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 (**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 (**I, A**)
boscalid + pyraclostrobin – (Pristine) BASF (**F**)
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)**
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) UAP **(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) Syngenta **(I)**
cyprodinil – (Vangard) Syngenta **(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)**
dimethoate – (Clean Crop Dimethoate) UAP (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; (Phaser) Bayer; (*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)**
fluazifop-p-butyl – (Fusilade) Syngenta **(H)**
fludioxonil – (Scholar) Syngenta **(F)**
flumioxazin – (Chateau) Valent (H)
fosetyl-Al – (Aliette) Bayer **(F)**

gamma cyhalothrin – (*Proaxis) Dow AgroSciences **(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) Syngneta; (There may be others) ? **(H)**
hexakis – (*Vendex) UniPhos **(I)**
hexythiazox – (Savey) Gowan **(A)**
hydrogen dioxide – (OxiDate, StorOx) Biosafe Systems **B, F)**

imidacloprid – (*Provado) Bayer **(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 – (Clean Crop Malathion) UAP; (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)**
methidathion – (*Supracide) Gowan **(I)**
methomyl – (*Lannate) DuPont **(I)**
methoxyfenozide – (*Intrepid) Dow AgroSciences **(I)**
metiram – (Polyram) BASF **(F)**
myclobutanil – (Nova, Rally) Dow AgroSciences **(F)**

napropamide – (Devrinol) United Phosphorus **(H)**
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)**

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

sethoxydim – (Poast) BASF **(H)**
simazine – (Princep) Syngenta; (Simazine) Drexel; (Sim-Trol) Sipcam Agro **(H)**
soap, insecticidal – (M-Pede) Dow AgroSciences **(I)**
spinosad – (SpinTor) Dow AgroSciences **(I)**
spinetoram – (Delegate) Dow AgroSciences **(I)**
streptomycin – (Agri-mycin, Streptrol) Nufarm; (Firewall) UniPhos; (Agricultural Streptomycin) Farm Saver **(B)**

tebuconazole – (Elite) 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) 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) 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)**

Abound – (azoxystrobin) Syngenta **(F)**
Acramite – (bifenazate) Chemtura **(A)**
Actara – (thiamethoxam) Syngenta **(I)**
§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**)
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)**

Battalion – (deltamethrin) Arysta **(I)**
Bayleton – (triadimefon) Amvac **(F)**
*Baythroid – (cyfluthrin) 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) UAP **(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)
Clean Crop Dimethoate – (dimethoate) UAP **(I)**
Clean Crop Malathion – (malathion) UAP **(I)**
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)**
Deliver – (B.t.) 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 **(I)**
Dipel – (B.t.) 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)**
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 – (terramycin) 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)**
Gly-4 – (glyphosate) Universal Crop Protection Alliance **(H)**
Goal – (oxyfluorfen) Dow AgroSciences **(H)**
*Gramoxone MAX, INTEON – (paraquat) Syngenta **(H)**
*Guthion – (azinphos-methyl) Bayer **(I)**

Hyvar – (bromacil) DuPont **(H)**

*Imidan – (phosmet) Gowan **(I)**
Indar – (fenbuconazole) Dow AgroSciences **(F)**
*Intrepid – (methoxyfenozide) Dow AgroSciences **(I)**
Iprodione – (iprodione) MicroFlo **(F)**

Javelin – (B.t.) 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)**
Lime Sulfur Solution – (liquid lime sulfur) Miller Chemical (**A, F, I**)
*Lorsban – (chlorpyrifos) Dow AgroSciences, Gowan **(I)**

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

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

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)**
Phaser – (endosulfan) Bayer **(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)**

Recoil (glyphosate and 2,4-D) NuFarm
Rally – (myclobutanil) Dow AgroSciences **(F)**
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)**
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)**
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)**

*Unison – (2,4-D) Helena **(H)**

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

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

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. Indar also may fail to control leaf spot on cherries where the cherry leaf spot fungus has become resistant to SI fungicides. It may also fail to control brown rot in orchards with SI-resistant brown rot

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 4 basic types: copper oxychloride and copper sulfate (e.g., C-O-C-S WDG); copper hydroxide (e.g., Kocide 2000, Champ Formula 2); complexed forms of basic copper sulfate (e.g., Cuprofix Ultra 40 Disperss), and copper salts of fatty and rosin acids (e.g., Tenn-Cop). 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 phenylpyrrole 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.

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 (Nova, Rally) 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, Nova 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: Nova is no longer effective against apple scab in a number of orchards where the pathogen has developed resistance to the SI fungicide group. Nova 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 leaf spot on cherries where the cherry leaf spot fungus has become resistant to SI fungicides. It may also fail to control brown rot in orchards with SI-resistant brown rot.

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.

§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) 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 leaf spot on cherries where the cherry leaf spot fungus has become resistant to SI fungicides. It may also fail to control brown rot in orchards with SI-resistant brown rot.

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. It is a moderately effective apple scab fungicide, but is weaker than captan or mancozeb. Thiram is also effective against apple rusts and provides moderate control of summer rots. Thiram is sometimes used for its activity as a deer and rabbit repellent. Thiram labels issued after 2006 still contain recommendations for peaches but no longer list apples as a registered use for this material.

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 fail to control leaf spot on cherries where the cherry leaf spot fungus has become resistant to SI fungicides.

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.

§Terramycin (Mycoshield, Flameout), another antibiotic, is registered for use on peaches to control bacterial spot and is the best material available for this use. It is also registered for control of fire blight on 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.

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: Clean Crop Dimethoate 400 (UAP): 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: Clean Crop Malathion (UAP) 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.

*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 (UAP) 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.

*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.

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 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. 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; Phaser (Bayer) 3EC: 264-638, 50WS: 264-656; *Thionex (Makhteshim-Agan) 3EC: 66222-63; *Thionex (Makhteshim-Agan) 50WP: 66222-62.

*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, mealybugs, 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.

Spinosad (SpinTor, §Entrust) 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 obliquebanded leafroller, although activity against spotted tentiform leafminer is also exhibited. Spinosad is essentially nontoxic to birds, fish, aquatic invertebrates, and most beneficials. It has a low bee-poisoning hazard.

Formulations available and EPA registration numbers: §Entrust (Dow AgroSciences) 80WP: 62719-282./ 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 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: .

Hexythiazox (Savey) 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.

§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 54 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.

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.

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.

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.

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 micro-organisms 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 5.8.1).

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 5.8.2): (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		
*chloropictrin 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 0z/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.*