndown herbicide (glyphosate, paraquat, 2,4-D, Rely 200) for control of emerged weeds. May be tank mixed with Surflan, simazine or diuron for additional residual weed control. Use 6.0 oz. rate on sandy soils and/or where trees are less than three years old.				
Dandelion and other broadleaf weeds in sod cover				
	2,4-D amine	1.4		
	(*2,4-D Amine)		3.0 pt	48
	(*Weedar 64; *Unison)		3.0 pt	48
Apply fall (best) or early spring BEFORE TREES OR DANDELIONS BEGIN TO BLOOM. AVOID CONTACT WITH FRUIT, FOLIAGE, STEMS, OR LOWER LIMBS OF TREES. Yearly application is needed to control dandelions.				
Trees Established in Orchard at Least Two Full Years				
Materials as listed for younger trees				
or				
Annual grasses and broadleaf weeds				
	diuron	0.8-1.6		
	(Karmex 80DF)		1.0-2.0 lb	12
plus	terbacil	0.8-1.6		
	(Sinbar 80WP)		1.0-2.0 lb	12
Apply late fall or early spring before weeds emerge. See label for soil-texture rate limitations for diuron and terbacil. Add *paraquat if emerged weeds are present. May require a 2nd *paraquat application for late season weeds.				

Table 17.4.1. Weed control guidelines for PEACHES.

Weeds Controlled	Materials	Active Ingredient (lb)/A	Formulated Product/A	REI (hrs)
Newly Planted or Established Orchards				
Perennial weeds, woody brush and vines				
	glyphosate (Roundup, etc.) (WIPER APPLICATION ONLY)	— 33% solution	(mix 1 gal in 2 gal water)	12
Best timing varies with weed type; see label for specific directions. AVOID ANY CONTACT WITH FOLIAGE, BRANCHES, OR TRUNKS OF TREES BECAUSE OF EXTREME SENSITIVITY TO THESE MATERIALS.				
Established perennial broadleaf weeds				
	*Clopyralid (*Stinger)	0.12-0.24	1/3-2/3 pt	12
Apply for post-emergence control of specific problem weeds such as Canada thistle, clover, vetch, dandelion, in row and row middles. Not to exceed 2/3 pt/A/year.				

Refer to label for registration status before applying any pesticide to nectarines.

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17.5 Apricots

Table 17.5.1. Weed control guidelines for APRICOTS.

Weeds Controlled	Materials	Active Ingredient (lb)/A	Formulated Product/A	REI (hrs)
Year of Planting				
Annual grasses and broadleaf weeds				
Apply as soon as soil has settled and no cracks are present				
	oxyfluorfen (Goal 2XL)	1.2-2.0	2.4-4 qt	24
Oxyfluorfen applications limited to dormant trees (before buds on trees begin to grow).				
plus either	napropamide (Devrinol 50DF)	4.0	8 lb	12
or	pendimethalin (Prowl 3.3EC, Prowl H20)	4.0	4.8 qt	24
or	oryzalin (*Surflan AS)	3.0-6.0	3-6 qt	24
Add *paraquat to help control established perennial grasses and weeds. Additional control measures may be needed to control later emerging weeds.				
	*paraquat (*Gramaxone Inteon)	0.63-1.0	1.7-2.7 pt	12
Apply to emerged weeds as needed. Avoid contact of *paraquat with foliage OR trunks of trees. SEE LABEL FOR WORKER SAFETY CAUTIONS.				
	carfentrazone-ethyl (Aim EW, EC)	0.03	1.9 oz	12
Apply in tank mix with paraquat for broadleaf and grass control, but avoid contact with green bark and foliage.				

Table 17.5.1. Weed control guidelines for APRICOTS.

Weeds Controlled	Materials	Active Ingredient (lb)/A	Formulated Product/A	REI (hrs)
Annual grasses and broadleaf weeds *(continued)*				
	Chateau (flumioxazin)		6.0	12
Protect trees from spray contact by non-porous wraps, grow tubes, or waxed containers.				
Annual and perennial grasses				
	fluazifop	0.25-0.375		
	(Fusilade DX)		1-1.5 pt	12
Grasses 2-8 in tall. Repeat before regrowth is 10 in tall. Use surfactant OR crop oil according to label directions.				
	sethoxydim	0.28-0.47		
	(Poast)		1.5-2.0 pt	12
Apply to actively growing grasses before tillering OR seedhead formation. Use crop oil according to label directions. Apply as a separate spray.				
Established perennial grasses				
	*pronamide	2.0-4.0		
	(*Kerb 50WP)		4-8 lb	24
Apply late fall before soil freeze-up (November). Spring-planted trees must be established at least 6 mo, fall-planted trees at least 1 yr. Effective on quackgrass.				
Trees Established in Orchard at Least One Full Year				
Materials as listed for Year of Planting				
or				
Annual grasses and broadleaf weeds				
	norflurazon	2.0-2.4		
	(Solicam 80DF)		2.5-3.0 lb	12
plus either	napropamide	4.0		
	(Devrinol 50DF)		8 lb	12
or	pendimethalin	4.0		
	(Prowl 3.3EC, Prowl H2O)		4.8 qt	24
or	oryzalin	3.0-4.0		
	(Surflan AS)		3-4 qt	24
Apply late fall OR early spring before weed emergence. Will not control established perennial grasses OR weeds. Add *paraquat to help control emerged weeds.				
	Chateau (flumioxazin)		6.0-12.0	12
Chateau should be tank mixed with labeled burndown herbicide (glyphosate, paraquat, 2,4-D, Rely200) for control of emerged weeds. May be tank mixed with Surflan, simazine or diuron for additional residual weed control. Use 6.0 oz. rate on sandy soils and/or where trees are less than three years old.				
Dandelion and other broadleaf weeds in sod cover				
	2,4-D	1.4		
	(*2,4-D Amine)		3.0 pt	48
	(*Weedar 64; *Unison)		3.0 pt	48
Fall (best) OR early spring BEFORE TREES OR DANDELIONS BEGIN TO BLOOM. Yearly application is needed to control dandelions. Avoid contact with fruit, foliage, stems, OR lower limbs of trees. Unison not a vaporizer.				

Table 17.5.1. Weed control guidelines for APRICOTS.

Weeds Controlled	Materials	Active Ingredient (lb)/A	Formulated Product/A	REI (hrs)
Newly Planted and Established Orchards				
Annual grasses & broadleaved weeds, perennial weeds, woody brush and vines				
	glyphosate (Roundup, etc.) (WIPER APPLICATION ONLY)	— 33% solution	(mix 1 gal in 2 gal water)	12
Best timing varies with weed type; see label for specific directions. AVOID ANY CONTACT WITH FOLIAGE, BRANCHES, OR TRUNKS OF TREES BECAUSE OF EXTREME SENSITIVITY TO THESE MATERIALS.				
Established perennial broadleaf weeds				
	*Clopyralid (*Stinger)	0.12-0.24	1/3-2/3 pt	12
Apply for post-emergence control of specific problem weeds such as Canada thistle, clover, vetch, dandelion, in row and row middles. Not to exceed 2/3 pt/A/year.				

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17.6 Plums and Prunes

Table 17.6.1. Weed control guidelines for PLUMS and PRUNES.

Weeds Controlled	Materials	Active Ingredient (lb)/A	Formulated Product/A	REI (hrs)
Year of Planting				
Annual grasses and broadleaf weeds				
Apply as soon as soil has settled and no cracks are present				
	oxyfluorfen (Goal 2XL)	1.2-2.0	2.4-4 qt	24
Oxyfluorfen applications limited to dormant trees (before buds on trees begin to grow).				
plus either	napropamide (Devrinol 50DF)	4.0	8 lb	12
or	pendimethalin (Prowl 3.3EC, Prowl H2O)	4.0	4.8 qt	24
or	oryzalin (Surflan AS)	3.0-6.0	3-6 qt	24
Add *paraquat to help control established perennial grasses and weeds. Additional control measures may be needed to control later emerging weeds.				
	*paraquat (*Gramaxone Max)	0.63-1.0	1.7-2.7 pt	12
Apply to emerged weeds as needed. Avoid contact of *paraquat with foliage or trunks of trees. SEE LABEL FOR WORKER SAFETY CAUTIONS.				
	carfentrazone-ethyl (Aim EW, EC)	0.03	1.9 oz	12
Apply in tank mix with paraquat for broadleaf and grass control, but avoid contact with green bark and foliage.				

Table 17.6.1. Weed control guidelines for PLUMS and PRUNES.

Weeds Controlled	Materials	Active Ingredient (lb)/A	Formulated Product/A	REI (hrs)
Annual grasses and broadleaf weeds *(continued)*				
	Chateau (flumioxazin)		6.0	12
Protect trees from spray contact by non-porous wraps, grow tubes, or waxed containers.				
Annual and perennial grasses				
	fluazifop	0.25-0.375		
	(Fusilade DX)		1-1.5 pt	12
Grasses 2-8 in tall. Repeat before regrowth is 10 in tall. Use surfactant OR crop oil according to label directions.				
	sethoxydim	0.28-0.47		
	(Poast)		1.5-2.0 pt	12
Apply to actively growing grasses before tillering or seedhead formation. Use of sethoxydim limited to NONBEARING TREES ONLY. Use surfactant or crop oil according to label directions. Apply as a separate spray.				
Established perennial grasses				
	*pronamide	2.0-4.0		
	(*Kerb 50WP)		4-8 lb	24
Apply late fall before soil freeze-up (November). Spring-planted trees must be established at least 6 mo, fall-planted trees at least 1 yr. Effective on quackgrass.				
Trees Established in Orchard at Least One Full Year				
Materials as listed for Year of Planting				
or				
Annual grasses and broadleaf weeds				
	norflurazon	2.0-2.4		
	(Solicam 80DF)		2.5-3.0 lb	12
plus either	napropamide	4.0		
	(Devrinol 50DF)		8 lb	12
or	pendimethalin	4.0		
	(Prowl 3.3EC, Prowl H2O)		4.8 qt	24
or	oryzalin	3.0-4.0		
	(Surflan AS)		3-4 qt	24
Apply late fall or early spring before weed emergence. Add *paraquat to help control emerged weeds. Will not control established perennial grasses or weeds.				
	Chateau (flumioxazin)		6.0-12.0	12
	Rimsulfuron (Matrix 25 DF use in tank mix with other herbicides)		4 oz	
Chateau should be tank mixed with labeled burndown herbicide (glyphosate, paraquat, 2,4-D, Rely) for control of emerged weeds. May be tank mixed with Surflan, simazine or diuron for additional residual weed control. Use 6.0 oz. rate on sandy soils and/or where trees are less than three years old.				
Dandelion and other broadleaf weeds in sod cover				
	2,4-D	1.4		
	(*2,4-D Amine)		3.0 pt	48
	(*Weedar 64; *Unison)		3.0 pt	48
Apply 2,4-D fall (best) or early spring BEFORE TREES OR DANDELIONS BEGIN TO BLOOM. AVOID CONTACT WITH FRUIT, FOLIAGE, STEMS, OR LOWER LIMBS OF TREES. Yearly application is needed to control dandelions.				

Table 17.6.1. Weed control guidelines for PLUMS and PRUNES.

Weeds Controlled	Materials	Active Ingredient (lb)/A	Formulated Product/A	REI (hrs)
Newly Planted and Established Orchards				
Perennial weeds, woody brush and vines				
	glyphosate (Roundup, etc.) (WIPER APPLICATION ONLY)	— 33% solution	(mix 1 gal in 2 gal water)	12
Best timing varies with weed type; see label for specific directions. AVOID ANY CONTACT WITH FOLIAGE, BRANCHES, OR TRUNKS OF TREES BECAUSE OF EXTREME SENSITIVITY TO THESE MATERIALS.				
Established perennial broadleaf weeds				
	*Clopyralid (*Stinger)	0.12-0.24	1/3-2/3 pt	12
Apply for post-emergence control of specific problem weeds such as Canada thistle, clover, vetch, dandelion, in row and row middles. Not to exceed 2/3 pt/A/year.				

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18 Appendices

18.1 Pesticide Data

Table 18.1.1. Common names, product names, formulations, and days-to-harvest for pesticides used on tree fruits.

Common Names/ Products Formulations	DAYS TO HARVEST (A)					
	Apples	*Apricots*	*Cherries*	*Peaches*	*Pears*	*Plums*
Insecticides and Acaricides						
*abamectin						
*Agri-Mek 0.15EC	28	—	—	—	28	21
acequinocyl						
Kanemite 15SC	14	—	—	—	14	—
acetamiprid						
Assail 70WP, 30SG	7	—	—	—	7	—
§azadirachtin						
Aza-Direct	0	0	0	0	0	0
Azatin XL	0	0	0	0	0	0
Neemix 4.5 L	0	0	0	0	0	0
*azinphos-methyl						
*Guthion 50WS	14-21(A)	—	15	—	14-21(A)	—
bifenazate						
Acramite 50WS	7	3	3	3	7	3
*bifenthrin						
*Brigade WSB	—	—	—	—	14	—
*Fanfare 2EC	—	—	—	—	14	—
§Bt (*Bacillus thuringiensis*)						
Deliver 18WG	0	0	0	0	0	0
Dipel DF	0	0	0	0	0	0
Biobit XL	0	0	0	0	0	0
Javelin WG	0	0	0	0	0	0
Agree WG	0	—	—	0	0	0
buprofezin						
Centaur WDG	14	14	14	14	14	14
carbaryl						
Sevin 4F, XLR Plus, 80S, 80WSP	3	3	3	3	3	3
chlorantraniliprole						
Altacor	14	10	10	10	14	10
chlorpyrifos						
Lorsban 50W	DD/28(A)	—	14(C)	—	—	—
*Lorsban 4EC	DD/28(A)	—	21	14	DD	DD
Lorsban 75 WG	PF/28(A)	—	DD/21(A)	DD/14 (A)	DD	DD
clofentezine						
Apollo 4SC	45	21	21	21	21	—
*cyfluthrin						
*Baythroid 2 XL	7	7	7	7	7	7
*Leverage 2.7 SE	7	7	7	7	7	7
*diazinon						
*Diazinon 50W, AG 600	21	21	21	21	21	21
dicofol						
Kelthane 50WSP	7	—	—	—	7	—
dimethoate						
Dimethoate 400, 4EC	—	—	—	—	28	—

Table 18.1.1. Common names, product names, formulations, and days-to-harvest for pesticides used on tree fruits.

Common Names/ Products Formulations	DAYS TO HARVEST (A)					
	Apples	*Apricots*	*Cherries*	*Peaches*	*Pears*	*Plums*
*emamectin benzoate						
*Proclaim 5 SG	14	—	—	—	14	—
*endosulfan						
*Thionex 50W	21	21/30(A)	21	21/30(A)	7	7
*Thionex 3EC	21	21/30(A)	21	21/30(A)	7	7
*esfenvalerate						
*Asana XL	21	14	14	14	28	14
etoxazole						
Zeal Miticide	14	—	—	—	14	—
Zeal Miticide-1	—	—	7	—	—	—
*fenbutatin-oxide, hexakis						
*Vendex 50WP	14	—	14	14	14	14
*fenpropathrin						
*Danito1 2.4EC	14	—	—	—	14	—
fenpyroximate						
Portal 5EC	14	—	—	—	14	—
flonicamid						
Beleaf 50SG	21	14	14	14	21	14
flubendiamide						
Belt SC	14	7	7	7	14	7
*gamma-cyhalothrin						
*Proaxis	21	14	14	14	21	14
§granulosis virus						
Carpovirusine	0	—	—	—	0	—
Cyd-X	0	—	—	—	0	0
hexythiazox						
Savey 50DF, Onager 1EC	28	28	28	28	28	28
*imidacloprid						
Provado 1.6F	7	0	7	0	7	7
*Leverage 2.7SE	7	7	7	7	7	7
Sherpa	7	0	7	0	7	7
indoxacarb						
Avaunt	14	14	14	14	28	14
insecticidal soap						
M-Pede	0	0(G)	0(G)	0	0(G)	0(G)
§kaolin						
Surround WP	0	0	0	0	0	0
*lambda-cyhalothrin						
*Warrior, Warrior II	21	14	14	14	21	14
malathion						
Malathion 57EC, 5EC	3	7	3	7	—	—
*methidathion						
*Supracide 25W	DD	DD	DD	DD	DD	DD
*methomyl						
*Lannate LV, SP	14	—	—	4	7	—
*methoxyfenozide						
*Intrepid 2F	14	—	7	7	14	7

Table 18.1.1. Common names, product names, formulations, and days-to-harvest for pesticides used on tree fruits.

Common Names/ Products Formulations	DAYS TO HARVEST (A)					
	Apples	*Apricots*	*Cherries*	*Peaches*	*Pears*	*Plums*
§neem oil extract						
Trilogy	0	PT	PT	PT	PT	PT
novaluron						
Rimon .83EC	14	-	-	-	-	-
*oxamyl						
*Vydate L	14	—	—	—	14	—
*permethrin						
*Pounce 3.2EC, 25WP	PF	—	3	14	PB	—
*phosmet						
*Imidan 70W	7	14	7 (C)	14	7	7
§pyrethrin/rotenone						
PyGanic EC 1.4	0	0	0	0	0	0
Pyrenone	0	0	0	0	0	0
pyridaben						
Nexter 75WS	25	300	300	7	7	7
pyriproxyfen						
Esteem 35WP	45	14	14	14	45	14
spinetoram						
Delegate 25 WG	7	14	7	14	7	7
spinosad						
SpinTor 2SC	7	14	7	14	7	7
§Entrust 80WP	7	14	7	14	7	7
§GF-120	0	0	0	0	0	0
spirodiclofen						
Envidor 2SC	7	7	7	7	7	7
spirotetramat						
Movento	7	7	7	7	7	7
*thiacloprid						
*Calypso 4F	30	—	—	—	30	—
thiamethoxam						
Actara	14/35 (A)	14	14	14	14/35 (A)	14
thiamethoxam/chlorantraniliprole						
Voliam flexi	35	14	14	14	35	14
Fungicides and Bactericides						
tebuconazole/trifloxystrobin						
Adament 50 wG	-	-	14	14	-	-
azoxystrobin						
Abound	—	0	0	0	—	0
Bacillus subtilis						
Serenade ASO	0	0	0	0	0	0
captan						
Captan 50WP(E), 80WDG						
Captec 4L	0	0	0	0	—	0

Table 18.1.1. Common names, product names, formulations, and days-to-harvest for pesticides used on tree fruits.

Common Names/ Products Formulations	DAYS TO HARVEST (A)					
	Apples	*Apricots*	*Cherries*	*Peaches*	*Pears*	*Plums*
chlorothalonil						
Bravo Weather Stik, Ultrex	—	SS	SS,PH	SS	—	SS
Echo 720, 90DF	—	SS	SS,PH	SS	—	SS
Chloronil 720	—	SS	SS,PH	SS	—	SS
Concorde	—	SS	SS,PH	SS	—	SS
Equus 500ZN	—	SS	SS,PH	SS	—	SS
Applause	—	SS	SS,PH	SS	—	SS
copper hydroxide						
Kocide 2000, 4.5LF, 101, DF	HIG	BL	BL(G)	21	BL	BL
Champ Formula 2F	GT	BL	BL(G)	21	BL	BL
NuCop 50DF,	HIG	BL	BL(G)	21	BL	BL
KOP-Hydroxide 50W	HIG	BL	BL(G)	21	BL	BL
Basicop	HIG	BL	BL(G)	21	BL	BL
copper oxychloride sulfate						
C-O-C-S WDG	HIG,BL(A)	PF	PF(G)	PF	BL	PF
copper salts						
Tenn-Cop 5E	GT	—	PF(C)	BL	—	—
copper sulfate						
Cuprofix Disperss	2C	BL	PH	SS	BL	BL
cyprodinil						
Vangard WG	72	BL	BL(C)	BL	72	BL
DCNA						
Botran 75W	—	10	10(F)	10	—	BL
difenoconazole						
Inspire Super MP	72	-	-	-	72	-
dodine						
Syllit 65WP, FL	7	—	0	15	7	—
fenarimol						
Rubigan EC	30	—	0	—	30	—
fenbuconazole						
Indar 75WSP	14	0	0	0	—	—
fenhexamid						
Elevate 50WDG	—	0	0	0	—	0
ferbam						
Ferbam Granuflo	7	—	0	21	7	—
fosetyl-Al						
Aliette WDG	14	(B)	(B)	(B)	14	(B)
hydrogen dioxide						
OxiDate	0	0	0	0	0	0
iprodione						
Rovral 50WP, 4 Flowable,	—	PF	PF	PF	—	PF
Iprodione 4L AG	—	PF	PF	PF	—	PF
kresoxim-methyl						
Sovran 50WG	30	—	—	—	30	—
lime sulfur						
Allpro Lime Sulfur	0	—	0	0	0	0
Miller Lime Sulfur Solution	0	—	0	0	0	0
Sulforix Lime Sulfur	0	—	0	0	0	0
Suregard Lime Sulfur	0	—	0	0	0	0

Table 18.1.1. Common names, product names, formulations, and days-to-harvest for pesticides used on tree fruits.

Common Names/ Products Formulations	DAYS TO HARVEST (A)					
	Apples	*Apricots*	*Cherries*	*Peaches*	*Pears*	*Plums*
mancozeb						
Dithane F-45, M45, 75DF	BL,77(A)	—	—	—	BL,77(A)	—
Manzate 75DF, Flowable	BL,77(A)	—	—	—	BL,77(A)	—
Penncozeb 75DF, 80WP	BL,77(A)	—	—	—	BL,77(A)	—
mancozeb + copper hydroxide						
ManKocide	HIG	—	—	—	BL	—
maneb						
Manex	BL,77(A)	—	—	—	—	—
mefanoxam					—	
Ridomil Gold EC	GT	GT	GT	GT	—	GT
metconazole						
Quash	-	14	14	14	-	14
metiram						
Polyram 80DF	BL,77(A)	—	—	—	—	—
myclobutanil						
Rally 40W	14	0	0	0	—	0
§neem oil extract						
Trilogy	0	0	0	0	0	0
oxytetracycline						
Mycoshield,	—	—	—	21	60	—
Flameout 17WP	—	—	—	21	60	—
phosphite products						
Agri-fos	0	0	0	0	0	0
Fungi-Phite	0	0	0	0	0	0
Phostrol	0	0	0	0	0	0
Topaz	0	0	0	0	0	0
prohexadione calcium						
Apogee	45	—	—	—	—	—
propiconazole						
Orbit	—	0	0	0	—	0
pyraclostrobin + boscalid						
Pristine	0	0	0	0	0	0
pyrimethanil						
Scala	72	2	—	2	72	2
quinoxyfen						
Quintec	-	-	7	-	-	-
streptomycin						
Agri-mycin 17	50	—	—	—	30	—
Firewall	50	—	—	—	30	—
Streptrol 17WP	50	—	—	—	30	—
Agricultural streptomycin 17WP	50	—	—	—	30	—
sulfur						
Kumulus DF	PH,PF(A)	—	0	0	PH,PF(A)	0
Microthiol Disperss	PH,PF(A)	—	0	0	PH,PF(A)	0
Wettable sulfur	PH,PF(A)	—	0	0	PH,PF(A)	0
Thiolux Jet	PH,PF(A)	—	0	0	PH,PF(A)	0
tebuconazole						
Elite 45WP	—	—	0	0	—	—

Table 18.1.1. Common names, product names, formulations, and days-to-harvest for pesticides used on tree fruits.

Common Names/ Products Formulations	DAYS TO HARVEST (A)					
	Apples	*Apricots*	*Cherries*	*Peaches*	*Pears*	*Plums*
thiophanate-methyl(E)						
Topsin M WSB, 70WDG, 70WP	0	1	1	1	1	1
Topsin 4.5L	1	1	1	1	—	1
T-methyl 70W WSB	0	1	1	1	1	1
Thiophanate Methyl 85WDG	0	1	1	1	1	1
thiram						
Thiram Granuflo	—	—	—	7	—	—
triadimefon						
Triadimefon 50DF	45	—	—	—	45	—
Bayleton	45	—	—	—	45	—
trifloxystrobin						
Flint	14	—	—	—	14	—
Gem 500 SC	—	1	1	1	—	1
triflumizole						
*Procure 50WS	14	—	1	—	14	—
ziram						
Ziram 76DF	14	30	14	14	14	—
Ziram Granuflo 76WDG	14	30	14	14	14	—

Key:
BL Do not apply beyond bloom.
GT Do not apply beyond green tip.
HIG Do not apply beyond 1/2-in green.
PB Prebloom applications only.
PF Do not apply beyond petal fall.
PH Postharvest applications allowed.
SS Do not apply behond shuck split.
2C Do not apply after 2d cover spray.
DD Delayed dormant application
PT Do not apply beyond pit hardening in stone fruits

(A) If more than one value is given, depends on rate, method and/or number of applications; check label.
(B) Nonbearing trees only.
(C) Tart cherries only.
(D) Restricted entry interval: 96 hr (peaches), 72 hr (apples), 48 hr (pears).
(E) Refer to label for details of restricted entry interval.
(F) Sweet cherries only.
(G) Refer to label for details on timing of application

— Not registered for use on crop.
* Restricted-use pesticide; may be purchased and used only by certified applicators, or used by someone under the supervision of a certified applicator.
§ Potentially acceptable in certified organic programs

Table 18.1.2. HERBICIDES - Common names, product names, formulations, pre-harvest intervals, restricted entry intervals, and personal protective equipment (PPE) for herbicides available for tree fruit crops.

Common Name (group) Product Name	Formulation	EPA Reg. Number	Crops	Pre-Harvest Interval (days)	REI (hrs)	Applicator PPE	Early Entry PPE
2,4-D (4)							
*2,4-D Amine 4	3.8 lb AI/gal	1381-103	Pome/Stone fruits	14/40	48	bdghij	bdghj
Amine 4	3.8 lb AI/gal	34704-120	Pome/Stone fruits	14/40	48	abch	bchk
Formula 40	3.67 lb AI/gal	228-357	Stone fruits	40	48	abchi	bchk
Unison	1.74 lb AI/gal	5905-542	Pome/Stone fruits	14/40	48	acfhi	cfhk
*Weedar 64	3.8 lb AI/gal	71368-1	Pome/Stone fruits	14/40	48	dfghij	dfghj
bromacil (5)							
*Hyvar X	80WP	352-287	Non-crop sites only	NA	until dry	acfo	cfk
*Hyvar X-L	2 lb AI/gal	352-346	Non-crop sites only	NA	until dry	acf	NA
carfentrazone-ethyl (14)							
Aim EC	2 lb AI/gal	279-3241	Pome/Stone fruits	3	12	abc	bck
Aim EW	1.9 lb AI/gal	279-3242	Pome/Stone fruits	3	12	abc	bck
clethodim (?)							
Select	2EC	59639-3	All	365	24	acfh	cdefh
clopyralid (?)							
Stinger	3 lb AI/gal	62719-73	Stone fruits	30	12	acfh	cfhk
dichlobenil (?)							
Casoron 4G	4G	400-168	Apple, pear, cherry	Follow label	12	Acf	cfk
diuron (7)							
Direx 4L	4 lb AI/gal	1812-257	Pome fruits/Peach	Follow label/20	12	afcl	cfk
Direx 80DF	80DF	1812-362	Pome fruits/Peach	Follow label/90	12	acf	cfk
Diuron 4L (Drexel)	4lb AI/gal	19713-36	Pome fruits/Peach	Follow label/90	12	acf	cfk
Diuron 4L (Agrisolutions)	4lb AI/gal	9779-329	Pome fruits/Peach	Follow label/90	12	acfh	cfhk
Diuron 4L (MANA)	4lb AI/gal	66222-54	Pome fruits/Peach	Follow label/90	12	acfl	cfk
Diuron 80DF (MANA)	80DF	66222-51	Pome fruits/Peach	Follow label/90	12	acfl	cfk
Diuron 80DF (Agrisolutions)	80DF	9779-318	Pome fruits/Peach	Follow label/90	12	ac	bck
Diuron 80WDG	80WDG	34704-648	Pome fruits/Peach	Follow label/90	12	acf	cfk
Karmex DF	80DF	352-692	Pome fruits/Peach	Follow label/20	12	abf	cfk
Karmex XP	80% AI	352-692	Pome fruits/Peach	Follow label/90	12	acfil	cfk
fluazifop-p-butyl (1)							
Fusilade DX	2lb AI/gal	100-1070	Pome/Stone fruits	365/14	12	acfhi	cfk
flumioxazin (14)							
Chateau WDG	51WDG	59639-119	All crops	60	12	acf	cfk
glufosinate-ammonium							
Rely 200	1.67 lb AI/gal	264-660	Apple	14	12	acfh	cfhk
glyphosate (9)							
Cornerstone	4 lb AI/gal	524-445-1381	Pome/Stone fruits	1/17	12	ac	bck
Credit (etc.)	4 lb AI/gal	71368-20	All	1/17	4	ac	d/e, f, c
Gly-4 Plus	4lb AI/gal	42750-61-72693	Pome/Stone fruits	1/17	4	ach	bchk
Roundup Original	4 lb AI/gal	524-445	Pome/Stone fruits	1/17	12	ach	cfhk
Roundup Original Max	5.5 lb AI/gal	524-539	Pome/Stone fruits	1/17	4	acf	cfk
Roundup Ultradry	64.9% AI	524-504	Pome/Stone fruits	1/17	4	ac	cfk
Roundup Weathermax	5.5 lb AI/gal	524-537	Pome/Stone fruits	1/17	4	acf	cfk

Table 18.1.2. HERBICIDES - Common names, product names, formulations, pre-harvest intervals, restricted entry intervals, and personal protective equipment (PPE) for herbicides available for tree fruit crops.

Common Name (group) Product Name	Formulation	EPA Reg. Number	Crops	Pre-Harvest Interval (days)	REI (hrs)	Applicator PPE	Early Entry PPE
glyphosate (9) (*continued*)							
Touchdown HiTech	5 lb AI/gal	100-1182	Pome/Stone fruits	1/17	12	ac	cfk
Touchdown IQ	3 lb AI/gal	100-1117	Pome/Stone fruits	1/17	12	ac	cfk
Touchdown Total	4.17 lb AI/gal	100-1169	Pome/Stone fruits	1/17	12	acf	cfk
glyphosate & 2,4-D (9, 4)							
Recoil	1.6 & 1 lb AI/gal	71368-35	Pome/Stone fruits	14/40	12	dfghi	fghk
isoxaben (?)							
Gallery	75DF	62719-145	All	365	12	a, c	d/e, b, c
napropamide (?)							
Devrinol 50DF	50DF	70506-36	All crops	35	12	Acf	cfk
norflurazon (?)							
Solicam DF	80DF	100-849	All crops	60	12	abc	bck
oryzalin (3)							
Oryzalin 4 A.S.	4 lb AI/gal	72167-17-73220	All crops	-	24	acfi	cfk
Surflan Dry Flowable	85% AI	70506-46	All crops	-	24	acf	cfk
Surflan A.S. (UPI)	4 lb AI/gal	70506-43	All crops	-	24	acfi	cfk
oxyfluorfen (14)							
Galigan 2E	2 lb AI/gal	66222-28	All crops	Follow label	24	dfghij	dfghj
Goal 2XL	2 lb AI/gal	62719-424	All crops	Follow label	24	efghij	efghj
***paraquat (22)**							
*Gramoxone INTEON	2 lb AI/gal	100-1217	All	Follow label	12	acfhino	cfhk
*Gramoxone MAX	3 lb AI/gal	100-1074	Pome fruits	Follow label	12	acfhino	cfhk
*Gramoxone MAX	3 lb AI/gal	100-1074	Cherry, plum, apricot	28	12	acfhino	cfhk
*Gramoxone MAX	3 lb AI/gal	100-1074	Peach	14	12	acfhino	cfhk
pendimethalin (3)							
Prowl 3.3 EC	3.3 lb AI/gal	241-337	All crops	NB, 365	24	acf	cfk
Prowl H_20	3.8 lb AI/gal	241-418	All crops	60	24	acf	cfk
rimsulfuron (2)							
Matrix FNV	25% DF	352-671	All	7 pome/14 stone	4		
***pronamide (?)**							
*Kerb 50W	50WP	62719-397	Pome/Stone fruits	Follow label	24	bdgij	bdgj
sethoxydim (?)							
Poast	1.5EC	7969-58	Pome fruits	14	12	dfghij	dfghj
Poast	1.5EC	7969-58	Cherry, peach, apricot	25	12	dfghij	dfghj
Poast	1.5EC	7969-58	Plum	365	12	dfghij	dfghj
simazine (5)							
Princep Caliber 90	90WDG	100-603	Pome, peach/ cherry, plum	-	12	acf	cfk
Princep 4L	4 lb AI/gal	100-526	Pome, peach/ cherry, plum	-	12	acf	cfk
Simazine 4L (Drexel)	4 lb AI/gal	19713-60	Pome, cherry, peach, plum	-	12	acf	cfk

Table 18.1.2. HERBICIDES - Common names, product names, formulations, pre-harvest intervals, restricted entry intervals, and personal protective equipment (PPE) for herbicides available for tree fruit crops.

Common Name (group) Product Name	Formulation	EPA Reg. Number	Crops	Pre-Harvest Interval (days)	REI (hrs)	Applicator PPE	Early Entry PPE
Simazine 90DF (Drexel)	90WDG	19713-252	Pome, cherry, peach, plum	-	12	acf	cfk
simazine (5) (*continue*d)							
Sim-Trol 90DF	90DF	35915-12-60063	Pome, cherry, peach, plum	-	12	abc	bck
Sim-Trol 4L	4 lb AI/gal	35915-11-60063	Pome, cherry, peach, plum	-	12	acf	cfk
terbacil (?)							
Sinbar	80 WP	352-317	Apple, peach	60	12	acf	cfk
Sinbar	80 WP	352-317	Nonbearing fruit trees	NB, 365	12	acf	cfk

Key:

* Restricted-use pesticide; may be purchased and used only by certified applicators, or used by someone under the supervision of a certified applicator.

\- Pre-Harvest Interval information not listed on label except if tank mixed with other materials.

Pome fruits = apple, pear

Stone fruits = cherry, peach, apricot, plum

NB = Nonbearing

REI = Restricted entry interval

PPE = Personal protective equipment

a Long-sleeved shirt & long pants
b Waterproof gloves
c Shoes plus socks
d Coveralls over short-sleeved shirt & short pants
e Coveralls over long-sleeved shirt & long pants
f Chemical-resistant gloves; refer to label for specifics
g Chemical-resistant footwear & socks
h Protective eyewear
i Chemical-resistant apron when cleaning equipment, mixing or loading
j Chemical-resistant headgear for overhead exposure
k Coveralls
l Dust/mist filtering respirator (MSHA/NIOSH approval no. prefi x TX-21C)
m Respirator with either an organic vapor-removing cartridge with a pre-filter approved for pesticides (MSHA/NIOSH approval no. prefix TC-3) or a canister for pesticides (MSHA/NIOSH approval no. prefix TC-14G)
n Face shield for mixing and loading
o Dust/mist filtering respirator (NIOSH approved) with any N, R, P or HE filter

Table 18.1.3. Common names, product names, formulations, and days-to-harvest for growth regulators.

Common Name/ Product Name	Formulation	EPA Reg. No.	Crop	Preharvest Interval
Amid-Thin W naphthalene-acetamide	8.4 WP	5481-426	Apple, pear	—
Apogee prohexadione calcium	27.5% DF	7969-188	Apple	45 days
Ethrel ethephon	2 lb/gal	264-267	Apple, cherries	7 days
Exilis Plus cytokinin	2.0% liquid	62097-9	Apple	86 days
Fruitone N naphthalene-acetic acid	3.1%	5481-427	Apple, pear	2 days
Maxcel cytokinin	1.9%	73049-407	Apple	86 days
Novagib gibberellin	1.0% liquid	62097-7	Apple	—
Perlan cytokinin+gibberellin	1.8% + 1.8% liquid	62097-6	Apple	—
Pro-Gibb gibberellic acid	4% liquid	73049-15	cherries	0 days
Pro-Gibb Plus 2X gibberellic acid	20% SP	73049-16	Sweet cherry	0 days
Pro-Vide gibberellin	2% liquid	73049-3	Apple	—
Pro-Vide gibberellin	10% SG	73049-409	Apple	—
Promalin cytokinin+gibberellin	1.8% + 1.8% liquid	73049-41	Apple, pear, sweet cherry	—
Retain AVG	15% SP	73049-45	Apple, pear	7 days
RiteSize cytokinin+gibberellin	1.8% + 0.18% liquid	55146-86	Apple	—
RiteWay cytokinin	1.9% liquid	71368-60	Apple	86 days
Tre-Hold RTU naphthalene-acetic acid	1.15%	5481-452	Apple, pear, nectarine	—
Typy cytokinin+gibberellin	1.8% + 1.8% liquid	55146-78	Apple	—

— Preharvest interval information not provided on label.

Table 18.1.4. EPA numbers and worker protection standard re-entry and personal protective equipment (PPE) guidelines.

Worker Notification: Under most circumstances, worker employers must make sure that workers are notified about areas where pesticide applications are taking place or where restricted-entry intervals are in effect. Some pesticide labels require you to notify workers BOTH orally AND with signs posted at entrances to the treated area. Unless the pesticide labeling requires both types of notification, notify workers EITHER orally OR by the posting of warning signs at entrances to treated areas. You must inform workers which method of notification is being used. For details on notification requirements both for these products and those not represented below, refer to the product label and the Worker Protection Standard, 40 CFR part 170.

INSECTICIDES & ACARICIDES Product	EPA Reg. No.	Common Name	REI (hrs)	Applicator PPE	Early Entry PPE
Abba 0.1EC	66222-139	abamectin	12	dfghij	dfghj
Acramite 50WS	400-503	bifenazate	12	ac	cfk
Actara	100-938	thiamethoxam	12	acf	cfk
§Agree WG	70051-47	Bt	4	abcp	bck
*Agri-Mek 0.15EC	100-898	abamectin	12	dfghij	dfghj
Altacor	352-730	chlorantraniliprole	4	ac	ac
Apollo SC	66222-47	clofentezine	12	acf	cfk
*Asana XL	352-515	esfenvalerate	12	acfh	cfhk
Assail 70WP	8033-23	acetamiprid	12	abcj	bck
Avaunt	352-597	indoxacarb	12	acf	efg
§Aza-Direct	71908-1-10163	azadirachtin	4	abc	bck
§Azatin XL 0.27EC	70051-27-59807	azadirachtin	4	acfh	cfhk
*Baythroid 2EC	264-745	cyfluthrin	12	acfh	cfhk
*Baythroid XL 1EC	264-840	beta-cyfluthrin	12	acfh	cfhk
Beleaf 50SG	71512-10-279	flonicamid	12	abc	bck
Belt SC	264-1025	flubendiamide	12	acf	cfk
§Biobit XL	73049-54	Bt	4	abcp	bck
*Brigade WSB	279-3108	bifenthrin	12	abc	bck
*Calypso 4F	264-806	thiacloprid	12	acf	cfk
§Carpovirusine 0.99SC	66330-55	granulosis virus	4	acfhlo	achf
Centaur WDG	71711-21	buprofezin	12	abc	beg
§Checkmate OFM-F 24.6S	56336-24	pheromone	0	abc	—
§Cyd-X	70051-44	granulosis virus	4	ac	bck
*Danitol 2.4EC	59639-35	fenpropathrin	24	acfh	cfhk
Delegate 25WG	62719-541	spinetoram	4	ac	cfk
§Deliver 18WG	70051-69	Bt	4	abcp	bck
*Diazinon 50W	66222-10	diazinon	96	abcj	efgj
Dimethoate 4EC	19713-231	dimethoate	48	afghjlmq	fghjk
Dimethoate 4E	51036-110	dimethoate	48	acfhjlmq	cfhjk
§Dipel DF	73049-39	Bt	4	abcp	bck
§Entrust 80WP	62719-282	spinosad	4	ac	bck
Envidor 2SC	264-831	spirodiclofen	12	abc	abc
Esteem 35WP	59639-115	pyriproxyfen	12	ac	bce
*Fanfare 2EC	66222-99	bifenthrin	12	acfh	cfk
§GF-120	62719-498	spinosad	4	ac	bck

INSECTICIDES & ACARICIDES Product	EPA Reg. No.	Common Name	REI (hrs)	Applicator PPE	Early Entry PPE
*Guthion 50WS	66222-162	azinphos-methyl	14-15 days(E)	efghijm	efghj
*Imidan 70W	10163-169	phosmet	72	acfij	cfjk
*Intrepid 2F	62719-442	methoxyfenozide	4	acf	cfk
§Isomate LPTB	53575-23	pheromone	0	abc	—
§Isomate-M 100	53575-19	pheromone	0	abc	—
§Javelin WG	70051-66	Bt	4	abcp	bck
Kanemite 15SC	66330-38	acequinocyl	12	acf	cfk
Kelthane 50WSP	62719-414	dicofol	48	bcehijl	bchk
§Kumulus DF	51036-352	sulfur	24	acfh	cfhk
*Lannate 90SP	352-342	methomyl	48-96(E)	acfhlq	cfhk
*Lannate LV 2.4L	352-384	methomyl	48-96(E)	acfhilq	cfhk
*Leverage 2.7SE	264-770	imidacloprid/cyfluthrin	12	dfghi	fghk
*Lorsban 4EC	62719-220	chlorpyrifos	96	dfgijlq	dfgj
Lorsban 50WS	62719-221	chlorpyrifos	96	dfgijlq	dfgj
Lorsban 75WG	62719-301	chlorpyrifos	96	dfgijlq	dfgj
Malathion 8 Aquamul	34704-474	malathion	12	acfh	cfhk
Malathion 5	9779-5	malathion	12	acfhj	cfhjk
Movento	264-1050	spirotetramat	24	acfh	acfh
§M-Pede 49L	62719-515	insecticidal soap	12	dfghij	bck
Nexter 75WS	81880-4	pyridaben	12	abchjlo	bchjklo
Onager 1EC	10163-277	hexythiazox	12	abc	abc
Portal Miticide/Insecticide	71711-19	fenpyroximate	12	acfhj	dfghij
*Pounce 3.2EC	279-3014	permethrin	12	abc	bck
*Pounce 25 WP	279-3051	permethrin	12	abc	bck
*Proaxis	74921-3-34704	gamma-cyhalothrin	24	acfh	cfk
*Proclaim	100-904	emamectin benzoate	12	cef	cfhk
*Provado 1.6F	264-763	imidacloprid	12	acf	cfk
§PyGanic 1.4EC	1021-1771	pyrethrins	12	acf	cfk
§Pyrenone	432-1033	Pyrethrins/PBO	12	acf	cfk
Rimon 0.83EC	66222-35-400	novaluron	12	acfh	cefh
Savey 50DF	10163-250	hexythiazox	12	abc	abc
Sevin 80S	264-316	carbaryl	12	abcj	bcjk
Sevin 80WSP	264-526	carbaryl	12	abcj	bcjk
Sevin XLR Plus	264-333	carbaryl	12	acfj	cfjk
Sevin 4F	264-349	carbaryl.	12	acfj	cfjk
Sherpa	34704-983	imidacloprid	12	acf	cfk
SpinTor 2SC	62719-294	Spinosad	4	ac	cfk
*Supracide 25W	10163-244	methidathion	48/14 days(E)	abclq	bck
§Surround WP	70060-14	kaolin	4	aclo	ac
*Temprano 0.15EC	67760-71-400	abamectin	12	acfh	dfgh
*Thionex 3EC	66222-63	endosulfan	48	efghijm	efghj
*Thionex 50W	66222-62	endosulfan	4 days	bcdhijm	bcjk

INSECTICIDES & ACARICIDES Product	EPA Reg. No.	Common Name	REI (hrs)	Applicator PPE	Early Entry PPE
§Trilogy	70051-2	neem extract	4	acf	cfk
*Vendex 50WP	1812-413	hexakis	48	dfghijq	cfhk
Voliam flexi	100-1319	thiamethoxam/ chlorantraniliprole	12	acf	cfk
*Vydate L	352-372	oxamyl	48	efghijm	cfk
*Warrior	100-1112	lambda-cyhalothrin	24	acfh	cfk
*Warrior II	100-1295	lambda-cyhalothrin	24	acfh	cfk
Zeal	59639-138	etoxazole	12	acf	acf

FUNGICIDES & BACTERICIDES Product	EPA Reg. No.	Common Name	REI (hrs)	Applicator PPE	Early Entry PPE
Abound	100-1098	azoxystrobin	4	acf	cfk
Adament	264-1052	tebuconazole	24	acf	cef
Ag Streptomycin	66222-121	streptomycin	12	acfo	efgo
Agri-mycin 17WP	55146-96	streptomycin	12	acf	efg
Agri-fos	71962-1	phosphite	4	abch	bcdh
Aliette WDG	264-516	fosetyl-Al	12	abch	bchk
Allpro Lime Sulfur	769-558	lime sulfur	48	efghijl	efghj
Apogee 27.5%	7969-188	prohexadione calcium	12	acf	cfk
Applause 720	50534-188	chlorothalonil	12	acfhl	cfhk
Bac-Master	55146-80-5481	streptomycin	12	abcl	fchk
Bayleton 50DF	264-737-5481	triadimefon	12	acfj	cfk
Botran 75W	10163-189	dichloronitroaniline	12	ac	bck
Bravo Weather Stik	50534-188-100	chlorothalonil	12	acf	cfhk
Bravo Ultrex	50534-201-100	chlorothalonil	12	dfghijlo	dfghj
Captan 50WP (Microflo)	51036-166	captan	96(E)	abchilo	bchk
Captan 80WDG	66222-58-51036	captan	24(E)	acfhio	cfhk
Captec 4L	51036-181	captan	24(E)	acfi	cfhk
§Champ Formula-2 4.6F	55146-64	copper hydroxide	24(E)	acfh	cfhk
Chloronil 720	50534-188-100	chlorothalonil	12	acf	cfhk
C-O-C-S WDG	34704-326	opper oxychloride & basic copper sulfate	24	acfh	cfhk
§Cuprofix Ultra 40 Disperss	4581-413-82695	basic copper sulfate	12	ac	cfk
Dithane Rainshield DF	62719-402	mancozeb	24	cefhi	cef
Dithane F-45 Rainshield	62719-396	mancozeb	24	cefhi	cef
Dithane M45	62719-387	mancozeb	24	cefhi	cef
Echo 720	60063-7	chlorothalonil	12(E)	acfhm	cfhk
Echo 90DF	60063-10	chlorothalonil	12(E)	acfhm	bchk
Elevate 50WDG	66330-35	fenhexamid	12	acf	cfk
Elite 45WP	264-749	tebuconazole	12	acfh	acfh
Equus 500ZN	72167-27-66222	chlorothalonil	12	acfh	cfhk
Ferbam Granuflo	45728-7	ferbam	24	acfhjl	cfhjk
Firewall	80990-4-82695	streptomycin	12	acfq	cfe

FUNGICIDES & BACTERICIDES Product	EPA Reg. No.	Common Name	REI (hrs)	Applicator PPE	Early Entry PPE
Flameout 17WP	80990-1-4581	oxytetracycline HCl	12	acfhq	cefh
Flint	264-777	trifloxystrobin	12	acf	cfk
Fungi-Phite	83472-1	phosphite	4	abch	bchk
GEM 500 SC	264-826	trifloxystrobin	12	acf	cfk
Indar 75WSP	62719-421	fenbuconazole	12	acfj	cfk
Inspire Super MP	100-1262	difenoconazole	12	acfh	cfhk
Iprodione 4L AG	51036-340	Iprodione	24	efgijl	cef
§Kocide 2000	1812-358	copper hydroxide	24(E)	acfh	cfhk
§Kocide 4.5LF	1812-303	copper hydroxide	24(E)	acfh	cfhk
§Kocide 101	1812-288	copper hydroxide	24(E)	acfh	cfhk
§Kocide DF	1812-334	copper hydroxide	24(E)	acfh	cfhk
§Kumulus DF	51036-352	sulfur	24	acfh	cfhk
*Manzate 75DF	1812-414-352	mancozeb	24	cefhi	cef
Manzate Flowable	1812-416	mancozeb	24	cefhi	cefh
ManKocide	352-690	mancozeb + copper hydroxide	24	cefhi	cefh
Mertect 340-F	100-889	thiabendazole	12	ac	cfk
§Microthiol MZ Disperss	4581-373-82695	sulfur	24	abc	bchk
§Miller Lime Sulfur	66196-2-72	lime sulfur	48	efghijl	efghj
Mycoshield	55146-97	oxytetracycline HCl	12	acfh	cfhk
Nova 40W	62719-411	myclobutanil	24	acfh	cfhk
NuCop 50DF	45002-4	copper hydroxide	24	acfh	cfhk
Orbit	100-702	propiconazole	24	acfh	cfhk
OxiDate	70299-2	hydrogen dioxide	1	eg	bck
Penncozeb 75DF	4581-370	mancozeb	24	cefhi	cef
Penncozeb 4FL	4581-394	mancozeb	24	cefhi	cef
Phostrol	55146-83	phosphite	4	acfh	cfhk
Polyram 80DF	7969-105-34704	metiram	24	cefhi	cef
Pristine	7969-199	pyraclostrobin/boscalid	12	acf	cfk
*Procure 50WS	400-431	triflumazole	12	acf	cfk
Quash	59639-147	metconazole	12	ac	bck
Quintec	62719-375	quinoxyfen	12	acf	cfk
Rally 40WSP	62719-410	myclobutanil	24	acfh	cfhk
Ridomil Gold EC	100-801	mefanoxam	48	acf	cfk
Rovral 50WP	264-453	iprodione	24	efgijl	cfk
Rovral 4 Flowable	264-482	iprodione	24	efgijl	cfk
Rubigan EC	10163-273	fenarimol	12	dfghij	dfghi
Scala	264-788	pyrimethanil	12	acf	ac
Scholar 50WP	100-969	fludioxonil	psthvst	acf	—
Serenade ASO	69592-12	*Bacillus subtilis*	4	abco	abc
Sovran	7969-154	kresoxim-methyl	12	acf	cfk
Streptrol	55146-80	streptomycin	4	acfl	cef
Suregard Lime Sulfur	769-558	lime sulfur	48	efghijl	efghj
Syllit FL	55260-6	dodine	48	acfhij	efgj

FUNGICIDES & BACTERICIDES Product	EPA Reg. No.	Common Name	REI (hrs)	Applicator PPE	Early Entry PPE
§Tenn-Cop 5E	1812-381	copper salts	12	cdfhij	cdfhj
T-methyl 70W WSB	51036-344	thiophanate-methyl	12-72(E)	ac	cfk
§Thiolux Jet	100-1138	sulfur	24	acfh	efg
Thiophanate Methyl 85WDG	72167-10-73220	thiophanate-methyl	12-72(E)	acf	cfk
Thiram Granuflo	45728-21	thiram	24	acfj	acfj
Topaz	68573-2-1381	phosphate	4	acfh	cef
Topsin M 70WDG	73545-18-82695	thiophanate-methyl	12-72(E)	acf	cfk
Topsin M 70WP	73545-11-82695	thiophanate-methyl	12-72(E)	acf	cfk
Triadimefon 50DF	264-737-45728	triadimefon	12	acfjo	cfjk
§Trilogy	70051-2	neem extract	4	acf	cfk
Vangard WG	100-828	cyprodinil	12	acf	cfk
Wettable sulfur	5905-289	sulfur	24	acfh	cfhk
Ziram 76DF	4581-140	ziram	48	abchl	bchk
Ziram Granuflo 76WDG	45728-12	ziram	48	acfhjl	cfhjk

GROWTH REGULATORS Product	EPA Reg. No.	Common Name	REI (hrs)	Applicator PPE	Early Entry PPE
Amid-Thin W	5481-426	NAD	48	abc	bck
Apogee	7969-188	prohexadione Ca	12	afc	cfk
Ethrel	264-267	ethephon	48	acfh	efghj
Exilis Plus	62097-9	BA	12	acfhi	cfhk
Fruitone N	5481-427	NAA	48	acf	bck
Maxcel	73049-407	BA	12	acf	cfk
§Pro-Gibb 4%	73049-15	GA_3	12	acfh	cfhk
§Pro-Gibb Plus 2X	73049-16	GA_3	4	abc	bck
Pro-Vide PGR	73049-3	GA_{4+7}	12	acfh	cfhk
Pro-Vide 10 SG	73049-409	GA_{4+7}	12	acfh	cfhk
Promalin	73049-41	GA_{4+7} + BA	4	abch	bck
ReTain	73049-45	AVG	12	abc	bck
RiteSize	55146-86	BA + GA_{4+7}	12	ach	bchk
RiteWay	71368-60	BA	12	acfh	cfhk
Tre-Hold RTU	5481-452	NAA	12	acfh	cfhk
Typy	55146-78	BA + GA_{4+7}	12	dfghim	abch

Key:

a Long-sleeved shirt & long pants
b Waterproof gloves
c Shoes plus socks
d Coveralls over short-sleeved shirt & short pants
e Coveralls over long-sleeved shirt & long pants
f Chemical-resistant gloves; refer to label for specifics
g Chemical-resistant footwear & socks
h Protective eyewear
i Chemical-resistant apron when cleaning equipment, mixing or loading
j Chemical-resistant headgear for overhead exposure
k Coveralls
l Dust/mist filtering respirator (MSHA/NIOSH approval no. prefix TC-21C)
m Respirator with either an organic vapor-removing cartridge with a pre-filter approved for pesticides (MSHA/NIOSH approval no. prefix TC-3) or a canister for pesticides (MSHA/NIOSH approval no. prefix TC-14G)
n Face shield for mixing and loading
o Dust/mist filtering respirator (NIOSH approved) with any N, R, P or HE filter
p Dust/mist filtering respirator meeting NIOSH standards of at least N-95, R-95, and P-95
q NIOSH approved respirator with any R, P, or HE filter
PPE Personal protective equipment
REI Re-entry interval
(E) Refer to label for details of restricted entry interval
psthvst Post-harvest use only
§ Potentially acceptable in certified organic programs
* Restricted-use pesticide; may be purchased and used only by certified applicators, or used by someone under the supervision of a certified applicator.

Table 18.1.5. Spray Mixture Compatibility

Notes

This information is offered only as a general guide, and does not apply to pesticidal efficacy of mixtures. Read the label for specific crops or situations. Compatibilities indicated may be changed by certain adjuvants, different formulations, combinations of more than 2 materials, and environmental factors such as temperature and humidity.

- When potential compatibility is indicated, mini-mum agitation should be provided in all cases.
- Designations apply to at least one formulation of specified products. In cases where compatibility differs among formulations, the most conservative designation has been given. Defer to respective labels in all cases.
- Unless otherwise noted on the label, use soon after mixing, preferably in systems with continuous agitation.
- Physical compatibility: Although there may be no chemical incompatibility between the active ingredients of 2 given pesticides, some formulations of these products may not be physically compatible. This is particularly true when mixing at high concentrations and when mixing wettable powders with emulsifiable concentrates. It is recommended that a small batch of a proposed mixture be prepared before making tank combinations, to check for unacceptable physical reactions.

Directions

- Each product is assigned its own number, which appears to the left of the product name along the left-hand side of the chart.
- The product numbers (but not their names) are also listed along the top of the chart.
- To find the symbol representing our best information about compatibility of two products, find one product's number along the side and the other along the top, and trace the perpendicular lines to intersect in the table body.
- The compatibility values, which are highlighted in alternate rows and columns for ease in counting, are defined in the Key at the bottom. Also note the following footnotes:
  —§Bt products include Agree, Biobit, Deliver, Dipel, and Javelin, among others.
  —§Fixed copper products include C-O-C-S, Kocide, Champ, Cuprofix Disperss, and Tenn-Cop, among others.
- The "Mancozeb/+rams" category includes Dithane, Manzate, Penncozeb, as well as Thiram and Ziram.
- The "Pyrethroids" category refers primarily to Ambush and Pounce (permethrin).
- "Sterol Inhibitors" includes Rubigan, Nova, Indar, Orbit, Procure, and Elite.

Suggested Mixing Sequence

Always mix different spray materials in the following order, starting with:

- water soluble bags (WS)'
- water dispersible granules and dry flowables (WDG, DF)
- wettable powders (WP)
- liquid flowables (L, F, FC)
- sprayable concentrates (S, SC, LC)
- emulsifiable concentrates (EC)
- surfactants, oils, and adjuvants Do not add oils, surfactants, or emulsifiable concentrates prior to dry formulations, or lumping may occur.

Table 18.1.5. Spray Mixture Compatibility (Courtesy of The Pennsylvania State University)

	PRODUCT	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	Acramite	-	1	1	1	1	1	1	1	1	4	1	1	1	4	1	1	1	1	1	1	4	4	1
2	†Actara	1	-	1	1	1	1	1	1	1	4	1	1	1	4	1	1	1	1	1	1	4	4	1
3	Apollo	1	1	-	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1	1	4	4	1
4	*Asana	1	1	1	-	1	1	1	1	1	4	1	1	1	4	1	1	1	1	1	1	4	4	1
5	Assail	1	1	1	1	-	1	1	1	1	4	1	1	1	1	1	1	1	1	1	1	4	4	1
6	*AgriMek	1	1	1	1	1	-	1	1	1	4	1	1	1	4	1	1	1	1	1	1	4	4	1
7	†Avaunt	1	1	1	1	1	1	-	1	1	4	1	1	1	4	1	1	1	1	1	1	4	4	1
8	*azinphosmethyl	1	1	1	1	1	1	1	-	1	4	1	1	1	4	1	1	1	1	1	1	1	1	1
9	§Bt	1	1	1	1	1	1	1	1	-	3	1	1	1	1	1	1	3	1	1	1	3	1	1
10	§Bordeaux mixture	4	4	4	4	4	4	4	4	3	-	3	1	3	1	1	4	3	3	3	4	2	1	4
11	captan	1	1	1	1	1	1	1	1	1	3	-	1	1	1	1	1	1	1	5	1	1	4	1
12	carbaryl	1	1	1	1	1	1	1	1	1	3	1	-	1	1	1	1	1	1	4	1	1	1	1
13	*Carzol	1	1	1	1	1	1	1	1	1	3	1	1	-	1	1	1	1	4	1	1	1	4	1
14	chlorothalonil	4	4	1	4	1	4	4	4	1	1	1	1	1	-	1	1	1	1	4	4	5	4	1
15	chlorpyrifos	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-	1	1	1	1	1	1	1	1
16	*Danitol	1	1	1	1	1	1	1	1	1	4	1	1	1	4	1	-	1	1	1	1	4	4	1
17	*diazinon	1	1	1	1	1	1	1	1	3	3	1	1	1	4	1	1	-	1	1	1	1	2	1
18	dimethoate	1	1	1	1	1	1	1	1	1	3	1	1	4	1	1	1	1	-	1	1	2	4	1
19	*endosulfan	1	1	1	1	1	1	1	1	1	3	5	4	1	4	1	1	1	1	-	1	1	1	1
20	Esteem	1	1	1	1	1	1	1	1	1	4	1	1	1	4	1	1	1	1	1	-	4	4	1
21	ferbam	4	4	4	4	4	4	4	1	1	2	1	1	1	5	1	4	1	2	1	4	-	1	1
22	§fixed copper	4	4	4	4	4	4	4	1	1	1	4	1	4	4	1	4	2	4	1	4	1	-	4
23	*Imidan	1	1	1	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1	4	-
24	†*Intrepid	1	1	1	1	1	1	1	1	1	4	1	1	1	4	1	1	1	4	1	1	4	4	1
25	Kelthane	1	1	1	1	1	1	1	1	1	4	1	1	1	4	1	1	1	4	1	1	4	4	1
26	*Lannate	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1	1	4	1	4	1	1
27	lime	4	4	4	4	4	4	4	3	1	1	3	3	3	1	1	4	4	3	3	4	2	1	3
28	malathion	1	1	4	1	4	1	1	1	1	3	5	1	4	1	1	1	1	1	1	1	1	1	1
29	mancozeb/+rams	1	1	1	1	1	1	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1	1
30	†Nexter	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4	1	1	1	1
31	§oil	1	1	1	1	1	1	1	5	4	1	3	4	1	1	1	1	1	4	4	1	1	4	6
32	*Provado	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1
33	*pyrethroids	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1	1	1	1	4	4	1
34	Rovral	4	4	4	4	4	4	1	1	1	1	1	1	1	1	4	1	1	1	1	4	1	1	1
35	Savey	1	1	1	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1	1	4	4	1
36	Spintor	1	1	1	1	1	1	1	1	1	4	1	1	1	4	1	1	1	1	1	1	4	4	1
37	sterol inhibitors	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
38	§sulfur	1	1	1	1	1	1	5	1	3	1	6	1	1	1	1	1	1	1	1	1	1	1	1
39	*Supracide	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4
40	§Surround	1	1	1	1	1	1	1	1	1	3	1	1	1	4	1	1	1	1	1	1	4	4	1
41	Syllit	1	1	1	1	1	1	1	5	1	3	1	1	1	4	4	1	1	1	5	1	1	4	1
42	Topsin	1	1	1	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1	3	1
43	*Vendex	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1	4	1	1	1	4	1
44	*Vydate	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
45	*Warrior	1	1	1	1	1	1	1	1	4	1	1	1	1	4	1	1	1	1	1	1	1	1	4

KEY:
1 = Potentially compatible, if used as directed
2 = Decomposes on standing, residual action reduced
3 = Not compatible or causes general injury
4 = CAUTION: Compatibility not clear, or questionable or not known
5 = Use wettable powder forms
6 = May cause injury; refer to comments in "Fruit Crop Protectants" or crop's "General Pest Management Considerations"

Table 18.1.5. Spray Mixture Compatibility *(continued)*
(Courtesy of The Pennsylvania State University)

	PRODUCT	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
1	Acramite	1	1	1	4	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1
2	†Actara	1	1	1	4	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1
3	Apollo	1	1	1	4	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1
4	*Asana	1	1	1	4	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1
5	Assail	1	1	1	4	4	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1
6	*AgriMek	1	1	1	4	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1
7	†Avaunt	1	1	1	4	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1
8	*azinphosmethyl	1	1	1	3	1	1	1	5	1	1	1	1	1	1	5	1	1	5	1	1	1	1
9	§Bt	1	b	1	1	1	1	1	4	1	1	1	1	1	1	3	1	1	1	1	1	1	4
10	§Bordeaux mixture	4	1	3	1	3	1	1	1	3	3	1	4	4	1	1	1	3	3	3	3	1	1
11	captan	1	4	1	3	5	1	1	3	1	1	1	1	1	1	6	1	1	1	1	1	1	1
12	carbaryl	1	1	1	3	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1
13	*Carzol	1	1	1	3	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14	chlorothalonil	4	1	1	1	1	1	1	1	1	1	1	1	4	1	1	1	4	4	1	1	1	4
15	chlorpyrifos	1	4	1	1	1	1	1	1	1	1	4	1	1	1	1	1	1	4	1	1	1	1
16	*Danitol	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
17	*diazinon	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
18	dimethoate	4	4	1	3	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1	4	1	1
19	*endosulfan	1	1	4	3	1	1	4	4	1	1	1	1	1	1	1	1	1	5	1	1	1	1
20	Esteem	1	1	1	4	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1
21	ferbam	4	1	4	2	1	1	1	1	1	4	1	4	4	1	1	1	4	1	1	1	1	4
22	§fixed copper	4	4	1	1	1	1	1	1	4	4	1	4	4	1	1	1	4	4	3	4	1	4
23	*Imidan	1	1	1	3	1	1	1	6	1	1	1	1	1	1	1	4	1	1	1	1	1	1
24	†*Intrepid	-	1	1	4	1	1	1	4	1	1	1	1	1	1	4	1	1	1	1	1	1	1
25	Kelthane	1	-	1	2	4	1	1	4	1	1	4	1	1	1	4	4	1	1	1	1	1	1
26	*Lannate	1	1	-	3	4	4	1	4	1	4	1	1	1	1	4	1	1	4	1	1	1	1
27	lime	4	2	3	-	3	1	1	1	3	3	1	4	4	1	1	1	4	3	3	4	1	4
28	malathion	1	4	4	3	-	5	1	1	1	1	1	4	1	1	1	1	1	1	1	6	1	1
29	mancozeb/+rams	1	1	4	1	5	-	1	4	1	4	1	1	1	1	1	1	1	1	1	1	1	1
30	†Nexter	1	1	1	1	1	1	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
31	§oil	4	4	4	1	1	4	1	-	4	1	1	1	4	1	3	1	1	1	1	1	1	1
32	*Provado	1	1	1	3	1	1	1	4	-	1	1	1	1	1	1	1	1	1	1	1	1	1
33	*pyrethroids	1	1	4	3	1	4	1	1	1	-	1	1	1	1	4	1	1	4	1	1	4	1
34	Rovral	1	4	1	1	1	1	1	1	1	1	-	4	4	1	1	1	4	1	1	1	4	4
35	Savey	1	1	1	4	4	1	1	1	1	1	4	-	1	1	1	1	1	1	1	1	1	1
36	Spintor	1	1	1	4	1	1	1	4	1	1	4	1	-	1	4	1	1	1	1	1	1	1
37	sterol inhibitors	1	1	1	1	1	1	1	1	1	1	1	1	1	-	1	1	3	1	1	1	1	1
38	§sulfur	4	4	4	1	1	1	1	3	1	4	1	1	4	1	-	1	1	6	1	1	1	1
39	*Supracide	1	4	1	1	1	1	1	1	1	1	1	1	1	1	1	-	4	1	1	1	1	1
40	§Surround	1	1	1	4	1	1	1	1	1	1	4	1	1	3	1	4	-	1	1	1	1	1
41	Syllit	1	1	4	3	1	1	1	1	1	4	1	1	1	1	6	1	1	-	1	1	1	1
42	Topsin	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-	1	1	1
43	*Vendex	1	1	1	4	6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-	4	1
44	*Vydate	1	1	1	1	1	1	1	1	1	4	4	1	1	1	1	1	1	1	1	4	-	1
45	*Warrior	4	1	1	4	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1	1	-

KEY:
1 = Potentially compatible, if used as directed
2 = Decomposes on standing, residual action reduced
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4 = CAUTION: Compatibility not clear, or questionable or not known
5 = Use wettable powder forms
6 = May cause injury; refer to comments in "Fruit Crop Protectants" or crop's "General Pest Management Considerations"

Table 18.1.6. Tree Fruit Reference Materials.

Univ. Massachusetts Fact Sheets Online at: **http://www.umass.edu/fruitadvisor/factsheets/factsheets.html**

F-101R	Controlling Growth of Apple Trees
F-114R	Limb Positioning
F-116R	Maintaining a Balance Between the Top and Bottom of Apple Trees
F-118R	Thinning Apples Chemically
F-119R	Foliar Calcium Sprays for Apples
F-124	Nutrient Recommendations for Apples
F-126	Prebloom Nutrient Application for Apple Trees
F-127R	Apogee – A New Growth Retardant for Apples
F-128	Expansion of the Apple Harvest Season
F-129A	Late-season "Rescue" Thinning with Ethephon
F-130	Apple Tree Pruning and Training (English & Spanish)
F-131	Enhancing Return Bloom on Apple with Plant Growth Regulators
F-133	An Annual Fireblight Management Program
	Predicting Delicious Storage Scald
F-200	Peach Leaf Curl
	Block-specific Spray Calibration Worksheet
	Dogwood Borer in Dwarf Apples

Univ. Vermont Fact Sheets Online at: **orchard.uvm.edu/**

IPM 'Quick' Summary for Monitoring Apple Arthropod Pests
IPM Checklist for Vermont
Key Arthropods and Diseases Affecting Apples: A Synopsis
Apple Orchard Information for Beginners

Newsletters & Periodicals

Healthy Fruit Newsletter (UMass)	Online at: **http://www.umass.edu/fruitadvisor/healthy_fruit/**
Fruit Notes (UMass)	Online at: **http://www.umass.edu/fruitadvisor/fruitnotes/FruitNotes.htm**
Apple IPM News (UVM)	Online at: **http://orchard.uvm.edu/uvmapple/pest/**

Websites

- Pesticide labels and MSDS sheets for most registered pesticides: **http://www.cdms.net/manuf/manuf.asp** [NOTE: The labels at this site may or may not contain state-specific restrictions.]
- Up-to-date listing of maximum residue levels for countries that import U.S. fruits: **http://www.mrldatabase.com**
- Rhode Island Apple IPM: **http://www.uri.edu/research/ipm**
- Rhode Island Fruit Growers website: **http://www.rifruitgrowers.org**
- Rhode Island product registration: **http://state.ceris.purdue.edu/htm/ri.htm**
- UMaine Apple IPM : **http://pmo.umext.maine.edu/apple/**
- PRONewEngland: **http://pronewengland.org/**
- UMass Fruit Advisor: **http://www.umass.edu/fruitadvisor/** Provides resources for commercial tree- and small-fruit growers, including access to archives of *Healthy Fruit*, *Berry Notes*, and *Fruit Notes*, various fact sheets, videos, and other useful information for fruit growers.
- UConn IPM: **http://www.hort.uconn.edu/ipm** Provides timely information on fruit pests and other fruit topics including meeting announcements and the online version of Crop Talk, a newsletter for commercial fruit and vegetable growers.
- Univ. Vermont's OrganicA: **http://www.uvm.edu/organica/** A resource for organic apple production in New England.
- Univ. Vermont's Apple Program: **http://orchard.uvm.edu/** A website for commercial apple growers in Vermont.

Cornell Tree Fruit IPM Fact Sheets

Online at: **www.nysipm.cornell.edu/factsheets/treefruit/**

A series of fact sheets developed for insect and disease pests of tree-fruit crops. These outline the biology, monitoring, and management of various pests and include color photographs to aid in identification.

Insect IPM Fact Sheets

102GFSTF-I1	Pear Psylla. 1978.
102GFSTF-I2	Codling Moth. 1996.
102GFSTF-I3	Plum Curculio. 1980.
102GFSTF-I4	Green Fruitworm. 1980.
102GFSTF-I5	Obliquebanded Leafroller. 1980.
102GFSTF-I6	Peachtree Borer. 1980.
102GFSTF-I8	Apple Maggot. 1991.
102GFSTF-I9	Spotted Tentiform Leafminer. 1980.
102GFSTF-I10	European Red Mite. 1980.
102GFSTF-I11	Rosy Apple Aphid. 1980.
102GFSTF-I12	San Jose Scale. 1980.
102GFSTF-I13	White Apple Leafhopper. 1980.
102GFSTF-I14	Dogwood Borer. 1985.
102GFSTF-I15	Cherry Fruit Fly & Black Cherry Fruit Fly. 1988.
102GFSTF-I16	Woolly Apple Aphid. 1988.
102GFSTF-I17	Oriental Fruit Moth. 1988.
102GFSTF-I18	Beneficial Insects. 1989.
102GFSTF-I19	Redbanded Leafroller. 1989.
102GFSTF-I20	European Apple Sawfly. 1991.
102GFSTF-I21	Tarnished Plant Bug. 1991.
102GFSTF-I22	Comstock Mealybug. 1991.
102GFSTF-I23	Predatory Mites. 1995.
102GFSTF-I24	American Plum Borer. 1997.
102GFSTF-I25	Phytophagous Mirid Bugs. 1998.
102GFSTF-I26	Apple-Boring Beetles. 1999.

Disease IPM Fact Sheets

102GFSTF-D3	Fire Blight. 1994.
102GFSTF-D4	Powdery Mildew of Apple. 2004.
102GFSTF-D5	Cedar Apple Rust. 1981.
102GFSTF-D6	Black Knot of Plum. 1992.
102GFSTF-D7	Phytophthora Root and Crown Rots. 1992.
102GFSTF-D8	Cherry Leaf Spot. 1993.
102GFSTF-D9	Apple Scab. 1993.
102GFSTF-D10	Brown Rot of Stone Fruits. 1993.
102GFSTF-D11	Sooty Blotch and Flyspeck. 1994.
102GFSTF-D12	Perennial Canker. 1995.

Mammal IPM Fact Sheets

102GFSTF-M1	Meadow Vole and Pine Vole. 1988.

Cornell Extension Bulletins

IB 219	Orchard Nutrition Management. 1991. **hdl.handle.net/1813/3305**
IB 221	Predicting Harvest Date for Apples. 1992. **hdl.handle.net/1813/3299**
IPM207	Apple IPM. 1999. **nysipm.cornell.edu/publications/apple_man**

Cornell's Scaffolds Newsletter

Online at: **http://www.nysaes.cornell.edu/ent/scaffolds/**

Cornell Food and Life Sciences Bulletins

Online at: **http://www.nysaes.cornell.edu/pubs/fls/**

FLS 50	Green Fruitworms. 1974.
FLS 58	Growth Stages in Fruit Trees - From Dormant to Fruit Set. 1976.
FLS 92	Biology and Control of Cytospora Fungi in Peach Plantings. 1982.
FLS 95	Blister Spot of Apple. 1982.
FLS 108	Diagnostic Keys for Diseases of Apple, Peach and Cherry. 1984.
FLS 116	Chemical Thinning of Apples. 1986.
FLS 117	Peach and Nectarine Varieties in New York State. 1986.
FLS 118	Preventing Decomposition of Agricultural Chemicals by Alkaline Hydrolysis in the Spray Tank. 1986.
FLS 123	Basing European Red Mite Control Decisions on a Census of Mites Can Save Control Costs. 1988.
FLS 124	Insects Associated with Apple in the Mid-Atlantic States. 1988.
FLS 127	Sweet and Tart Cherry Varieties: Descriptions and Cultural Recommendations. 1989.
FLS 128	Effects of Ground Cover Manipulations on Pest and Predator Mite Populations on Apple in Eastern NY. 1989.
FLS 142	Fruit Pest Events and Phenological Development According to Accumulated Heat Units. 1993.
FLS 143	Sampling Second Generation Spotted Tentiform Leafminer. 1993.
FLS 158	New York Integrated Fruit Production Protocol for Apples. 2006.

NRAES Publications

Available from NRAES, Natural Resource, Agriculture and Engineering Service, Cooperative Extension, P.O. Box 4557, Ithaca, NY 14852-4557, Tel: 607-255-7654 FAX: 607-254-8770

NRAES-37	Orchard Spraying: Getting Results. 1993.
NRAES-38	Hydraulic nozzles for boom sprayers. 1994.
NRAES-78	On-Farm Agrichemical Handling Facilities. 1995.
NRAES-169	Tree Fruit Field Guide to Insect, Mite and Disease Pests and Natural Enemies of Eastern North Amer. 2006.

18.2 Diagnostic and Analytical Services

To submit samples for insect or disease diagnosis or plant identification, contact:

UConn Home & Garden Education Center
Ratcliffe Hicks Building , Room 4
1380 Storrs Rd., Unit 4115
Storrs, CT 06269-4115
(860)486-6271 or toll-free 1-877-486-6271
www.ladybug.uconn.edu

Plant Disease Information Office
The Connecticut Agricultural Experiment Station
123 Huntington Street, P.O. Box 1106
New Haven, CT 06504
(203) 974-8601
www.ct.gov/caes/cwp/view.asp?a=2835&q=377502

UMaine Insect & Plant Disease Diagnostic Laboratory
University of Maine Cooperative Extension
Pest Management Office
491 College Avenue
Orono, ME 04473
Insect Inquiries: 207-581-2963
Disease Inquiries: 207-581-3883
http://pmo.umext.maine.edu/ipddl/ipddl.htm

UMass Extension Plant Diagnostics Laboratory
160 Holdsorth Way
Holdsworth Natural Resources Center
University of Massachusetts
Amherst, MA 01003
413-545-3208
http://www.umass.edu/agland/diagnostics/

UNH Arthropod Identification Center
G28 Spaulding Hall
University of New Hampshire
38 College Road
Durham, NH 03824
603-862-3200
http://extension.unh.edu/Agric/AGPDTS/ArthroID.htm

UNH Plant Diagnostic Laboratory
G37 Spaulding Hall
University of New Hampshire
38 College Road
Durham, NH 03824
603-862-3841
http://extension.unh.edu/Agric/AGPDTS/PlantH.htm

URI Plant Clinic
3 East Alumni Ave.
Cooperative Extension Education Center
Kingston, RI 02881
401-874-2900
http://www.uri.edu/ce/ceec/plantclinic.html

To submit soil or leaf tissue nutrient analysis samples, contact:

Connecticut Agricultural Experiment Station
Slate Laboratory
P.O. Box 1106
New Haven, CT 06504
203-974-8521
http://www.caes.state.ct.us/Soiloffice/soiltesting.htm

UConn Soil Nutrient Analysis Laboratory
6 Sherman Place, U-102
University of Connecticut
Storrs, CT 06269-5102
860-486-4274
http://www.soiltest.uconn.edu

UMaine Analytical Laboratory
Maine Soil Testing Service
5722 Deering Hall
University of Maine
Orono, ME 04469
207-581-2945
http://anlab.umesci.maine.edu/

UMass Soil & Tissue Testing Laboratory
West Experiment Station
682 North Pleasant Street
University of Massachusetts
Amherst, MA 01003
413-545-2311
http://www.umass.edu/soiltest/

UNH Cooperative Extension Soil Testing Program
G28A Spaulding Life Science Center
38 College Road
University of New Hampshire
Durham, NH 03824
603-862-3200
http://extension.unh.edu/Agric/AGPDTS/SoilTest.htm

UVM Agricultural & Environmental Testing Laboratory
209 Hills Building
University of Vermont
Burlington, VT 05405
802-656-3030
http://www.uvm.edu/pss/ag_testing/

18.3 Extension Faculty and Staff

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VERMONT		
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18.4 Abbreviations and Symbols Used in this Publication

Formulations

a.e. ..... acid equivalent
A ..... acre
AI ..... active ingredient
AS ..... aqueous solution
CS ..... capsule suspension
D ..... dust
DF ..... dry flowable
DG ..... dispersible granule
E, EW ..... emulsion, emulsifiable
EC ..... emulsifiable concentrate
E.U.P. ..... Experimental Use Permit
F, FL ..... flowable
FC ..... flowable concentrate
FM ..... flowable microencapsulated
G ..... granular
L ..... liquid
LC ..... liquid concentrate
P ..... pellets
PHI ..... preharvest interval
S ..... sprayable
SC ..... suspension concentrate
SG ..... soluble granule
SP ..... soluble powder
SS ..... soluble salt
ULV ..... ultralow volume
W ..... wettable
WBC ..... water-based concentrate
WDG, WG ..... water dispersible granules
WS ..... water soluble packets
WP ..... wettable powder

Product-specific Symbols

* ..... restricted-use pesticide; may be purchased and used only by certified applicators, or used by someone under the supervision of a certified applicator.

\# ..... 2(ee) recommendation based on an efficacy statement

..... 2(ee) recommendation based on quantitative efficacy data

§ ..... potentially acceptable in certified organic programs

PHI (Pre-Harvest Interval) and REI (Restricted Entry Interval) Abbreviations

BL ..... Do not apply beyond bloom
DD ..... Delayed dormant application
GT ..... Do not apply beyond green tip
HIG ..... Do not apply beyond 1/2-in. green
PB ..... Prebloom applications only
PF ..... Do not apply beyond petal fall
PH ..... Postharvest applications allowed
SS ..... Do not apply beyond shuck split
2C ..... Do not apply after 2d cover spray
(A) ..... Depends on rate, method or number of applications; refer to label for more details
(B) ..... Nonbearing trees only
(C) ..... Tart cherries only
(D) ..... Restricted entry interval: 96 hr (peaches), 72 hr (apples), 48 hr (pears)
(E) ..... Refer to label for details of restricted entry interval
(F) ..... Sweet cherries only
(G) ..... Refer to label for details on timing of application