

5 Characteristics of Crop Protectants Used On Tree Fruits

5.1 Cross Reference of Chemical vs. Trade Names of Pesticides

Key to pesticide type: (A), Acaricide; (B), Bactericide; (F), Fungicide; (H), Herbicide; (I), Insecticide.

NOTE: See Chapter 8 for a discussion of herbicides used in tree fruit.

5.1.1 By Common Name

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

abamectin/avermectin – (*Agri-Flex, *Agri-Mek) Syngenta; (*Abba) Makhteshim; (*Gladiator) FMC (A, I)

acequinocyl – (Kanemite) Arysta LifeScience (A)

acetamiprid – (Assail) United Phosphorus (I)

azadirachtin – (Aza-Direct) Gowan; (Neemix 4.5, Azatin XL) Certis (I)

azoxystrobin – (Abound) Syngenta (F)

§*Bacillus subtilis* – (Serenade products) Bayer (B, F)

§*Bacillus amyloliquefaciens* – (DoubleNickel products)

Certis (B, F) bifenazate – (Acramate) Agriphar (A)

bifenthrin – (*Brigade) FMC; (*Fanfare) Makhteshim Agan (I, A)

boscalid + pyraclostrobin – (Pristine) BASF (F)

Bacillus thuringiensis (B.t.) – (Agree) Certis; (Bibot)

Valent BioSciences; (Dipel) Valent BioSciences;

(Deliver) Certis; (Javelin) Certis (I)

bromacil – (Hyvar, Hyvar X-L) DuPont (H)

buprofezin – (Centaur) Nichino America (I)

buprofezin + flubendiamide (Tourismo) Nichino (I)

Burkholderia rinojensis - (Venerate) Marrone Bio

Innovations (I)

captan – (Captan) Micro Flo, Drexel, Makhteshim Agan; (Captec) Micro Flo (F)

carbaryl – (Carbaryl) Drexel; (Sevin) TKI (I)

carfentrazone-ethyl – (Aim, Rage) FMC (H)

chlorantraniliprole – (Altacor) DuPont ;(Voliam Flexi, Voliam Xpress) Syngenta (I)

chlorpyrifos – (Lorsban) Dow AgroSciences, Gowan (I)

chlorothalonil – (Bravo) Syngenta; (Echo) Sipcam Agro;

(Concorde) Griffin; (Equus) Makhteshim Agan (F)

Chromobacterium subsugae metabolites - (Grandevo)

Marrone Bio Innovations (I)

clofentezine – (Apollo) Makhteshim Agan (A)

clopyralid – (Stinger) Dow AgroSciences (H)

clothianidin – (Clutch, Belay) Valent BioSciences (I)

clethodim - (Select Max) Valent (H)

copper hydroxide – (Kocide, Champ, § Badge X2) Griffin, Nufarm Americas, Gowan (B, F)

copper oxychloride/copper sulfate – (C-O-C-S, Badge SC) Loveland, Gowan (B, F) copper sulfate – (Cuprofix

Ultra Disperss) United Phosphorus; (Basicop) Griffin (B, F)

§copper, low MCE organic copper (Cueva) Certis (B,F)

cyantraniliprole - (Exirel) DuPont (I)

cyflumetofen - (Nealta Miticide) BASF (A)

cyfluthrin – (*Baythroid, *Leverage) Bayer (I)

cyprodinil – (Vangard) Syngenta (F)

diazinon – (*Diazinon) Makhteshim (I)

dichlobenil – (Casoron) Agriphar (H)

dicloran – (Botran) Gowan (F)

difenoconazole + cyprodinil – (Inspire Super) Syngenta (F)

dimethoate – (Dimethoate) Loveland; (Dimethoate) Drexel (I)

dinotefuran – (Scorpion, Venom) Gowan, Valent (I)

diuron – (Direx, Karmex) Griffin; (Diuron) Drexel,

Loveland, WinField Solutions, Makhteshim Agan (H)

dodine – (Syllit FL) Agriphar (F)

emamectin benzoate – (*Proclaim) Syngenta (I)

endosulfan – (Endosulfan) Drexel; (Phaser) Bayer;

(*Thionex) Makhteshim Agan (I)

esfenvalerate – (*Asana) Valent (I)

etoxazole – (Zeal) Valent (A)

fenbuconazole – (Indar) Dow AgroSciences (F)

fenbutatin-oxide – (*Vendex) Griffin (A)

fenhexamid – (Elevate) Arysta (F)

fenpropathrin – (*Danitol) Valent BioSciences (I)

fenpyroximate – (Portal) Nichino America (A, I)

flonicamid – (Beleaf) FMC (I)

flubendiamide – (Belt) Bayer, Turismo (Nichino) (I)

ferbam – (Ferbam Granuflo) Taminco (F)

fluazifop-p-butyl – (Fusilade) Syngenta (H)

fludioxonil – (Scholar) Syngenta (F)

flumioxazin – (Chateau) Valent (H)

fluopyram + trifloxystrobin – (Luna Sensation) Bayer (F)

fluopyram + pyrimethanil – (Luna Tranquility) Bayer (F)

flutriafol – (Topguard) Cheminova (F)

fluxapyroxad + pyraclostrobin – (Merivon) BASF (F)

fosetyl-Al – (Aliette) Bayer (F)

gamma cyhalothrin – (*Proaxis) Loveland (I)

glufosinate-ammonium – (Rely) Bayer (H)

glyphosate – (Roundup Original, Roundup Original II,

Roundup Original Max, Roundup Ultra, Roundup

Ultradry, Roundup Weathermax) Monsanto; (Atila,

Credit) Nufarm; (Cornerstone) WinField Solutions;

(Glystar Original) Albaugh; (Touchdown HiTech,

Touchdown IQ, Touchdown Total IQ) Syngenta; (Rage)

FMC (H)

halosulfuron – (Sanda) Gowan (H)

hexakis – (*Vendex) United Phosphorus (I)

hexythiazox – (Savey, Onager) Gowan (A)

hydrogen dioxide – (OxiDate, StorOx) Biosafe Systems (B, F)

- imidacloprid – (Admire Pro, *Leverage) Bayer (I)
indaziflam – (Alion) Bayer (H)
indoxacarb – (Avaunt) DuPont (I)
insecticidal virus – (Cyd-X §Madex) Certis;
(Carpovirusine) Arysta LifeScience (I)
iprodione – (Rovral) Bayer; (Iprodione) MicroFlo, (Meteor)
United Phosphorus (F)
Isaria fumosorosea (PFR-97) Certis (I)
- kaolin – (Surround) TKI (A,F,I)
kasugamycin – (Kasumin 2L) Arysta LifeScience (B)
kresoxim-methyl – (Sovran) BASF (F)
- lambda-cyhalothrin – (*Lambda-Cy) United Phosphorus;
(*Taiga Z) WinField Solutions; (*Endigo, *Voliam
Xpress, *Warrior) Syngenta (I)
liquid lime-sulfur – (Suregard Lime Sulfur) Value Garden
Supply; (Sulforix Lime Sulfur, Lime Sulfur Solution)
Miller Chemical (A, F, I)
- malathion – (Clean Crop Malathion) Loveland; (Malathion)
Drexel; (Prentox Malathion) Prentiss (I)
mancozeb – (Dithane) Dow AgroSciences; (Manzate)
United Phosphorus; (Penncozeb) United Phosphorus (F)
mefanoxam – (Ridomil Gold) Syngenta (F)
maneb – (Manex) Griffin (F)
metconazole – (Quash) Valent (F)
methomyl – (*Lannate) DuPont (I)
methoxyfenozide – (Intrepid) Dow AgroSciences (I)
metiram – (Polyram) BASF (F)
myclobutanil – (Rally) Dow AgroSciences (F)
- napropamide – (Devrinol) United Phosphorus (H)
norflurazon – (Solicam) Syngenta (H)
novaluron – (Rimon) Agriphar (I)
- oryzalin – (Surflan) United Phosphorus; (Oryza Ag)
AgValue; (Oryzalin) FarmSaver.com; (H)
oxamyl – (*Vydate) DuPont (I)
oxyfluorfen – (Goal) Dow AgroSciences; (Galigan)
Makhteshim Agan; Collide (United Phosphorus (H)
oxytetracycline – (Mycoshield) Nufarm; (Fireline)
Agrosource (B)
§oxytetracycline calcium – (*Tree Tech OTC) Florida
Silvics (B)
- Pantoea agglomerans* strain E325 – (Bloomtime
Biological) Northwest Agricultural Products (B)
paraquat – (*Gramoxone) Syngenta-(H)
pendimethalin – (Prowl) BASF (H)
penthiopyrad – (Fontelis) DuPont (F)
permethrin – (*Ambush) AMVAC; (*Pounce) FMC (I)
pheromones – (Checkmate) Suterra; (Isomate) CBC;
(SPLAT) ISCA Tech (I)
phosmet – (Imidan) Gowan (I)
phosphite – (Phostrol) NuFarm (F, B)
phosphite – (ProPhyt) Luxembourg-Pamol (F)
phosphorous acid – (Fosphite) JH Biotech; (Topaz
Fungicide) WinField Solutions (F)
phosphorous acid – (Agri-Fos) Agrichem Manufacturing
Industries; (Fungi-Phite) Biagro Western Sales; (F, B)
- pronamide – (*Kerb) Dow AgroSciences (H)
propiconazole – (Tilt) Syngenta; (Bumper) Makhteshim
Agan (F)
pyraclostrobin (Cabrio EG) BASF (F)
pyraclostrobin+boscalid – (Pristine) BASF (F)
pyraflufen ethyl – (Venue) Nichino (H)
pyrethrins/rotenone – (PyGanic, Pyrenone) McLaughlin
Gormley King, Bayer (I)
pyridaben – (Nexter) Gowan (A,I)
primethanil – (Scala) Bayer; (Penbotec) Janssen (F)
pyriproxyfen – (Esteem) Valent BioSciences (I)
- quinoxifen – (Quintec) Dow AgroSciences (F)
- Reynoutria sachalinensis* - (Regalia) Marrone Bio
Innovations (F,B)
rimsulfuron – (Matrix) DuPont (H)
rynaxypyr – (Altacor) DuPont (I)sethoxydim – (Poast)
BASF (H)
- simazine – (Princep) Syngenta; (Simazine) WinField
Solutions, Drexel, Loveland Products; (Sim-Trol)
Sipcam Agro (H)
soap, insecticidal – (M-Pede, Des-X) Dow AgroSciences,
Certis (I)
spinetoram – (Delegate) Dow AgroSciences (I)
spinosad – (Entrust) Dow AgroSciences (I)
spirodiclofen – (Envidor) Bayer (A)
spirotriamet – (Movento) Bayer CropScience (I)
streptomycin – (Agri-mycin, Streptrol) Nufarm;
(Agricultural Streptomycin) Farm Saver; (Firewall)
AgroSource (B)
sulfur – (Microthiol Disperss) United Phosphorus (F)
- tebuconazole – (Elite) Bayer; (Tebuzol) United
Phosphorus(F)
tebufenozide – (Confirm) Gowan (I)
terbacil – (Sinbar) DuPont (H)
thiabendazole – (Mertect) Syngenta; (Shield-Brite TBZ)
Pace International (F)
thiacloprid – (Calypso) Bayer (I)
thiamethoxam – (Actara, *Agri-Flex, Endigo, Voliam
Flexi) Syngenta (I)
thiophanate-methyl – (Topsin M) United Phosphorus;
(Thiophanate-methyl) FarmSaver, Makhteshim Agan;
(T-Methyl) Nufarm (F)
thiram – (Thiram Granuflo) Taminco (F)
tolfenpyrad - (Apta) Nichino (I)
triadimefon – (Triadimefon) Taminco; (Bayleton)
Amvac (F)
trifloxystrobin – (Flint, Adament), Gem) Bayer (F)
triflumizole – (Procure) Agriphar (F)
- zeta-cypermethrin – (*Gladiator) FMC (A,I)
ziram – (Ziram) United Phosphorus; (Ziram Granuflo)
Taminco (F)

5.1.2 By Trade Name

2,4-D Amine 4 – (2,4-D) WinField Solutions (H)

*Abba – (abamectin) Makhteshim (A, I)
 Abound – (azoxystrobin) Syngenta (F)
 Acramite – (bifenazate) Agriphar (A)
 Actara – (thiamethoxam) Syngenta (I)
 Adament – (tebuconazole & trifloxystrobin) Bayer (F)
 Admire Pro – (imidacloprid) Bayer (I)
 §Agree – (*Bacillus thuringiensis*) Certis (I)
 *Agri-Flex – (abamectin + thiamethoxam) Syngenta (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)
 Alion – (indaziflam) Bayer (H)
 Allpro Lime Sulfur – (liquid lime-sulfur) Value Garden Supply (A, F, I)
 Altacor – (chlorantraniliprole/rynaxypyr) DuPont (I)
 Amine 4 – (2,4-D) Loveland Products (H)
 *Ambush – (permethrin) AMVAC (I)
 Applause – (chlorothalonil) Loveland (F)
 Apollo – (clofentezine) Makhteshim (A)
 Apta - (tolfenpyrad) Nichino (I)
 *Asana – (esfenvalerate) Valent (I)
 Assail – (acetamiprid) United Phosphorus (I)
 Atila Plus – (glyphosate) Nufarm (H)
 Avaunt – (indoxacarb) DuPont (I)
 Aza-Direct – (azadirachtin) Gowan (I)
 Azatin XL – (azadirachtin) Certis (I)

Badge SC - (copper oxychloride) Gowan (B, F)
 Badge X2 - (copper hydroxide) Gowan (B, F)
 Basicop – (copper sulfate) Griffin (B, F)
 Bayleton – (triadimefon) Amvac (F)
 *Baythroid – (cyfluthrin) Bayer (I)
 Belay – (clothianidin) Valent BioSciences (I)
 Beleaf – (flonicamid) FMC (I)
 Belt – (flubendiamide) Bayer (I)
 Biobit – (*Bacillus thuringiensis*) Valent BioSciences (I)
 Botran – (dicloran) Gowan (F)
 Bravo – (chlorothalonil) Syngenta (F)
 *Brigade – (bifenthrin) FMC (I, A)
 Bumper – (propiconazole) Makhteshim Agan (B)

C-O-C-S – (copper oxychloride/copper sulfate) Loveland (B, F)
 Cabrio EG – (pyraclostrobin) BASF (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) Agriphar (H)
 Centaur – (buprofezin) Nichino America (I)
 Champ – (copper hydroxide) Nufarm Americas (B, F)
 Chateau – (flumioxazin) Valent (H)

Checkmate – (pheromones) Suterra (I)
 Clean Crop Malathion – (malathion) Loveland (I)
 Clutch – (clothianidin) Valent BioSciences (I)
 Collide – (oxyfluorfen) United Phosphorus (H)
 Concorde – (chlorothalonil) Griffin (F)
 Cornerstone – (glyphosate) WinField Solutions (H)
 Credit – (glyphosate) Nufarm (H)
 §Cuevo - (low MCE organic copper) Ceris (B, F)
 Cuprofix Ultra Disperss – (copper sulfate) United Phosphorus (B, F)
 Cyd-X – (codling moth granulosis virus) Certis (I)

*Danitol – (fenpropathrin) Valent BioSciences (I)
 Delegate – (spinetoram) Dow AgroSciences (I)
 Deliver – (*Bacillus thuringiensis*) Certis (I)
 Des-X - (insecticidal soap) Certis (I)
 Devrinol – (napropamide) United Phosphorus (H)
 Diazinon – (*Diazinon) Makhteshim (I)
 Dimate – (dimethoate) WinField Solutions (I)
 Dimethoate – (dimethoate) Drexel, Loveland, Cheminova (I)
 Dipel – (*Bacillus thuringiensis*) Valent BioSciences (F)
 Direx – (diuron) Griffin (H)
 Dithane – (mancozeb) Dow AgroSciences (F)
 Diuron – (diuron) WinField Solutions, Drexel, Loveland Products, Makhteshim Agan (H)
 §Double Nickel 55/LC – (*Bacillus amyloliquefaciens*) Certis (B, F)
 Echo – (chlorothalonil) Sipcam Agro (F)

Elevate – (fenhexamid) Arvesta (F)
 Elite – (tebuconazole) Bayer (F)
 *Endigo – (lambda-cyhalothrin/thiamethoxam) Syngenta (I)
 Endosulfan – (endosulfan) Drexel (I)
 §Entrust – (spinosad) Dow AgroSciences (I)
 Envidor – (spiroadiclofen) Bayer (A)
 Equus – (chlorothalonil) Makhteshim Agan (F)
 Esteem – (pyriproxyfen) Valent BioSciences (I)
 Exirel – (cyantraniliprole) DuPont (I)

*Fanfare – (bifenthrin) Makhteshim Agan (A, I)
 Ferbam Granuflo – (ferbam) Taminco (F)
 Fireline – (oxytetracycline) AgroSource (B)
 Firewall – (streptomycin) AgroSource (B)
 Flint – (trifloxystrobin) Bayer (F)
 Fontelis – (penthiopyrad) DuPont (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)
 Gem – (trifloxystrobin) Bayer (F)
 *Gladiator – (ivermectin B1/zeta-cypermethrin) FMC (A, I)
 GlyStar Original – (glyphosate) Albaugh (H)
 Goal – (oxyfluorfen) Dow AgroSciences (H)
 Gramoxone (paraquat) Syngenta (H)
 Grandevo - (*Chromobacterium subsugae* metabolites) Marrone Bio Innovations (I)

- Hyvar – (bromacil) DuPont (H)
- Imidan – (phosmet) Gowan (I)
- Indar – (fenbuconazole) Dow AgroSciences (F)
- Inspire Super – (difenoconazole & cyprodinil) Syngenta (F)
- Intrepid – (methoxyfenozide) Dow AgroSciences (I)
- Iprodione – (iprodione) MicroFlo (F)
- Isomate – (pheromones) CBC (I)
- Javelin – (*Bacillus thuringiensis*) Certis (I)
- Kanemite – (acequinocyl) Arysta LifeScience (A)
- Karmex – (diuron) Griffin (H)
- Kasumin 2L – (kasugamycin) Arysta LifeScience (B)
- *Kerb – (pronamide) Dow AgroSciences (H)
- Kocide – (copper hydroxide) Griffin (B, F)
- *Lambda-Cy – (lambda-cyhalothrin) United Phosphorus (I)
- *Lannate – (methomyl) DuPont (I)
- *Leverage – (cyfluthrin/imidacloprid) Bayer (I)
- Lime Sulfur Solution – (liquid lime sulfur) Miller Chemical (A, F, I)
- Lorsban – (chlorpyrifos) Dow AgroSciences, Gowan (I)
- Luna Sensation – (fluopyram/trifloxystrobin) Bayer (F)
- Luna Tranquility (fluopyram/pyrimethanil) Bayer (F)
- §Madex – (insecticidal virus) Certis (I)
- Malathion – (malathion) Drexel (I)
- Manex – (Maneb) DuPont (F)
- Manzate – (mancozeb) Griffin (F)
- Matrix – (rimsulfuron) DuPont (H)
- Merivon – (fluxapyroxad + pyraclostrobin) BASF (F)
- Mertect – (thiabendazole) Syngenta (F)
- Messenger – (harpin) Eden Bioscience (B)
- Meteor – (iprodione) United Phosphorus (F)
- Movento – (spirotetramat) Bayer CropScience (I)
- M-Pede – (insecticidal soap; potassium salts of fatty acids) Gowan (I)
- Mycoshield – (oxytetracycline) Nufarm (B)
- Microthiol Disperss – (sulfur) Unifos (F)
- Nealta Miticide - (cyflumetofen) BASF (A)
- Neemix 4.5 – (azadirachtin) Certis (I)
- Nexter – (pyridaben) Gowan (A, I)
- Onager – (hexythiazox) Gowan (A)
- Orbit – (propiconazole) DuPont (F)
- Oryza Ag – (oryzalin) AgValue (H)
- Oryzalin – (oryzalin) FarmSaver.com (H)
- OxiDate – (hydrogen dioxide) Biosafe Systems (B, F)
- Penbotec – (pyrimethanil) Janssen (F)
- Penncozeb – (mancozeb) United Phosphorus (F)
- PFR-97 - (*Isaria fumosorosea*) Certis (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 + boscalid) BASF (F)
- *Proaxis – (gamma-cyhalothrin) Loveland (I)
- *Proclaim – (emamectin benzoate) Syngenta (I)
- ProPhyt – (potassium phosphite) Luxembourg-Pamol (F)
- Procure – (triflumizole) Agriphar (F)
- Prowl – (pendimethalin) BASF (H)
- PyGanic, Pyrenone – (pyrethrins) McLaughlin Gormley King, Bayer (I)
- Quash – (metconazole) Valent (F)
- Quintec – (quinoxifen) Dow AgroSciences (F)
- Rage – (carfentrazone/glyphosate) FMC (H)
- Regalia - (*Reynoutria sachalinensis*) Marrone Bio Innovations (F, B)
- Rely – (glufosinate-ammonium) Bayer (H)
- Ridomil Gold – (mefanoxam) Syngenta (F)
- Rimon – (novaluron) Agriphar (I)
- Roundup Original – (glyphosate) Monsanto (H)
- Roundup Original II – (glyphosate) Monsanto (H)
- Roundup Original Max – (glyphosate) Monsanto (H)
- Roundup Ultra – (glyphosate) Monsanto (H)
- Roundup Ultradry – (glyphosate) Monsanto (H)
- Roundup Weathermax – (glyphosate) Monsanto (H)
- Rovral – (iprodione) Bayer (F)
- Sandea – (halosulfuron) Gowan (H)
- Savey – (hexythiazox) Gowan (A)
- Scala – (pyrimethanil) Bayer (F)
- Scholar – (fludioxonil) Syngenta (F)
- Scorpion – (dinotefuran) Gowan (I)
- Select Max - (clethodim) Valent (H)
- §Serenade – (*Bacillus subtilis*) AgraQuest (B, F)
- Sevin – (carbaryl) Bayer (I)
- Shield-Brite TBZ – (thiabendazole) Pace International (F)
- Simazine – (simazine) WinField Solutions, Drexel, Loveland Products (H)
- Sim-Trol – (simazine) Sipcam Agro (H)
- Sinbar – (terbacil) DuPont (H)
- Solicam – (norflurazon) Syngenta (H)
- Sovran – (kresoxim-methyl) BASF (F)
- SPLAT – (pheromones) ISCA Tech (I)
- Stinger – (clopyralid) Dow AgroSciences (H)
- StorOx – (hydrogen dioxide) Biosafe Systems (B, F)
- Streptrol – (streptomycin) Nufarm (B)
- Suregard Lime Sulfur – (liquid lime-sulfur) Value Garden Supply (A, F, I)
- Surflan – (oryzalin) United Phosphorus (H)
- Sulfurix Lime Sulfur – (liquid lime-sulfur) Miller Chemical (A, F, I)
- Surround – (kaolin) TKI (A, F, I)
- Syllit – (dodine) Loveland, Agriphar (F)

T-Methyl – (thiophanate-methyl) Micro Flo (F)
 *Taiga Z – (lambda-cyhalothrin) WinField Solutions (I)
 *Thionex – (endosulfan) Makhteshim (I)
 Thiophanate-methyl – (thiophanate-methyl) FarmSaver,
 Makhteshim Agan (F)
 Thiram Granuflo – (thiram) Tamico (F)
 Tilt – (propiconazole) Syngenta (F)
 Topaz Fungicide – (phosphorous acid) WinField Solutions
 (F)
 Topguard – (flutriafol) Cheminova (F)
 Topsin M – (thiophanate-methyl) United Phosphorus (F)
 Turismo – (flubendiamide & buprofezin) Nichino (I)
 Touchdown HiTech – (glyphosate) Syngenta (H)
 Touchdown IQ – (glyphosate) Syngenta (H)
 Touchdown Total IQ – (glyphosate) Syngenta (H)
 §Tree Tech OTC – (oxytetracycline) Florida Silvics (B)
 Triadimefon – (triadimefon) Taminco (F)

Unison – (2,4-D) Helena (H)

Vanguard – (cyprodinil) Syngenta (F)
 *Vendex – (hexakis, fenbutatin-oxide) United Phosphorus
 (A)
 Venerate - (*Burkholderia rinojensis*) Marrone Bio
 Innovations (I)
 Venom - (dinotefuran) Valent (I)
 Venue – (pyraflufen ethyl) Nichino (H)
 Voliam Flexi – (thiamethoxam/chlorantraniliprole)
 Syngenta (I)
 Voliam Xpress – (lambda-cyhalothrin) Syngenta (I)
 *Vydate – (oxamyl) DuPont (I)

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

Zeal – (etoxazole) Valent (A)
 Ziram – (ziram) United Phosphorus (F)
 Ziram Granuflo – (ziram) Taminco (F)

5.2 Restricted Highly Toxic Pesticides

2,4-D, some formulations (Unison, Agrisolutions 2,4-D
 Amine, Weedar 64)

abamectin (*Agri-Flex, *Agri-Mek, *Abba, *Temprano)
 azinphos-methyl (*Guthion)

bifenthrin (*Bifenture, *Brigade, *Fanfare)

carbaryl (*Sevin 80WS) - "G" restriction
 chloropicrin (*Telone C-17)
 clopyralid (Stinger)
 cyfluthrin (*Baythroid, *Leverage)

emamectin benzoate (*Proclaim)
 endosulfan (*Thionex)
 esfenvalerate (*Asana)

fenpropathrin (*Danitol)

hexakis, fenbutatin-oxide (*Vendex)

imidacloprid (, *Leverage)

lambda - cyhalothrin (*Endigo, *Lambda-Cy, *Taiga Z,
 *Warrior, *Voliam Xpress)

methomyl (*Lannate)
 methyl bromide

oxamyl (*Vydate)

paraquat (Gramoxone Inteon)
 permethrin (*Ambush, *Perm-Up *Pounce)
 pronamide (*Kerb)

zinc phosphide

5.3 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 2d is
 the spray lime in lb, and the 3d 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. Recent formulations may have a 24-hr re-entry: 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. Tank-mixing captan with foliar nutrients or spray adjuvants that enhance penetration such as Regulaid may severely damage fruit finish and cause spotting and necrosis of the foliage. The potential for fruit finish and foliar phytotoxicity increases when applications made under slow drying conditions (e.g. high relative humidity, light rain, etc.) Given the potential for fruit finish and foliar damage, the use of adjuvants in tank mixes, and the susceptibility of young developing tissues, captan should not be applied from petal fall to 2nd cover.

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 <mrlatabase.com>

Chlorothalonil (Bravo, Echo, Applause, Concorde, 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 not at risk for development of fungicide-resistance in pathogens that it controls.

Cyprodinil (Vanguard) is an anilinoimidazole 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, Vanguard is not recommended for use beyond tight cluster. Vanguard can provide 48 to 72 hr of postinfection activity against apple scab on leaves. In efficacy trials conducted in Cornell orchards, Vanguard was rarely more effective against scab than mancozeb fungicides except in situations where post-infection 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.

Difenoconazole + Cyprodinil (Inspire Super) is labeled for use on for diseases of apples, pear, plums, peaches, and apricots and has provided outstanding control of apples scab, powdery mildew, and flyspeck and sooty blotch in research trials. Given the efficacy considerations mentioned above for Cyprodinil, it is important to note that a considerable portion of this fungicide premix's efficacy likely results from the difenoconazole component. No more than 60 fl oz./A of Inspire Super can be applied in a single season and no

more than two consecutive applications of Inspire Super can be made before rotating to a non-frac group 3 or 9 chemistry. The product comes as a premix. In apples there is a 14 day PHI.

Note: Inspire Super is able to control SI resistant apple scab in varieties that have reduced susceptibility apple to apple scab (e.g. develop less scab than ‘McIntosh’) in seasons with low disease pressure. However, this material should not be used specifically to manage SI resistant apple scab.

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 no longer recommend the use of dodine alone for apple scab control both because of uncertainty about the levels of resistance in most orchards and as a resistance management strategy for dodine where the scab population is still dodine-sensitive. Dodine should be applied at no more than 1.5 pt/A and should be combined with either captan (1.5-2 lbs a.i./acre) or a mancozeb fungicide (2.25 lbs a.i./acre). Syllit can provide excellent pre-symptom and antispore activity against dodine-sensitive strains of apple scab. However, regular use of dodine for post-infection suppression of scab will generate selection pressure for dodine-resistant scab populations and therefore is not recommended. Dodine provides excellent control of cherry leaf spot on both sweet and sour cherry, although dodine-resistant cherry leaf spot has been reported in Michigan. Dodine is not effective against brown rot on cherries or against mildew and rust diseases on apples.

Warning: Incompatibility problems have been reported for tank mixes consisting of Syllit and copper and Syllit with the insecticide Chlorpyrifos.

Fenbuconazole (Indar) is a sterol inhibitor fungicide labeled for use on stone fruits and apples. Indar has provided outstanding control of brown rot in university trials and commercial orchards, 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. For stone fruit, there is a 0-day PHI with respect to residue tolerance, and a 12-hour restricted-entry interval for worker protection. Indar has most recently been approved for use on apples. It has demonstrated outstanding control on apple scab, and is also labeled for control of powdery mildew, rusts, and flyspeck and sooty blotch.

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

Fenhexamid (Elevate) is labeled for control of brown rot blossom blight and fruit rot on all stone fruits. University trials in other states 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 russetting 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, Badge SC); copper hydroxide (e.g., Kocide 3000, Kocide 2000, Champ Formula 2, Badge X2); complexed forms of basic copper sulfate (e.g., Cuprofix Ultra Dispers). 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. Copper compounds acceptable for organic production have changed regularly in recent years, be sure to check with your certifying agency before applying copper materials in organic orchards.

Fludioxonil (Scholar) is a 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 mrl database.com).

Fluopyram + Trifloxystrobin (Luna Sensation) is labeled for apples and cherries to control several diseases including apple scab, powdery mildew, cherry leaf spot, brown rot blossom blight and fruit rot and various post-harvest rots. It is premixed and contains a succinate dehydrogenase inhibitor (SDHI) (Group 7) plus a strobilurin (Group 11) fungicide. It has both preventative, systemic, and curative properties. Even though Luna Sensation is a premix of two fungicide modes of action, both are at risk of fungicide resistance development. To limit resistance development, make no more than two sequential applications of Fontelis, tank mix with an EBDC or captan, and rotate with other non-SDHI and other non-strobilurin fungicides. Do not apply where spray drift may reach Concord grapes as spray injury may occur.

Fluopyram + Pyrimethanil (Luna Tranquility) is a fungicide labeled for apples to control scab and powdery mildew. It is premixed and contains a succinate dehydrogenase inhibitor (SDHI) (Group 7) and an anilinoimidazole (Group 9). It can be used where strobilurin resistant scab is suspected. However, the Even though Luna Tranquility is a premix of two fungicide modes of action, both are at risk of fungicide resistance development. To limit resistance development, make no more than two sequential applications of Fontelis, tank mix with an EBDC or captan, and rotate with other non-SDHI and other non-strobilurin fungicides. Also it has a 72 day pre-harvest interval.

Flutriafol (Topguard) is a member of the triazole group of sterol inhibitor fungicides. It is exceptionally effective against powdery mildew, cedar apple rust, and scab on apples. Fruit scab control is usually improved by tank-mixing with a contact fungicide (captan, mancozeb).

Warning: In the western United States, there have been some reports of foliar phytotoxicity when Topguard has been applied with that enhance penetration such as Regulaid. Moreover, Topguard may not be effective against apple scab in many New England orchards where the pathogen has developed resistance to the SI fungicide group. The inclusion of a contact fungicide (captan, mancozeb) will help this fungicide overcome an apple scab population with practical resistance to SI fungicides. Against a powdery mildew susceptible cultivar (e.g. 'Jonagold'), this fungicide would perform well. Topguard also may fail to control other diseases where the pathogen populations have become resistant to SI fungicides.

Fluxapyroxad + Pyraclostrobin (Merivon) is a premixed combination of two fungicides, a succinate dehydrogenase inhibitor (SDHI; Group 7) and a strobilurin (QoI; Group 11). Merivon is registered on apple, pear, sweet and tart cherry, peach, nectarine, apricot, plum, and prune. Merivon has activity against apple scab and powdery mildew on apple and cherry

leaf spot, American brown rot, and powdery mildew of sweet and tart cherry. Even though Merivon is a premix of two fungicide modes of action, both are at risk of fungicide resistance development. To limit resistance development, make no more than two sequential applications of Fontelis, tank mix with an EBDC or captan, and rotate with other non-SDHI and other non-strobilurin fungicides.

Fosetyl-AI (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, Meteor) is highly effective for control of brown rot blossom blight on stone fruits (Group 2 fungicide). 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.

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

Mancozeb (Dithane, Manzate Max, 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 effective in 1992 allow low-rate uses up to 77 days before harvest, whereas high rate applications are not allowed after bloom.

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.

Metconazole (Quash) is a sterol inhibitor fungicide labeled for control of brown rot on apricots, cherries, nectarines, peaches, and plums. It is also labeled for cherry leaf spot, powdery mildew, and peach scab. Orbit has a 14-day PHI and a 12-hour restricted-entry interval for worker protection.

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

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. Label changes effective in 1992 impose use limits similar to those for mancozeb.

Myclobutanil (Rally) is a member of the triazole group of sterol inhibitor fungicides. It is very active against powdery mildew, cedar apple rust, and scab on apples. Like the other sterol inhibitors, Rally is particularly active against apple scab in the kickback and presymptom modes. Fruit scab control is usually

improved by tank-mixing with a contact fungicide (captan, mancozeb). It is also registered and very effective for control of brown rot blossom blight and powdery mildew on some stone fruits (cherries, peaches, and nectarines), and for control of cherry leaf spot. It is neither registered nor effective for control of fruit brown rot.

Warning: Rally is no longer effective against apple scab in some New England orchards where the pathogen has developed resistance to the SI fungicide group. The inclusion of a contact fungicide (captan, mancozeb) will help this fungicide overcome an apple scab population with practical resistance to SI fungicides. Against a powdery mildew susceptible cultivar (e.g. 'Jonagold'), this fungicide would perform well. Rally may fail to control other diseases where the pathogen populations have become resistant to SI fungicides.

Penthiopyrad (Fontelis) is a succinate dehydrogenase inhibitor (SDHI) fungicide (Group 7) labeled for pome and stone fruit to control scab, *Botrytis*, powdery mildew and brown rot. Fontelis is rainfast within 1 hour of application. To limit the potential for resistance development, make no more than 2 sequential applications of Fontelis, tank mix with a broad-spectrum protectant such as an EBDC or Captan, and rotate with other non-SDHI fungicides. Fontelis has a 12-hr REI; a 28-day PHI for apple and pear, and a 0-day PHI for stone fruits. There have been reports of phytotoxicity with tank mixes of Fontellis and captan applied from petal fall to 2nd cover. Hence, tank mixes of Fontellis and captan should not be applied during this timeframe (see captan section).

Propiconazole (Tilt, Bumper) is a sterol inhibitor fungicide labeled for control of brown rot on apricots, cherries, nectarines, peaches, and plums. (Do not use on Stanley plums.) It is also labeled for cherry leaf spot. Tilt and Bumper have a 0-day PHI and a 12-hour restricted-entry interval for worker protection.

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

Pyraclostrobin (Cabrio) is a fungicide registered for use on cherries. Pyraclostrobin is in the strobilurin fungicide group with activity similar to that of Flint and Sovran. Cabrio controls brown rot and powdery mildew. It may be applied up to 2 times per season on cherries, but may not be applied more than two times in a row without rotating to non-group 11 fungicide.

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

Pyraclostrobin + boscalid (Pristine) is a 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 boscalid 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.

Pyraclostrobin + fluxapyroxad (Merivon) is a 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 fluxapyroxad is a succinate dehydrogenase fungicide with good activity against apple scab, flyspeck sooty blotch, brown rot, and other post-harvest rots of stone fruits. Pyraclostrobin 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, fruit decays caused by Botrytis and Penicillium, and other post-harvest rots of stone fruits. It may be applied up to 3 times per season on stone fruits and 4 times per season on pome fruits. It has a 0-day PHI. Merivon may prove useful for managing DMI and QoI fungicide resistance in apple scab, powdery mildew, brown rot and cherry leaf spot. Merivon provides excellent control of summer diseases on apples (i.e. black rot, white rot, bitter rot, fly speck, sooty blotch). Do not mix merivon with EC formulations or with crop oil concentrates and methylated seed oils

Pyrimethanil (Penbotec, Scala) is a anilinopyrimidine fungicide (same class as Vanguard) 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 Vanguard (cyprodinil): it is most effective under cool conditions and has up to 48 to 72 hr of postinfection activity against apple scab. In trials in the Hudson Valley, it 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.

Pyrimethanil + fluopyram (*†Luna Tranquility) is a fungicide for use on apples against apple scab and powdery mildew. Pyrimethanil is an anilinopyrimidine fungicide with activity similar to that of Scala and Vanguard whereas fluopyram is a succinate dehydrogenase fungicide. The product has good activity against apple scab. The product also provides some control of apple powdery mildew. It may be applied up to 3-4 times per season. It has a 72-day PHI. *†Luna Tranquility may prove useful for managing DMI and QoI fungicide resistance in apple scab and powdery mildew.

Quinoxifen (Quintec) is a fungicide that inhibits signal transduction mechanisms in powdery mildew fungi. It is labeled for grapes, strawberries, hops, and cherries for control of powdery mildew. It provides protectant activity, but no post-infection activity. It does have vapor redistribution and re-adsorption into adjacent plant tissues. Quintec has a 7-day PHI and a 12-hour restricted-entry interval for worker protection.

(§)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 90% 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 russetting 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.

Check with your local organic certifier to confirm the acceptability of specific materials before using them in organic orchards.

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

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

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

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. Topsin M 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 New England 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 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 fungicide for brown rot, peach leaf curl, and peach scab, but is weaker than captan. Thiram Granuflo is no longer labeled for use on apples. Thiram is sometimes used for its activity as a deer and rabbit repellent.

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

Trifloxystrobin (Flint, Gem) is a strobilurin fungicide. Like Sovran, Flint is an excellent protectant 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 and good control of black rot bitter rot. Gem is the formulation registered for control of stone fruit

diseases such as cherry leaf spot, scab, and mildew on stone fruits. **Warning:** Flint may fail to control disease where the pathogen populations have become resistant to QoI fungicides.

Trifloxystrobin + tebuconazole (Adament) is a new fungicide that is registered for use on both pome fruits and stone fruits. Trifloxystrobin is in the strobilurin fungicide group and is the same active ingredient in Flint, whereas tebuconazole is a sterol-inhibitor fungicide with good control against brown rot. Adament can control against apple scab, and is also labeled for control of powdery mildew, cedar apple rust, flyspeck and sooty blotch, and white and bitter rot. Adament can also control of brown rot blossom blight and fruit rot in stone fruit and is also labeled for controlling jacket rot, mildew, anthracnose, cherry leaf spot, along with several other diseases on stone fruit. To limit resistance development, Adament or another fungicide from FRAC groups 11 or 3 should not be applied for more than two consecutive applications.

Triflumizole (Procure) is a sterol inhibitor fungicide with activities, strengths, and weaknesses similar to those of 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 many New England orchards because the pathogen has developed resistance to the SI fungicide group. Procure may fail to control other disease where the pathogen populations have become resistant to SI fungicides.

Ziram (Ziram) 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.

5.4 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 form. Streptomycin is commonly used in 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 several NY counties. Indiscriminate use of this material during summer covers or for shoot blight control will hasten the further development of resistance.

Streptomycin use in organic orchards is currently allowed for fire blight management only. This use is scheduled to end in 2014, after which streptomycin will be restricted from use in organic production.

Kasugamycin (Kasumin 2L- is a bactericide used for fire blight of apples and pears. It is formulated as kasugamycin hydrochloride in a 2.3% liquid solution. Kasugamycin is at bloom at the rate of 64 fl oz/100 gal for fire blight control, and it can be used at combination with wetting agents to enhance efficacy. It should be applied only in conjunction with disease forecasting models. It can be applied until 90 days prior to harvest. However, summer sprays of streptomycin are NOT recommended, except following a hailstorm.

Resistance to kasugamycin has not been detected in the fire blight pathogen *Erwinia amylovora*. However, indiscriminate use of this material during summer covers or for shoot blight control may hasten the development of resistance.

(§)**Oxytetracycline** (Mycoshield, Fireline, & Tree Tech OTC), another antibiotic, is registered for foliar use on peaches and nectarines to control bacterial spot. It is also registered on peach for microinjection to manage peach X-disease. It is also registered for control of fire blight on pear, but is not as effective as streptomycin.

Oxytetracycline use in organic orchards is only allowed for management of fire blight in apples and pears. This use is scheduled to end in 2014, after which oxytetracycline will be restricted from use in organic production.

5.5 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.

§**Bloomtime Biological** (*Pantoea agglomerans* strain *E325*) is a biopesticide labeled for control of the blossom blight phase of fire blight. Bloomtime Biological is a wettable powder formulation of the bacterium *Pantoea agglomerans* strain *E325*. The bacterium acts by colonizing susceptible blossom tissues and using up available nutrients in an effort to prevent colonization of fire blight bacteria (*Erwinia amylovora*). This competitive inhibition will, in theory, prevent the buildup of *Erwinia amylovora* numbers, and in turn, prevent blossom infections. Bloomtime Biological provides only partial control of fire blight in commercial orchards in New York. When used appropriately, studies conducted in NY indicate that Bloomtime Biological can provide up 50% compared to streptomycin under commercial conditions. Bloomtime Biological should be applied as a preventive and should not be applied after fruit set.

§**DoubleNickel 55/LC** (*Bacillus amyloliquefaciens*) is a biofungicide labeled for control of fire blight, apple scab, powdery mildew, and summer diseases like flyspeck and sooty blotch. Double Nickel 55 is a 25% water-dispersible granule (WDG) formulation, while Double Nickel LC is a 99% aqueous suspension of the bacterium *Bacillus amyloliquefaciens*, a common soil resident. The bacterium acts by releasing lipopeptides during growth that destroy the cell walls of plant pathogenic fungi and bacteria. DoubleNickel may be less effective than conventional fungicide for controlling fungal diseases under the favorable climatic conditions that exist in New York. However, tests at the NYSAES have indicated that it provides good control of fly speck sooty blotch when used in combination with low MCE organic copper (e.g. Cueva). When used alone, DoubleNickel provides only some control of fire blight. In alternation with streptomycin, it sometimes provides control approaching that of a full streptomycin program. DoubleNickel should be applied as a preventive and can be applied up to and including the day of harvest.

§**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, ProPhyt) 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. Experience in NY 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.

§**Regalia** (*Reynoutria sachalinensis*) is a biofungicide labeled for powdery mildew control and fire blight suppression. Its complex mode of action creates a defense response in the treated plants.

§**Serenade Optimum** (*Bacillus subtilis*) is a biofungicide labeled for control of fire blight, apple scab and powdery mildew. Serenade Optimum 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 optimum may be less effective than conventional fungicide for controlling fungal diseases under the climatic conditions that exist in New England. When used alone, Serenade Optimum provides only some control of fire blight. In alternation with streptomycin, it sometimes provides control approaching that of a full streptomycin program. Serenade Optimum should be applied as a preventive and can be applied up to and including the day of harvest.

5.6 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.

5.6.1 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.

Chlorpyrifos (Lorsban) is registered for control of San Jose scale during the dormant/delayed dormant period on apples, pears, peaches, cherries 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, nectarines and cherries to control peachtree borers and in apples as a trunk spray to control a variety of borers. 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 *3.76EC or *4EC formulations. This label also lists postbloom trunk sprays for many borer species in apple. All 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. On apples, only one application of any chlorpyrifos containing product can be made per year.

Diazinon has caused russetting 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 principally used prebloom for control of San Jose scale. On apples, post-bloom applications are for San Jose scale and woolly apple aphid. It is generally less persistent than other standard phosphates and has a high bee-poisoning hazard.

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 and will control apple maggot. It has a high bee-poisoning hazard.

Malathion is a mild phosphate that is used where a high degree of safety to people or animals is desired. It is no longer labeled for apples. It is registered for use on cherry, peach, nectarine and apricot for a variety of pests including aphids, scales, codling moth, oriental fruit moth, plum curculio and Japanese beetle. It has a very short PHI, is compatible with most other insecticides and fungicides and has a high bee-poisoning hazard. **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.

5.6.2 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.

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 48 hours for pears. It has a high bee-poisoning hazard.

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. It has a moderate bee-poisoning hazard.

5.6.3 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** (*Brigade) 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.

Cyfluthrin (*Baythroid) is registered for use on all pome and stone fruits in New England. This 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. It has a high bee poisoning hazard.

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 New York pear psylla populations. It has a high bee-poisoning hazard.

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

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.

Lambda-cyhalothrin (*Lambda-Cy, *Taiga Z, *Voliam Xpress, *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.

Permethrin (*Ambush, *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.

5.6.4 Neonicotinoids

Neonicotinoid insecticides are chemically related to nicotine. The neonicotinoids show reduced toxicity compared with earlier classes of broad-spectrum materials such as organophosphates and carbamates. Most neonicotinoids show much lower toxicity in mammals than insects, but some breakdown products are toxic to some non-target species, including beneficial insects. Neonicotinoids are currently represented by four single-a.i. products widely used on tree fruits in New England, plus as components of several pre-mix formulations containing more than one active ingredient (refer to section 5.6.5).

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.

Clothianidin (Belay) is labeled for post bloom applications on pome fruits and peaches, but no other stone fruit crops. These uses are currently on a supplemental label which must be in the possession of the user at the time of application. Belay is effective on tarnished plant bug and stink bugs, including the brown marmorated stink bug. This product is toxic to bees exposed to treatment and for more than 5 days following treatment. Do not apply this product to blooming, pollen-shedding or nectar-producing parts of plants if bees may forage on the plants during this time period.

Dinotefuran (Scorpion, Venom) is labeled for control of aphids, leafhoppers, peach tree borer, plum curculio, and stink bugs on peaches and nectarines. The rate applied affects the length of control. Use the higher rate where infestations occur later in crop development. Scorpion may be mixed and/or alternated with commonly used insecticides for resistance management.

Imidacloprid (Admire Pro, *Leverage 360) is a broad spectrum contact and locally systemic chloronicotinyl insecticide with low mammalian toxicity. It is primarily effective against aphids, whiteflies, thrips, scales (crawlers), psylla, leafhoppers, mealybugs, some beetle

and weevil species, and leafminers. The original Provado formulation has been replaced by AdmirePro, which is labeled on pome and stone fruits for aphids (except woolly apple aphid), leafminers, leafhoppers, San Jose scale, pear psylla, mealybug, Japanese beetle, cherry fruit flies and San Jose scale. It has also shown activity against pear midge when applied at petal fall. It is additionally labeled for use as a soil-applied product against woolly apple aphid. 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 AdmirePro and other flowables, and emulsifiable concentrates last.

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 nicotinic acetylcholine 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.

Thiamethoxam (Actara) is a broad-spectrum neonicotinoid material labeled for use in pome and stone fruits 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, leafminers, leafhoppers, mealybugs, cherry fruit fly, stink bugs, plant bugs, thrips, 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. When making multiple applications to pome and stone fruits, do not exceed a total of 0.172 lbs a.i. of thiamethoxam-containing products per acre per growing season.

5.6.5 Pre-Mixes

Pre-mix products are formulations of insecticides sold as pre-mixed combinations of at least two active ingredients that are available as single-a.i. products. For best

effectiveness and insecticide resistance management, their use should be reserved for situations when multiple pest species are present and appropriately matched to the combination of active ingredients and modes of action contained in the product.

Chlorantraniliprole/lambda-cyhalothrin (*Voliam Xpress) is labeled against a wide range of pests of pome fruit and stone fruit. It is a combined formulation of chlorantraniliprole, the a.i. found in Altacor, plus the pyrethroid lambda-cyhalothrin, the a.i. in *Warrior. The pome fruit label includes internal worms and leafrollers, aphids (excluding woolly apple aphid), apple maggot and cherry fruit fly adults, leafhoppers, leafminers, plum curculio, Japanese beetle, pear psylla, plant bugs, stink bugs, and other caterpillars. The stone fruit label also includes peachtree and American plum borers. It has a high bee poisoning hazard.

Chlorantraniliprole/thiamethoxam (Voliam Flexi) is registered for use against a range of pests in pome and stone fruits. This product is a mixture of thiamethoxam, the a.i. of Actara, and chlorantraniliprole, the a.i. found in Altacor and *Voliam Xpress. The label lists lepidopteran pests such as codling moth and oriental fruit moth, obliquebanded leafroller, leafminers and green fruitworm; plum curculio; European apple sawfly; leafhoppers and aphids (except woolly apple aphid); pear psylla; plus (in stone fruits only) cherry fruit fly, stink bugs, tarnished plant bug and thrips. It has a 12-hr REI, and a PHI of 35 days in pome fruits, 14 days in stone fruits. No more than a total of 14 oz/acre of formulated product may be applied per season; this use corresponds to the 0.172 lb a.i./acre of thiamethoxam allowed, whether applied as Voliam Flexi, Actara, or *Endigo. This product is highly toxic to bees exposed to direct treatment on blooming crops or weeds; it may not be applied between early pink and petal fall in apples, between green cluster and petal fall in pears, and between swollen bud and petal fall in stone fruit.

***Beta-cyfluthrin/imidacloprid (*Leverage 360)** is labeled against a wide range of pests of pome fruit and stone fruit. It is a combined formulation of imidacloprid, the a.i. found in Admire Pro, plus the pyrethroid beta-cyfluthrin. The pome fruit label includes internal worms and leafrollers, aphids (except woolly apple aphid), apple maggot (combined with a sticker), sawfly, plum curculio, San Jose scale crawlers, and plant bugs; the stone fruit label adds Japanese beetle, American plum borer, and cherry fruit fly, among others. This product may not be applied prebloom. It has a high bee poisoning hazard.

Flubendiamide + buprofezin (Tourismo) is labeled for use in stone fruits and pome fruits against many Lepidoptera, including leafrollers, codling moth, oriental fruit moth, lesser appleworm, fruitworms and leafminers. The flubendiamide is in the same class of

ryanodine receptor modulators (IRAC Group 28) as chlorantraniliprole, found in Altacor and *Voliam Xpress. Buporfezin is the same as Centaur. It is an insect growth regulator for the control of the nymphal stages of San Jose scale, mealybugs, leafhoppers and pear psylla. It works by inhibiting chitin biosynthesis, suppressing oviposition by adults, and reducing viability of eggs. Treated susceptible pests may remain alive on the plant for 3-7 days, but feeding damage during this time is typically very low. It is not disruptive to beneficial insects and mites, and has a low bee-poisoning hazard.

Lambda-cyhalothrin/thiamethoxam (*Endigo) is registered in pome fruits and stone fruits against a range of pests. This is a pre-mix, combining lambda-cyhalothrin, the a.i. in *Warrior, with thiamethoxam, the a.i. in Actara. The pome fruit label includes leafhoppers, leafminers, stink bugs, plant bugs, Japanese beetle, internal worms, apple maggot and sawflies. The stone fruit label includes aphids, stink bugs, plant bugs, Japanese beetle, and borer species. Because of pollinator restrictions, do not apply in apples/pears during pink bud/green cluster through bloom, or in stone fruits from swollen bud through bloom. Do not apply more than 28 fl oz/A per season; PHI is 35 days in pome fruits, 14 days in stone fruits; REI = 24 hr. It has a high bee poisoning hazard.

Thiamethoxam/abamectin (*Agri-Flex) is registered for use against a range of pests in apples and pears. This product is a mixture of thiamethoxam, the a.i. of Actara, and abamectin, the a.i. found in *Agri-Mek. In apples, its label lists plum curculio, European apple sawfly, green aphids, mealybugs, leafminers and leafhoppers, pear psylla (in pears), and mites. The label states that it must be mixed with a nonionic adjuvant or horticultural spray oil (not a dormant oil). It has a 12-hour REI, and a PHI of 35 days. This is a restricted-use product, and no more than a total of 17 fl oz/acre of formulated product may be applied per season; this use corresponds to the total amount of 0.258 lb a.i./acre of thiamethoxam allowed, whether applied as *Agri-Flex, Voliam Flexi, Actara, or *Endigo. Do not make more than 2 applications per season. This product is highly toxic to bees exposed to direct treatment on blooming crops or weeds; it may not be applied between early pink and petal fall in apples, or between green cluster and petal fall in pears.

Zeta-cypermethrin/avermectin B1 (*Gladiator) is labeled against a wide range of pests of pome fruit and stone fruit. It is a combined formulation of the pyrethroid zeta-cypermethrin, plus the macrocyclic glycoside avermectin B1, which is the major component of the insecticide/miticide abamectin, the a.i. found in *Agri-Mek and related products. The pome fruit label includes internal worms and leafrollers, apple maggot, European apple sawfly, plum curculio, pear

psylla, rosy apple aphid, spirea aphid, leafminers and leafhoppers, tarnished plant bug, stink bugs, and Japanese beetle. The stone fruit label lists American plum borer, leafrollers, leafhoppers, peachtree borers, plum curculio, oriental fruit moth, stink bugs, tarnished plant bugs. It is also labeled for European red mite and twospotted spider mite in all tree fruit crops. It has a high bee poisoning hazard.

5.6.6 Other Materials

***Abamectin (*Agri-Mek)** is a natural fermentation product containing a macrocyclic glycoside, used on pome and stone fruits 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).

(§)Azadirachtin (Aza-Direct, Neemix 4.5, 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. Check with your organic certifying agency to confirm the acceptability of specific azadirachtin compound for organic production before use.

§*Bacillus thuringiensis* (Bt, Dipel, Deliver, Biobit, Javelin, Agree) is a microbial insecticide specifically for the control of caterpillars. It contains spores and crystalline endotoxin that must be ingested by larvae with high gut pH to provide control. It is effective against many fruit pests, including leafrollers and fruitworms. Although this material will control codling moth and other internal lepidopteran apple pests, it does not provide as effective control as do most conventional insecticides. One exception is the obliquebanded leafroller, which has become so difficult to control with

conventional toxicants that the Bt products work at least as well as any material available. This material is exempt from requirements for a tolerance on all raw agricultural commodities, thus it can be sprayed up until harvest. It is harmless to humans, animals, and beneficial insects, including the honey bee.

Buprofezin (Centaur) is an insect growth regulator registered in pome and stone fruits for the control of the nymphal stages of San Jose scale, mealybugs, leafhoppers and pear psylla. It works by inhibiting chitin biosynthesis, suppressing oviposition by adults, and reducing viability of eggs. Treated susceptible pests may remain alive on the plant for 3-7 days, but feeding damage during this time is typically very low. It is not disruptive to beneficial insects and mites, and has a low bee-poisoning hazard.

§***Burkholderia rinojensis*** (Venerate) is a microbial insecticide. Its unknown mode of action controls caterpillars, leafrollers, apple maggot, and San Jose scale. Include adjuvant in spray tank.

Chlorantraniliprole (rynaxypyr) (Altacor) belongs to a new chemical class, the anthranilic diamides, which activate the insect's ryanodine receptors, stimulating release of calcium from muscle tissues, and causing paralysis and death. Altacor is labeled for the control of a range of insect pests in pome and stone fruits, including codling moth, oriental fruit moth, and obliquebanded leafroller. Other species listed on the label include green fruitworm, spotted tentiform leafminer, apple sawfly, European corn borer, and suppression of apple maggot, cherry fruit fly, white apple leafhopper, and plum curculio. It has low toxicity to bees, beneficial mites, birds, fish and mammals.

§***Chromobacterium subtsugae*** (Grandevo DF) is a microbial insecticide. Its multiple mode of action targets caterpillars, leafrollers, apple maggot, spotted wing drosophila, rosy apple aphid, and San Jose scale. Recommended to use with adjuvant.

§**Codling moth granulosis virus** (Carpovirusine, Cyd-X, Madex) These products contain an insecticidal baculovirus, *Cydia pomonella* granulovirus, which is effective against the larval form of the codling moth; Cyd-X and Virosoft are registered for use in apples, pears, and plums; Madex, which contains the V22 isolate and is also effective against oriental fruit moth, is registered in all pome and stone fruits. 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 larvae upon ingestion. No adverse effect to fish, wildlife or beneficial organisms has been observed; it has a low bee-poisoning hazard.

Cyantraniliprole (Exirel) is from the chemical class of anthranilic diamides (Group 28). It controls a range of key chewing & sucking pests in pome and stone fruit including spotted wing drosophila, codling moth, European apple sawfly, fruitworms, leafrollers, leafminers, leafhoppers. For codling moth control make the first application prior to egg hatch. For obliquebanded leafroller control apply pink-petal fall, at the first sign of feeding. For summer OBLR generation, apply just prior to or at the beginning of egg hatch.

***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). In 2007, it was granted a 2(ee) registration for the control of 1st generation (only) codling moth in apples. *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.

***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. *Thionex has a moderate bee-poisoning hazard.

[Note: This product has a stop-use date of July 31, 2015.]

Flonicamid (Beleaf) is labeled against aphids and plant bugs for pome fruit and stone fruit; the label classifies it as a member of the pyridinecarboxamide family, an

IRAC Section 9C material, which is defined as "Unknown or non-specific mode of action – selective feeding blockers". Researchers have reported good efficacy against green peach aphid and tarnished plant bug in peaches. The label also lists apple aphid, black cherry aphid, rosy apple aphid, spirea aphid and woolly apple aphid. It has a low bee poisoning hazard.

Flubendiamide (Belt) is labeled for use in stone fruits and pome fruits against many Lepidoptera, including leafrollers, codling moth, oriental fruit moth, lesser appleworm, fruitworms and leafminers. The a.i. is in the same class of ryanodine receptor modulators (IRAC Group 28) as chlorantraniliprole, found in Altacor and *Voliam Xpress. PHI is 14 days in pome fruits and 7 days in stone fruits; REI = 12 hr. It has a low bee poisoning hazard. Refer to the label for additional aerial and buffer zone restrictions.

Indoxacarb (Avaunt) is a broad-spectrum oxadiazine 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. 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.

§**Insecticidal soaps (M-Pede, Des-X)** 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.

§***Sarisa fumosorosea* (PFR-97)** is a microbial insecticide for pome and stone fruit. Targets include thrips, whiteflies, aphids, spider mites, leafminers, psyllids, and mealybugs. Do not mix with fungicides or apply within 5 days of a fungicide application.

§**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 in New England while there is active foliar growth. Surround has a low bee poisoning hazard.

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 and pears, principally against obliquebanded leafroller, although activity against oriental fruit moth, codling moth and lesser appleworm is also exhibited. Intrepid is essentially safe to birds, fish, and most beneficials; however, it is toxic to aquatic invertebrates. It has a low bee-poisoning hazard.

Novaluron (Rimon) is an insect growth regulator for the control of a range of apple pests including codling moth, oriental fruit moth, obliquebanded leafroller, spotted tentiform leafminer, and redbanded leafroller. This product is an insect growth regulator that disrupts chitin synthesis in immature insects and eggs deposited on residues; it has no effect on adult stages, and must be ingested to be effective. Four applications per season are allowed. Novaluron is moderately to highly toxic to many beneficial arthropods, but relatively non-toxic to predatory mites. It has a moderate bee poisoning hazard.

(§)**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.

(§)**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 labeled 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.

Pyriproxyfen (Esteem), which is registered for use in all pome and stone fruits, 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. While it has no activity on adult insects, hatching of eggs laid by treated adults will be suppressed. 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.

Rynaxypyr (see Chlorantraniliprole)

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

(§) Spinosad (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.

Spirotetramat (Movento) is a tetramic acid registered for the control of a number of indirect pests in pome fruits and stone fruits, primarily aphids (including woolly apple aphid), mealybugs, pear psylla, and San Jose

scale. It has systemic activity, exhibiting 2-way movement in the plant, both upwards in the xylem to new shoots and leaves, and downwards in the phloem to the root tissues. Its mode of action is as a Lipid Biosynthesis Inhibitor (LBI), and it is active by ingestion against immature insects feeding on treated plants. Additionally, adult females have exhibited reduced fecundity and offspring survival. Movento is not toxic to bees or beneficial arthropods, and poses low risk to wildlife, including fish and birds.

Thiamethoxam/lambda-cyhalothrin (see Lambda-cyhalothrin/Thiamethoxam)

Tolfenpyrad (Apta) is a broad spectrum, contact insecticide that controls multiple life stages of many susceptible pests on stone fruit. It has a unique mode of action and under most conditions is fast-acting. Insects controlled includes leafrollers, cherry fruit fly, plum curculio, leafhoppers and mealybugs. Recommended to apply when populations are beginning to build. Pre-harvest interval is 14 days.

5.7 Acaricides

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

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 in New England 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.

Clofentezine (Apollo) is a tetrazine compound used as a contact acaricide that acts primarily as an oviicide/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.

Cyflumetofen (Nealta) provides a unique class of chemistry for strong knockdown power and residual control of spider mites at all life stages while being compatible with beneficial mites and insects. Apply to pome fruits at first sign of mites, before population increases. Application should be timed with recommended treatment threshold levels in developing mite populations. Use at least 100 gal water per acre. Do not use more than once before switching to a different miticide. Use no more than 27.4 oz per acre per growing season.

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 pome fruits and stone fruits. Only one application per year is permitted on pome fruit; two applications allowed on stone fruits. It has a low bee-poisoning hazard.

Fenpyroximate (Portal) is a phenoxypyrazole acaricide and insecticide labeled for use in apples and pears to control European red mite, twospotted spider mite, pear rust mite, leafhoppers, mealybugs and pear psylla. Portal belongs to the METI (Mitochondrial Electron Transport Inhibitor) class of compounds. For effective resistance

management, Portal should be used in rotation with other modes of action. The active ingredient in Portal, fenpyroximate, works by blocking cellular respiration, which gives it activity against all motile stages of mites: larvae, nymphs, and adults. Portal may not be used before petal fall; it has a 2 application per season maximum. It is classified as a reduced-risk material, and has a low bee-poisoning hazard.

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.

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

(§)**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 Section 17.4 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. Oil has a low bee-poisoning hazard.

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.

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.

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

Spirodiclofen (Envidor) is registered in pome and stone fruit to control red mites, two spotted mites, and rust mites. This group 23 miticide (lipid biosynthesis inhibitor) is active by contact against all developmental stages of mites, including eggs, nymphs and female adults. Best used as a preventative/early threshold material. A maximum of 1 application per season is allowed, with a PHI of 7 days. It is relatively harmless to beneficial species and has a low bee-poisoning hazard.

Table 5.7.1. Optimum properties of representative narrow-range oils available in the US¹

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
Unulfonated 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

¹Davidson 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

5.8 Fumigants and Nematicides for Tree Fruits

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

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

Although fumigants are frequently cost-effective, their potential benefits are often lost when they are applied to soils that are cold and wet or are otherwise poorly prepared. For best results, the site should be plowed as deeply as possible (at least 12 in.) after the old orchard is removed, and all old roots that turn up should be discarded. The land should then be limed, fertilized, fitted, and planted with a cover crop such as creeping red fescue, perennial ryegrass, or sudangrass. The land should be cover cropped for at least 1 yr, preferably 2 or 3. Near the end of July during the year before new trees are to be planted, the cover crop should be plowed under and nitrogen added to improve its decomposition. Poor decomposition of the cover crop or other weeds will reduce the effectiveness of the fumigant. The site should then be disked repeatedly to keep down weeds and work the soil into seedbed condition. The soil should be loose to a depth of at least 10 in. and free of any large, hard clods that the fumigant can't penetrate. Fumigants are generally most effective if applied while the soil is relatively warm and dry. The best time for fumigation is mid-August to early September, although materials may still be effective if applied until mid-October under some conditions. In N.Y. State soils, 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 5.8.1. Preplant nematicidal and broad-spectrum soil fumigants.

Soil Fumigant	Trade Name	Rate/ Treated A (gal)
Nematicidal Soil Fumigants		
*1-3-dichloropropene	*Telone II	10-15
Broad-Spectrum Soil Fumigants		
*chloropicrin plus *1,3-dichloropropene	*Telone C-17	32-42
*chloropicrin plus *1,3-dichloropropene	*Telone C-35	39-50
sodium methylthiocarbamate	Vapam HL	37.5-75
* Restricted-use pesticide; may be purchased and used only by certified applicators		

Table 5.8.2. Post-plant nematicides.

Product	Trade Name	Application Method	Rate/ Treated A
*oxamyl	*Vydate L	Foliar or ground (non-bearing only)	2-4 pt/A (foliar) or 1 gal/ treated acre (ground)
*fenamiphos	*Nemacur 3S	Soil	5-6.5 gal/treated A
* Restricted-use pesticide; may be purchased and used only by certified applicators			