# 2017
# Cornell Pest Management Guidelines for Commercial Tree Fruit Production

Cornell University
Cooperative Extension

Additional information available at the Cornell fruit homepage: www.fruit.cornell.edu

*These guidelines are not a substitute for pesticide labeling. Always read and understand the product label before using any pesticide.*

# 1 Integrated Crop and Pest Management

## 1.1 Background

Cornell University and Cornell Cooperative Extension actively promote the use of Integrated Crop and Pest Management (IPM) by New York growers in order to address agricultural concerns. In many areas of New York State, there are horticultural, economic, social, and political pressures to reduce the environmental impact and use of pesticides in crop production. Public concerns with nutrient and sediment movement into ground and surface water and pressure against pesticide applications is growing. In other regions, agricultural producers are being asked to submit nutrient and soil management plans to address the offsite impacts of their practices. In addition, the development of pesticide resistance in key pests; registration of fewer and more expensive new chemicals for pest control; loss of existing products; and increased competition from other regions continue to push New York agriculture to look for nonchemical alternatives.

IPM requires a combination of long and short term production strategies to maximize net profit while minimizing risks of undesirable environmental impacts of practices. Some of these practices include site selection, crop-specific production strategies, nutrient management, and cover cropping. IPM is a pest control strategy that promotes the use of a variety of tactics including pest-resistant cultivars and biological, cultural, and physical controls. Pesticides are a control tactic employed in IPM, but they are used preferably only when needed. Pesticide use is thus minimized without jeopardizing crop quality or yield. Applying multiple control tactics minimizes the chance that pests will adapt to any one tactic and allows growers to choose the most environmentally sound, efficacious, and economically efficient pest management program for their situation.

This manual provides information and references that will allow New York fruit growers to practice IPM for many of their crops. While information for the proper use of pesticides is a main component of this manual, other information is contained that can help growers reduce their reliance on pesticides and take advantage of alternatives to pesticides that may be less expensive, less environmentally harmful, and more acceptable to the non-agricultural community.

## 1.2 Practicing IPM

In an IPM program, it is important to accurately identify the pests (vertebrates, diseases, insects, and weeds) and assess pest abundance. See the listing (at the end of this publication) of laboratories at Cornell that do pest and disease diagnosis and soil and tissue analysis for assistance in maintaining crop health and nutrition. It is important to have knowledge of the biology and ecology of the pest(s) attacking the crop and the factors that can influence pest infestations. An understanding of the influence of factors such as weather and natural enemies on pest abundance will aid the choice of management tactics. IPM programs stress suppression of insect and disease populations to levels that do not cause economic damage, rather than total eradication of a pest. In the case of insect pests, it may be important to have at least some pests present to ensure that natural enemies will remain in the crop to suppress subsequent infestations.

## 1.3 IPM Components

### 1.3.1 Monitoring (Scouting)

Scouting includes detecting, identifying, and determining the level of pest populations on a timely basis. Insect traps can often be used to detect pests and identify times when scouting should be intensified or control measures should be taken. Monitoring individual orchard blocks throughout the season is the most effective way of assessing the insect, disease, and weed situation and, therefore, the need for chemical treatment in that block. Scientifically based, accurate, and efficient monitoring methods are available for many pests on fruit crops in New York. Brief descriptions of the recommended techniques are given in this manual.

### 1.3.2 Forecasting

Weather data and other information helps predict when specific pests will most likely occur. Weather-based pest forecast models for diseases and insects of many crops have been developed in New York. This information will be referred to for the pests that have such models available. Weather forecasts are available through the NYS IPM Program's Network for Environment and Weather Awareness (NEWA) on a daily basis.

Access to a computer network to obtain weather, regional insect, and disease forecasts is useful but not essential. NEWA provides automated local weather information and the results of pest forecasts on a daily basis. Access NEWA online at newa.nysaes.cornell.edu. Simple weather recording equipment such as thermometers, hygrometers, and rain gauges placed in orchards will assist the prediction of pest outbreaks. Information on the potential for pest outbreaks generally can also be obtained from local Cooperative Extension offices, newsletters, and regional crop advisors.

### 1.3.3 Thresholds

Use thresholds to determine when pest populations have reached a level that could cause economic damage. Thresholds have been scientifically determined by Cornell researchers. Following the thresholds indicated in this manual has reduced pesticide use by as much as 50%, saving significant money for growers. The term ***suggested***

# 3 Pesticide Information

## 3.1 Pesticide Classification and Certification

The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) created two classifications of pesticides – general-use and restricted-use. **General-use pesticides** may be purchased and used by anyone. **Restricted-use pesticides can** only be purchased by a certified applicator. Restricted-use pesticides must be also be used by a certified applicator or someone under their supervision.

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

A **commercial applicator** uses or supervises the use of pesticides for any purpose or on any property not covered by the private applicator classification. In New York, a commercial applicator must be certified to purchase or use any pesticide whether it is general- or restricted-use.

More information about pesticide certification and classification is available from your Cornell Cooperative Extension office (cce.cornell.edu/learnAbout/Pages/Local_Offices.aspx), regional NYSDEC pesticide specialist (www.dec.ny.gov/about/558.html), the Pesticide Applicator Training Manuals (store.cornell.edu/c-876-manuals.aspx), or the Pesticide Management Education Program (PMEP) at Cornell University (psep.cce.cornell.edu).

## 3.2 Use Pesticides Safely

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

### 3.2.1 Plan Ahead

Many safety precautions should be taken *before* you actually begin using pesticides. Too many pesticide applicators are dangerously and needlessly exposed to pesticides while they are preparing to apply them. Most pesticide accidents can be prevented with informed and careful practices. **Always read the label on the pesticide container before you begin to use the pesticide.** Make sure you understand and can follow all directions and precautions on the label. Be prepared to handle an emergency exposure or spill. Know the first aid procedures for the pesticides you use.

### 3.2.2 Move Pesticides Safely

Carelessness in transporting pesticides can result in broken containers, spills, and contamination of people and the environment. Once pesticides are in your possession, you are responsible for safely transporting them. Accidents can occur even when transporting materials a short distance. You are responsible for a pesticide accident so take every effort to transport pesticides safely. Be prepared for an emergency.

### 3.2.3 Personal Protective Equipment and Engineering Controls

Personal protective equipment needs depend on the pesticide being handled. **Required personal protective equipment (PPE) are listed on pesticide labels.** These requirements are based on the pesticide's toxicity, route(s) of exposure, and formulation. Label PPE requirements are the minimum that must be worn during the pesticide's use. Pesticide users can always wear more protection than the label requires.

The choice of protective equipment depends on the activity, environment, and handler. The type and duration of the activity, where pesticides are being used, and exposure of the handler influences the equipment you should use. Mixing/loading procedures often require extra precautions. Studies show you are at a greater risk of accidental poisoning when handling pesticide concentrates. Pouring concentrated pesticide from one container to another is the most hazardous activity. More information on personal protective equipment can be found online at umes.edu/NC170/Default.aspx?id= 7184.

Engineering controls are devices that help prevent accidents and reduce a pesticide user's exposure. One example is a closed mixing/loading system that reduces the risk of exposure when dispensing concentrated pesticides. More information on engineering controls can be found online at umes.edu/NC170/Default.aspx?id=7196.

### 3.2.4 Avoid Drift, Runoff, and Spills

Pesticides that move out of the target area can injure people, damage crops, and harm the environment. Choose weather conditions, pesticides, application equipment, pressure, droplet size, formulations, and adjuvants that

# 4 Sprayer Information

## 4.1 Solutions For Safer Spraying

### 4.1.1 Reducing Risk of Pesticide Exposure Through Use Of Engineering Controls

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

### 4.1.2 Areas of Potential Contamination

**1. Loading the Sprayer**

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

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

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

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

**2. Reducing Contamination at the Boom**

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

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

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

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

**3. Protecting from Drift and Contaminated Clothing in Cabs**

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

***Protective Clothing Lockers*** – To prevent contamination of the tractor or sprayer cab interior, entering the cab. A few sprayer companies offer a simple compartment (or

pressure gauge, replace it or refer the problem to the manufacturer or supplier.

**Nozzles**
*check…*

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

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

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

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

**Routine Maintenance**
The following checks should be carried out routinely:

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

## 4.4.5 Sprayer Calibration

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

## 4.4.6 Dilute Spraying

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

## 4.4.7 Concentrate Spraying

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

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

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

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

# 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; (**I**)= Insecticide.
🐝 = Active ingredient meets EPA criteria for acute toxicity to bees.

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

### 5.1.1 By Common Name

🐝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)**

*Bacillus subtilis* – (§Serenade products) Bayer **(B, F)**
*Bacillus amyloliquefaciens* – (§DoubleNickel prodcucts) Certis **(B, F)**
🐝bifenazate – (Acramite) Chemtura **(A)**
🐝bifenthrin – (*Brigade) FMC (**I, A**)
boscalid + pyraclostrobin – (Pristine) BASF (**F**)
*Bacillus thuringiensis* (B.t.) – (Agree) Certis; (Dipel) Valent BioSciences; (Deliver) Certis; (Javelin) Certis **(I)**
buprofezin – (*†Centaur) Nichino **(I)**

captan – (Captan) Micro Flo, Drexel, Makhteshim Agan; (Captec) Micro Flo **(F)**
🐝carbaryl – (Carbaryl) Drexel; (Sevin) TKI (**I**)
chlorantraniliprole – (*†Altacor) DuPont; (*†Voliam Flexi, *†Voliam Xpress) Syngenta **(I)**
🐝chlorpyrifos – (Lorsban) Dow AgroSciences, Gowan **(I)**
chlorothalonil – (Bravo) Syngenta; (Echo) Sipcam Agro; (Equus) Makhteshim Agan **(F)**
clofentezine – (Apollo) Makhteshim Agan **(A)**
copper hydroxide – (Kocide, Champ) DuPont, Nufarm Americas **(B, F)**
copper oxychloride/copper sulfate – (C-O-C-S) Loveland **(B, F)**
copper oxychloride/ copper hydroxide – (Badge SC, §Badge X2) Gowan **(B, F)**
copper octanoate – (Cueva) Certis **(B, F)**
copper sulfate – (Cuprofix Ultra Disperss) United Phosphorus **(B, F)**
🐝cyantraniliprole – (*†Exirel) DuPont **(I)**
cyflumetofen – (Nealta) BASF **(A)**
🐝cyfluthrin – (*Baythroid, *Leverage) Bayer **(I)**
cyprodinil – (Vangard) Syngenta **(F)**

🐝diazinon – (*Diazinon) Makhteshim **(I)**
difenoconazole + cyprodinil– (Inspire Super) Syngenta **(F)**
difenoconazole + fludioxonil– (Academy) Syngenta **(F)**
🐝dimethoate – (*Dimethoate) Loveland (*Dimethoate) Drexel **(I)**
dodine – (Syllit FL) Agriphar **(F)**

🐝emamectin benzoate – (*Proclaim) Syngenta **(I)**
🐝esfenvalerate – (*Asana) DuPont **(I)**
etoxazole – (Zeal) Valent **(A)**

🐝fenazaquin – (Magister) Gowan **(A)**
fenbuconazole – (Indar) Dow AgroSciences **(F)**
fenbutatin-oxide – (*Vendex) United Phosphorus **(A)**
fenhexamid – (Elevate) Arvesta **(F)**
🐝fenpropathrin – (*Danitol) Valent BioSciences **(I)**
fenpyroximate – (Portal) Nichino America **(A,I)**
flonicamid – (Beleaf) FMC **(I)**
flubendiamide – (*†Belt) Bayer **(I)**
flutriafol – (†Topguard) Cheminova **(F)**
fluopyram + pyrimethanil (*†Luna Tranquility) Bayer (**F**)
fluxapyroxad + pyraclostrobin) (*†Merivon) BASF (**F**)
ferbam – (Ferbam Granuflo) Taminco **(F)**
fludioxonil – (Scholar) Syngenta **(F)**
fosetyl-Al – (Aliette) Bayer **(F)**

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

🐝imidacloprid – (*Admire Pro, *Leverage) Bayer **(I)**
🐝indoxacarb – (Avaunt) DuPont **(I)**
insecticidal virus – (Cyd-X, §Madex) Certis; (Carpovirusine) Arysta LifeScience **(I)**
iprodione – (Rovral) Bayer; (Iprodione) MicroFlo **(F)**

kaolin – (Surround) TKI (**A,F,I**)
kasugamycin – (Kasumin 2L) Arysta LifeScience **(B)**
kresoxim-methyl – (Sovran) BASF **(F)**

🐝lambda-cyhalothrin – (*Lambda-Cy) United Phosphorus; (*Warrior; *†Voliam Xpress; *†Endigo) Syngenta **(I)**

🐝malathion – (Clean Crop Malathion) Loveland; (Malathion) Drexel; (*Prentox Malathion) Prentiss **(I)**
mancozeb – (Dithane) Dow AgroSciences; (Manzate) DuPont; (Penncozeb) United Phosphorus **(F)**
maneb – (Manex) Griffin **(F)**
mefanoxam – (Ridomil Gold) Syngenta **(F)**
metconazole – (Quash) Valent (**F**)
methidathion – (*Supracide) Gowan **(I)**
🐝methomyl – (*Lannate) DuPont **(I)**
methoxyfenozide – (*†Intrepid) Dow AgroSciences **(I)**
metiram – (Polyram) BASF **(F)**
metrafenone – (Vivando) BASF **(F)**
myclobutanil – (Rally) Dow AgroSciences **(F)**

novaluron – (*Rimon) Chemtura **(I)**

X-disease. It is also registered for control of fire blight on apples and pear, but is not as effective as streptomycin.

## 5.4 Other Materials

Acibenzolar-S-methyl (Actigard) is a systemic acquired resistance inducer. The material acts by inducing natural plant defenses to protect against infection bacteria and fungi. Trees with young tissued will respond better to the product than older trees. It's an attractive option for apple growers during establishment years when one doesn't wish to use prohexadione calcium to manage fire blight (shoot blight) as it restricts host growth. Actigard may be used in a drench in 8-16 fl oz water per tree. Drench applications may be fairly effective in 1-2 year old trees timed at green tip, but labor availability may make the practice less feasible in large operations. Actigard, may also be used in a foliar application, beginning at 20% bloom to ensure that host response is high when shoot blight infections occur later in the season. A minimum of 5 days is needed for the best induced resistance response.

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 lipipeptides 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, 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.

Prohexadione calcium Apogee & Kudos are plant growth regulators that reduces shoot growth. It acts by inhibiting the biosynthesis of gibberellin, the plant hormone that regulates cell elongation. Prohexadione calcium 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. Prohexadione calcium 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. Prohexadione calcium may be helpful in rescuing orchards of 5 or more years developing considerable shoot blight. Removal of shoot strike may stimulate new shoot growth and further systemic infections. A late application of prohexadione calcium may slow this growth and reduce systemic infection. Do not tank mix prohexadione calcium with calcium sprays because calcium will reduce the effectiveness of prohexadione calcium. One pound of ammonium sulfate may be added for each pound of prohexadione calcium if the water source for spray applications contains high levels of calcium carbonate (hard water). Use a standard adjuvant/non-ionic surfactant.

Serenade Optimium (*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 favorable climatic conditions that exist in New York. When used alone, Serenade Optimum provides only some control of fire blight. In alternation with streptomycin, it sometimes provides control

# 6 Disease Management

## 6.1 Apple Scab Fungicides

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

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

**Post-infection activity.** Post-infection activity refers to the ability of a fungicide to kill or stop the growth of the fungus and thereby prevent the establishment of scab lesions, if applied within a given period after the start of a wetting period. It is expressed as the period of time from the beginning of a wetting period within which the fungicide must be applied to stop infection. The data given in Table 6.1.3 are accurate at average temperatures of 50-60°F. At lower temperatures, the periods of after-infection activity for contact fungicides are longer than those listed.

**Presymptom activity.** Presymptom activity can be thought of as an extension of after-infection activity. When applied following an infection period, but beyond the time limits of its after-infection activity listed in Table 6.1.3, a fungicide with significant presymptom activity will allow small chlorotic lesions to develop; however, it will inhibit or greatly reduce the production of secondary spores from those lesions. Thus, if applied too late to completely stop infection, it will still greatly reduce the amount of inoculum available for secondary spread.

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

**Table 6.1.1. Activity spectrum of apple fungicides.**

| | | | Ratings for the Control of | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Active Ingredient (Trade Name)** | **Fungicide Family** | **FRAC code‡** | *Scab* | *Powdery Mildew* | *Cedar Apple Rust* | *Black/ White Rot* | *Sooty Blotch/ Fly speck* | *Bitter Rot* | *Mite Suppression(a)* |
| captan[g] | Phthalimide | M4 | 4 | 0 | | 2 | 3 | 2[e] | 3[e] |
| cyprodinil (Vangard) | Anilinopyrimidine | 9 | 2(f)[i] | 1 | | 0 | 0 | 0 | 0 |
| dodine (Syllit) | Guanidine | M7 | 4[i] | 0 | 1 | 1 | 1 | 0 | 0 |
| difenoconazole + cyprodinil (Inspire Super MP)[f] | DMI (SI) and Anilinopyrimidine | 3 | 4[c] | 3 | 4 | 2 | 4 | 2 | |
| fenarimol (Rubigan)[f] | DMI (SI) | 3 | 4[c] | 4 | 4 | 0 | 0 | 0 | |
| ferbam (Ferbam) | Dithiocarbamate | M3 | 2 | 0 | 2 | 1 | 2 | 1 | 0 |
| fenbuconazole (Indar 2F)[f] | DMI (SI) | 3 | 4[c] | 3 | 4 | 2 | 2 | 2 | |
| flutriafol (†Topguard) | DMI (SI) | 3 | 4[c] | 4 | 4 | 2 | 2 | 2 | — |
| kresoxim-methyl (Sovran) | Strobilurin (QoI) | 11 | 4[c] | 4 | 2 | 3 | 4 | 2 | 0 |
| mancozeb (Dithane, Manzate, Penncozeb) | Dithiocarbamate | M3 | 3[d] | 0 | 4 | 3 | 4 | 4 | 0 |
| maneb (Manex, Maneb) | Dithiocarbamate | M3 | 3[d] | 0 | 4 | 3 | 4 | 4 | 0 |
| metiram (Polyram) | Dithiocarbamate | M3 | 3[d] | 0 | 4 | 3 | 4 | 1 | 0 |
| myclobutanil (Rally)[f] | DMI (SI) | 3 | 4[c] | 4 | 4 | 2 | 2 | 2 | — |
| metrafenone (Vivando)[f] | aryl-phenyl-ketone | U8 | 0 | 4 | 0 | 0 | 0 | 0 | |

# 7 Insect and Mite Management

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

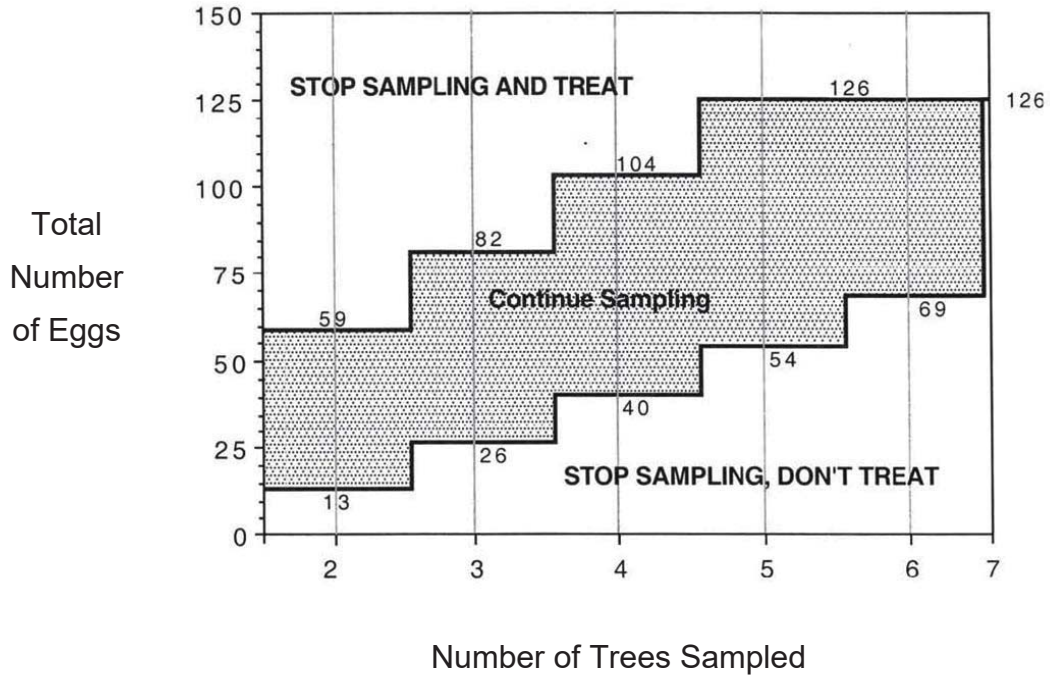
| | | *Ratings for the Control of* | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Trade Name (Active Ingredient)** | **IRAC‡** | **AM** | **Aph** | **EAS** | **Int** | **GFW** | **LH** | **OBLR** | **PC** | **PPs** | **RAA** | **RBLR** | **SJS** | **STLM** | **TPB** | **WAA** |
| *†Actara (thiamethoxam) | 4A | 1 | 3 | 3 | 1 | — | 3 | 0 | 3 | 3 | 3 | 0 | 0 | 2 | 2 | — |
| *Admire Pro (imidacloprid) | 4A | — | 3 | — | — | — | 3 | — | — | 2 | 3 | — | 2 | 3 | — | 2 |
| *†Agri-Flex (abamectin/ thiamethoxam | 6/4A | 1 | 3 | 3 | 1 | — | 3 | 0 | 3 | 3 | 3 | 0 | 0 | 3 | 1 | — |
| *Agri-Mek (abamectin) | 6 | — | — | — | — | — | 3 | — | — | 3 | — | — | — | 3 | — | — |
| *†Altacor (chlorantraniliprole) | 28 | 2 | 1 | 3 | 3 | 3 | — | 3 | 2 | — | — | 3 | 2 | — | 1 | — |
| *Ambush, *Pounce (permethrin) | 3A | 3 | 2 | 2 | — | 3 | 3 | 2-3 | 2 | 2 | 2 | 3 | 1 | 3 | 3 | — |
| *Asana XL (esfenvalerate) | 3A | 3 | 2 | 2 | 2-3 | 3 | 3 | 2-3 | 2 | 2 | 2 | 3 | 1 | 3 | 3 | — |
| Assail (acetamiprid) | 4A | 3 | 3 | 2 | 3 | — | 3 | 0 | 2 | 2 | 3 | 0 | 2 | 3 | 2 | 2 |
| Avaunt (indoxacarb) | 22 | 2 | 1 | 2 | 2 | — | 3 | 0 | 3 | — | 0 | — | 0 | 2 | 2 | — |
| §Aza-Direct, §Neemix, §Azatin (azadirachtin) | 18B | — | 2 | 1 | 2 | — | 2 | — | 0 | — | 2 | — | — | 3 | — | — |
| §B.t, (§Biobit, §Dipel, §Javelin, §MVP) | 11A | 0 | 0 | — | 2 | 3 | 0 | 3 | 0 | 0 | 0 | 3 | — | 0 | 0 | — |
| *Baythroid (cyfluthrin) | 3A | 3 | 2 | 2 | 2-3 | 3 | 3 | 2-3 | 2 | — | — | 3 | — | 3 | 3 | — |
| Beleaf (flonicamid) | 9C | — | 3 | — | — | — | — | — | — | — | — | — | — | — | 3 | 2 |
| *†Belt (flubendiamide) | 28 | — | — | — | 3 | 3 | — | 3 | — | — | — | 3 | — | 3 | — | — |
| *†Centaur (buprofezin) | 16 | — | — | — | — | — | 2 | — | — | 3 | — | — | 3 | — | — | — |
| *Danitol (fenpropathrin) | 3A | 3 | 2 | 2 | 2-3 | 3 | 3 | 2-3 | 2 | 2 | 2 | 3 | 1 | 3 | 3 | — |
| Delegate (spinetoram) | 5 | 2 | 0 | — | 3 | 3 | — | 3 | 2 | 3 | — | 3 | — | 3 | — | — |
| *diazinon | 1B | 3 | 1 | — | 2 | 2 | 1 | 0 | 2 | 0 | 3 | 0 | 2 | 1 | 1 | 3 |
| *dimethoate | 1B | 3 | 2 | — | 3 | 2 | 3 | 0 | 2 | 0 | 2 | 0 | 2 | 1 | 2 | — |
| *†Endigo (thiamethoxam/ lambda-cyhalothrin) | 3A/4A | 3 | 2 | 2 | 2-3 | 3 | 3 | 2-3 | 2 | 2 | 2 | 3 | 2 | 3 | 3 | — |
| §Entrust (spinosad) | 5 | 2 | 0 | — | 2 | 3 | 0 | 3 | 0 | – | 0 | 3 | — | 2 | 0 | — |
| Esteem (pyriproxyfen) | 7C | 0 | 0 | — | 2 | 0 | 0 | 0 | 0 | 3 | 3 | 0 | 3 | 2 | 0 | — |
| *†Exirel (cyantraniliprole) | 28 | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 0 | 3 | 0 | 0 |
| *Imidan (phosmet) | 1B | 3 | 1 | 3 | 3 | 1 | 1 | 1 | 3 | 0 | 1 | 3 | 2 | 1 | 1 | — |
| *†Intrepid (methoxyfen-ozide) | 18A | 0 | 0 | — | 2 | — | 0 | 3 | 0 | — | 0 | 3 | 0 | 2 | 0 | — |
| *Lannate (methomyl) | 1A | 2 | 2 | 1 | 3 | 3 | 3 | 2-3 | 2 | 0 | 1 | 3 | 2 | 3 | 1 | — |
| *Leverage (cyfluthrin/ imidacloprid) | 3A/4A | 3 | 3 | 2 | 3 | 3 | 3 | 2-3 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | — |
| Lorsban (chlorpyrifos) | 1B | — | — | — | — | — | — | — | — | — | 2 | 2 | 3 | 1 | 1 | — |
| §M-Pede, Des-X (insecticidal soap) | — | 0 | 2-3 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 1 | 0 | 1 | 0 | 0 | — |
| Malathion | 1B | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 0 | 1 | 2 | — | 1 | 1 | — |
| Movento (spirotetramat) | 23 | — | 3 | — | — | — | — | — | — | 3 | — | — | 3 | — | — | 3 |
| †Nexter (pyridaben) | 21 | — | 0 | — | — | — | 2 | — | — | 3 | — | — | — | — | — | — |
| §oil (Stylet, Damoil, PureSpray) | — | — | — | — | — | 1 | — | — | — | 2 | — | — | 3 | 1 | — | 1 |
| *Proclaim (emamectin benzoate) | 6 | 0 | 0 | — | 2 | 3 | 0 | 3 | 1 | 2 | 0 | 3 | 0 | 3 | 0 | — |

**Figure 7.1.1. STLM Pink Sampling Form**

- During the pink bud or early bloom stage, start near one corner of the block, and go to every other tree until you have sampled enough trees to reach a decision, Select 3 fruit clusters from around the canopy of each tree sampled.

- Using a magnifier, count the eggs on the undersides of the 2nd, 3rd, and 4th leaves in each cluster, counting leaves in the order they unfolded (see diagram at right).


- After 2 trees have been sampled, begin comparing the accumulated total number of eggs found with the decision lines shown in the chart below for that number of trees.




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

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

# 8 Weed Management

## 8.1 Calibration to Ensure Correct Herbicide Rate

Herbicide labels indicate rate of application as amount of product per acre; that is, per acre actually treated. Only if you broadcast herbicide over the entire orchard floor will the treated acreage equal the orchard acreage. Follow the instructions below to assure application of the correct herbicide rate.

### 8.1.1 Calculating Nozzle Flow Rate

**Travel Speed:**
For most situations, 2-2.5 mph is best (176-220 ft. /min.).

**Pressure:**
Use low pressure (20-35 psi) to minimize formation of small droplets, because small droplets can drift off target.

**Spray Volume per Treated Acre:**
Generally, low rates (20-30 gals./acre or less) are more suitable for postemergence herbicides, where runoff from weeds would reduce effectiveness. Higher rates, 40-50 gals./acre, may provide better coverage and control when using preemergence herbicides.

**Nozzles:**
Avoid nozzles that produce fine mist. Generally, hollow cone nozzles produce the finest droplets, flat sprays are second, and full cone nozzles produce the coarsest spray.

A single boomless off-center flat spray nozzle, or a flooding nozzle, may be suitable for some orchards, but one or more regular flat spray nozzles on a boom may be better where branches are close to the ground.

Use the following formula to determine nozzle flow rate in gal./min., then consult a nozzle manufacturer's chart to select the proper nozzle.

**Shields**:
By adding a shield over the spray boom, thin, young bark of fruit trees may be protected when using glyphosate or other herbicides that can injure fruit tree bark. If weeds are tall when treated and spring back into the tree banches after application under a shield, glyphosate can still be picked up through the leaves of the trees.

### 8.1.2 Definition of Terms

1. **Gallons per Treated Acre (G/TA)** = Amount of herbicide spray you want to apply per treated acre.
2. **Swath (S)** = Width of the sprayed area in feet.
3. **Travel Speed (TS)** = Feet traveled per minute.
4. **Nozzle flow rate** (gallons per minute) = (Gallons per Acre x Swath x Travel Speed) divided by 43,560

**Nozzle Flow Rate = (G/TA x S x TS) / 43,560**

*Example:*
What nozzle flow rate do you need to apply 25 gallons of herbicide spray mix per treated acre, using a 3-foot-wide swath and a travel speed of 220 feet per minute (=2.5 miles per hour)?

**Nozzle flow rate**
= (25 x 3 x 220) divided by 43,560
= (16,500) divided by 43,560
= 0.38 gallons per minute.

If using 2 nozzles, select 2 that will give 0.19 gallon per minute each at the selected pressure.

### 8.1.3 Checking Herbicide Sprayer Output

**Spray Pattern**:
Check uniformity of spray pattern, using corrugated fiberglass roofing panels as a spraying surface. Spray from the same height as will be used in the orchard. Compare liquid volume collected in each trough.

**Actual Spray Volume:**
With proper nozzles installed, travel a measured distance at the selected speed and pump pressure. Use this formula to determine the actual spray volume in gallons per treated acre.

**Gallons per Treated Acre:**
= (Gallons sprayed during trial run x 43,560) divided by (Feet traveled during trial run x Swath width in feet).

*Example:*
You emptied a tank containing exactly 3 gallons in a distance of 1,200 feet. The treated swath was 3 feet wide. How many gallons of spray are you applying per treated acre?

**Gallons per Treated Acre**
= (3 x 43,560) divided by (1,200 x 3)
= (130,680) / (3,600)
= 36.3 gallons

If you want to apply 4 lbs. of herbicide per acre, then in this case you would add 4 lbs. of herbicide to each 36 gallons of water in the tank.

**Agitation:**
If herbicides are allowed to settle or separate in the sprayer tank, distribution in the orchard will not be uniform. Provide constant agitation when using wettable powders, or any other insoluble formulation (emulsions, emulsifiable concentrates, dry flowables, liquid flowables, and suspensions). Use defoaming adjuvant when needed to control excessive foam.

**Table 8.4.3. Weed control guidelines for tree fruit.**

*Refer to back of book for key to abbreviations and footnotes.*

| Crop | | | | | | Tree Age | | | | PRODUCT NAME (*active ingredient, weight of active per unit of herbicide*)<br>*Notes:* |
|---|---|---|---|---|---|---|---|---|---|---|
| Apples | Pears | Cherries | Peaches | Apricots | Plum/Prune | Planting Year | 1 year plus | 2 years plus | 3 years plus | |
| X | X | X | | | | | X | X | | **CASORON 4G** (*dichlobenil, 0.04 lb/lb*)<br>*Weeds Controlled:* annual grasses and broadleaves, and perennials at high rates<br>*Rate (per acre):* 100-150 lb<br>*AI per acre (lbs/acre):* 4.0-6.0<br>*Days to harvest:* none listed<br>*REI (hours):* 12<br>*Comments:* November 15 to March 15 when soil temp is below 45˚. Allowed 4 weeks after transplanting |
| X | X | X | X | X | X | X | X | X | | **CHATEAU 51 SW** (*flumioxazin, .51 lb/lb*<br>*Weeds Controlled:* annual grasses and broadleaf weeds<br>*Rate (per acre):* 6-12 oz.<br>*AI per acre (lbs/acre):* 0.188-0.38<br>*Days to harvest:* Apples: by pinkbud; apricots, cherries, peaches, pears, and plums: by budbreak; or fall treatments after harvest<br>*REI (hours):* 12<br>*Comments:* 12 fl. oz is maximum rate for an application; with 24 fl. oz maximum for the season. If soil is covered with weeds at the time of application apply with paraquat. Can only be applied prior to the 'pink bud' stage in apple and "bud break" in stone fruit and pear or in the fall after harvest. **Do not apply to trees established less than 1 year unless protected from spray contact by non-porous tubes or wax containers. See label for further use restrictions and limitations.** |
| X | X | X | X | X | X | See notes | | | | **†FUSILADE DX** (*fluazifop-p-butyl, 2 lb/gal*)<br>*Weeds Controlled:* Annual and perennial grasses<br>*Rate (per acre):* 1-1.5pts<br>*AI per acre (lbs/acre):* 0.25-0.375<br>*Days to harvest:* Stone fruit, 14; apples and pears nonbearing<br>*REI (hours):* 12<br>*Comments:* Use on pears and apples limited to nonbearing trees. Grasses 2-8 in tall. Repeat before regrowth is 10 in tall. Use surfactant or crop oil according to label directions. |
| X | X | X | X | X | X | X | X | X | | **GALIGAN 2E** (*oxyfluorfen, 2 lb/gal*)<br>*Weeds Controlled:* annual grasses and broadleaf weeds<br>*Rates (per acre):* Pre-emergence: 5-6 pts; postemergence: 2-6 pts<br>*AI per acre (lbs/acre):* Pre-emergence: 1.25-1.5; postemergence: 0.5-1.5<br>*Days to harvest:* Do not apply between budswell and final harvest.<br>*REI (hours):* 24<br>*Comments:* Apply as soon as soil has settled and no cracks are present. Oxyfluorfen applications limited to dormant trees (before buds on trees begin to grow). |
| X | X | X | X | X | X | X | X | X | | **GOAL 2XL** (*oxyfluorfen, 2 lb/gal*)<br>*Weeds Controlled:* annual grasses and broadleaf weeds<br>*Rates (per acre):* 3.2-4 qt<br>*AI per acre (lbs/acre):* 1.6-2.0<br>*Days to harvest:* Do not apply between budswell and final harvest<br>*REI (hours):* 24<br>*Comments:* Apply as soon as soil has settled and no cracks are present. Oxyfluorfen applications limited to dormant trees (before buds on trees begin to grow). |


FIGURE 11.1.1
GROWTH STAGES IN
APPLE
1 Dormant
2 Silver tip
3 Green tip
4 Half-inch green
5 Tight Cluster
6 Pink
7 Bloom
8 Petal Fall
9 Fruit set

# 11 Apples

## 11.1 Insecticides and Fungicides for Apples

See Sections 11.2, 11.3, 11.4, and 11.5 for comments related to this table.

**Table 11.1.1 Pesticide Spray Table – Apples.**

*(Refer to back of book for key to abbreviations and footnotes.)*

| Pest | IRAC & FRAC | Product | Rates | PHI (days) | REI (hrs) | Efficacy | Comments (see text) |
|---|---|---|---|---|---|---|---|
| ***Silver Tip*** | | | | | | | |
| **Apple scab** | 9 + 7 | *†Luna Tranquility | 11.2-16 fl.oz./acre | 72 | 12 | High | |
| | M1 | Badge SC | 3.5-7.0 pts/acre | 0 | 48 | | [8.04] |
| | M1 | Badge X2 | 3.5-7.0 lb/acre | 0 | 48 | | [8.04] |
| **Black Rot & White Rot** | | Thiophanate Methyl 85WDG | | 1 | 48 | | |
| **Blister Spot** | 33 | Phostrol | 2.5-5.0 pts/acre | 0 | 4 | High | [5.1] |
| **Crown rot** | 04 | Ridomil Gold SL | 2 qt/acre<br>0.5 pt/100 gal water | | 48 | | [7.2] |
| | 33 | Aliette WDG | 2.5-5 lb/acre<br>0.5-1 pt/100 gal water | 14 | 12 | | |
| | 33 | Phostrol | 2.5-5.0 pts/acre | 0 | 4 | High | |
| | 33 | Prophyt | 2-4 pt/100 gal water | 0 | 4 | High | [7.3] |
| **European Fruit Lecanium** | | oil | 2-3 gal/100 gal water | | | High | [20.2] |
| **European Red Mite** | | oil | 2-3 gal/100 gal water | | | High | [20.2] |
| **Fire blight** | | Agri-mycin | | 50 | 12 | | [8.05] |
| | M1 | Badge SC | 3.5-7.0 pts/acre | 0 | 48 | | [8.04] |
| | M1 | Badge X2 | 3.5-7.0 lb/acre | 0 | 48 | | [8.04] |
| **Phytophthora Rots** | 33 | Phostrol | 2.5-5.0 pts/acre | 0 | 4 | High | [7.3] |
| | 33 | Prophyt | 2-4 pt/100 gal water | 0 | 4 | High | [7.3] |
| ***Green Tip*** | | | | | | | |
| **Apple scab** | M1 | Badge SC | 3.5-7.0 pts/acre | 0 | 48 | | [8.04] |
| | M1 | Badge X2 | 3.5-7.0 lb/acre | 0 | 48 | | [8.04] |
| | M3 | Manzate ProStik | 3.0-6.0 lb/acre<br>1.0-2.0 lb/100 gal water | BL, 77(A) | 24 | | [1.03,2.02] |
| | M3 | Penncozeb 75DF | 3.0-6.0 lb/acre<br>1.0-2.0 lb/100 gal water | BL, 77(A) | 24 | | [1.03,2.02,2.08] |
| | M3 | Polyram 80DF | 3.0-4.5 lb/acre | BL, 77(A) | 24 | | [1.03,2.02] |
| | M4 | Captan 50WP | 8.0 lb/acre<br>1.0-2.0 lb/100 gal water | 0 | 24 | | [2.01,2.02] |
| | M4 | Captan 80WDG | 5.0 lb/acre<br>0.65-1.25 lb/100 gal water | 0 | 24 | | [2.01,2.02] |
| | M4 | Captec 4L | 0.5-1.0 qt/100 gal water | Up to day | 24 | | [2.01,2.02] |
| | U12 | Syllit FL | 2.0 pts/acre | | | | [2.15] |
| | 9 | Scala | 7.0-10.0 fl.oz./acre | 72 | 12 | | |
| | 9 | Vangard WG | 3.0-5.0 oz/acre | 0 | 12 | | |
| | 9 + 7 | *†Luna Tranquility | 11.2-16 fl.oz./acre | 72 | 12 | High | |
| | 11 + 7 | *†Merivon | 4-5.5 fl.oz./acre | 0 | 12 | High | |

## 11.2 Apple Disease Notes

### 11.2.1 Apple Scab

**• Biology & Cultural**

Refer to the reference materials list at the end of this publication for a Fact Sheet containing details on the biology and management of this pest.

**• Pesticide Application Notes**

**[1.3]** The EBDC fungicides (mancozeb, maneb, Polyram) are labeled for use on apples in one of two different ways: (i) at a rate of 1.5-2 lb/100 gal (maximum 6 lb/A, no more than 24 lb/A per year), not to be applied after bloom; OR (ii) at a reduced rate of 3 lb/A (maximum 21 lb/A per year), which may be applied to within 77 days of harvest. The latter rate is adequate for control of rust diseases, and the extended timing is necessary to control rust infections on terminal leaves. It is illegal to combine or integrate the two treatment regimes.

**[2.1]** See discussion of inoculum reduction in the disease management section. Scab fungicide sprays beginning at green tip are absolutely essential in orchards with high carry-over inoculum or orchards where scab control with SI fungicides was less than satisfactory in previous years. If early season infections are allowed to become established, even the best fungicide programs will not prevent development of fruit scab in orchards where the scab fungus has developed resistance to all three of the fungicide groups (dodine, benzimidazoles, SI's) that previously provided presymptom and postinfection activity against apple scab.

**[2.2]** Fungicide rates per acre should never be reduced below either (i) 50% of the per-acre rate listed on the label or (ii) 1.5 multiplied by the Amt/100 gal listed on the label. This applies even when spraying small trees. Although tree-row volume calculations may suggest that lower rates are appropriate, applying less than 50% of the per-acre rate has frequently resulted in unsatisfactory scab control and/or more rapid development of fungicide resistance. In orchards with SI-resistant scab, a combination of a mancozeb fungicide at 3 lb/A plus a captan formulation that supplies 1.5 lb of active ingredient/A has provided excellent scab control when used in prebloom and bloom sprays. (A captan rate of 1.5 lb active ingredient/A translates to 3 lb/A of Captan 50W, 30 oz/A of 80W, or 1.5 qt/A for the 4L formulations.) This combination provides a better residual activity through heavy rains than would be available from either product used alone and it preserves the option of using mancozeb sprays after petal fall. The mancozeb-captan combination cannot be used close to prebloom oil sprays because of captan-oil incompatibilities. For reasons of economy and resistance management, it is recommended that SI and strobilurin fungicides not be used until pink, even when fungicidal protection is needed earlier; in such cases, make a single application of an alternative fungicide (captan, copper, EBDC) at green tip and half-inch green, then begin the SI/strobilurin program at pink. Do not apply captan or sulfur within 10 days of an oil spray. Do not apply liquid captan formulations with sulfur on sulfur-sensitive varieties. A further discussion of apple scab fungicide characteristics is presented in the section "Apple Scab Fungicides" and in Table 6.1.3.

**[2.4]** Sovran and Flint are excellent protectants, but they have only 48-72 hours of post-infection activity compared with 72-96 hr for the SI fungicides. Sovran and Flint also lack the presymptom activity that makes the SI fungicides so effective (in the absence of SI resistance) for arresting scab epidemics after primary scab lesions become visible in trees. Sovran and Flint have proven very effective against apple scab when applied at 7-9-day intervals to control primary scab, but they have not performed as well when used to control secondary scab in trees where scab lesions are already visible. Sovran and Flint control rust diseases fairly well when used as protectants, but they have little or no post-infection activity against rust diseases. CAUTION: Sovran has caused moderate to severe phytotoxicity (leaf burning) on several sweet cherry varieties when sprayed directly onto them at high labeled rates. The most sensitive varieties were: Somerset, Sweetheart, Valera, Van, and Vandalay; these varieties might also be injured by spray drift containing Sovran. Minor to moderate injury occurred on Cavalier, Coral Champagne, Emperor Francis, Royalton, Schmidt, Summit, and Viva; there is less danger of injury due to spray drift on these varieties. Many other sweet and sour cherry varieties (including Bing, Brooks, Cashmere, Gold, Hardy Giant, Hartland, Hedelfingen, Hudson, Kristin, Lapins, Lambert, Montmorency, Napoleon, Nelson Black Sweet, Rainier, Royal Ann, Sam, Stark Crimson, Stella, Sue, Tehranivee, Tulare, Ulster, Vega, Vic, Viscount, and Windsor) showed no injury when sprayed directly with high labeled rates. The Sovran manufacturer recommends: (i) Do not apply Sovran near or allow drift onto cherries in the highly sensitive group (Somerset, etc.); and (ii) thoroughly rinse spray equipment (tanks, hoses, nozzles) after spraying Sovran and before using this equipment on sensitive cherry varieties.

**[2.6]** Primary inoculum pressure is generally at a peak from pink through bloom—this is a critical time to maintain full coverage with proper fungicide rates.

**[2.7]** Serious losses from apple scab are usually the result of secondary spread to developing fruits. Therefore, it is important to carefully check blocks for the presence of primary scab lesions from petal fall through the early cover spray period. This is particularly important because fruit are most susceptible to infection during the first few weeks of their development. If scab is detected, the management strategy should be to (i) thoroughly protect the sensitive young fruitlets from fungal spores that are present, AND (ii) limit the number of new spores that can be produced. To protect fruitlets, use (a) the full rate of captan (e.g., 2 lb/100 gal of the 50WP formulation), or (b) the reduced rate of an EBDC fungicide (if allowable) supplemented with a half rate of captan, or (c) a strobilurin fungicide combined with a contact fungicide. To limit new spore production, use (a) an DMIfungicide through 2nd cover (to prevent new leaf lesions), or (b) a registered QoIfungicide (to prevent new leaf lesions and suppress spore production from existing lesions),. SI's should be used only in orchards where there

Apogee-treated apple trees usually set more fruit than untreated trees and often Apogee negates the efficacy of chemical thinners, thus it is important that no Apogee be applied either 10 days before or 10 days after the application of chemical thinners. It may also be necessary to use a more agressive thinning strategy. This may mean using an increased dosage of a chemical thinner (30-50% more) or multiple applications of chemical thinners to achieve desired crop load and fruit size. High rates of Apogee (>18 oz/acre/year) can reduce return bloom in some years. Apogee may cause fruit finish and cracking problems on Empire apples.

**ReTain** is a commercial formulation of aminoethoxyvinylglycine (AVG). It is used to reduce preharvest drop and to delay harvest. It acts by inhibiting the synthesis of ethylene in the plant. Since ethylene production by the fruit increases dramatically as fruits ripen, ReTain must be applied several weeks before fruits are mature to hold ethylene production in check. This is usually 3-4 weeks before normal harvest. ReTain will generally delay harvest and fruit drop by 7-10 days, thus giving growers flexibility with harvest date. ReTain also delays other aspects of fruit ripening such as color development, starch degradation and firmness loss, but if harvest is delayed 7-10 days, ReTain-treated fruits achieve normal color and maturity. The combination of ReTain and NAA (Fruitone) has given better drop control that either chemical alone. A split application of ReTain plus NAA at 4 weeks before harvest followed by a second application of ReTain plus NAA at 2 weeks before harvest has given the longest drop control.

**Table 11.7.1. Growth regulator uses in apples.**

| Timing | Product | Concentration | Rate of Formulated Product |
|---|---|---|---|
| ***Improve Shape (Typiness) of Delicious and Gal Apple Fruits*** | | | |
| **Early King Bloom to 50% Bloom** | Promalin, Perlan, Typy | 25-50 ppm | 1-2 pt/100 gal |
| Apply as a fine mist using 50-100 gallons/acre. Do not apply more than 2 pt/acre. Fruit thinning may occur at high rates. Use of a surfactant increases both typiness and thinning responses. | | | |
| ***Induction of Lateral Branching in Young Trees*** | | | |
| **1/2" of Terminal Shoot Growth** | Promalin Perlan, Typy | 250-500 ppm | 0.5-1 pt/5 gal |
| Include a non-ionic surfactant and apply as a directed spray to areas where additional branching is desired. This practice is more effective in the second and third growing seasons after planting. Response on weak or low-vigor trees is usually disappointing. | | | |
| ***Vegetative Growth Control/Fire Blight Suppression*** | | | |
| **1-3 inches of new growth** | Apogee | 125-250 ppm | 4.5-9 oz (lb)*/100 gal |
| **(Late bloom-early petal fall)** | | | |
| The first application should be made as soon as shoot growth begins with a second spray 3-4 weeks after the first. In some cases a third application may be required. Do not apply Apogee within 10 days of chemical thinners. Do not apply more than 48 ounces of Apogee per acre within any 21-day interval, and a max of 99 oz of Apogee per acre per season. Always use a surfactant and a water conditioner such as ammonium sulfate, Choice or Quest (these products control "hard water" deactivation of Apogee). Do not tank-mix with sprays containing calcium. Use of Apogee may necessitate use of increased chemical thinning to achieve desired crop load. Apogee must be applied well in advance of the appearance of fire blight symptoms to be effective for fire blight suppression. To control vigor in only the top of the tree, direct spray to the top of the tree. | | | |
| ***Induction of Lateral Branching in Nursery Trees*** | | | |
| **When terminal Shoot is 28-48" long** | Promalin | 125-500ppm | 0.25-1 pt/5 gal |
| | Maxcel | 250-500ppm | 128 oz/40 gal |
| Include a non-ionic surfactant and apply as a directed spray to areas where additional branching is desired when terminal shoot is at the height where branches are desired. Apply a second, third and fourth spray at 2 week intervals to stimulate additional branching as the shoot grows. | | | |
| ***Suppression of "Physiological" Fruit Russeting*** | | | |
| **Petal Fall** | TypRus 2% Liquid | 15-20 ppm | 10-13 fl oz/acre |
| | Pro-Vide 10 SG | 15-25ppm | 60-100 g/acre |
| Apply 2-4 applications beginning at petal fall and continuing at 7-10 day intervals. Spray at 100 gallons per acre. Max of 40 oz of ProVide per season. Do not use a surfactant when applying Pro-Vide. | | | |

# 17 Appendices

## 17.1 Pesticide Data

**Table 17.1.1 Common names, product names, formulations, and days-to-harvest for insecticides, acaricides, fungicides, and bactericides used on tree fruits.**

| Common Names/ Products Formulations | DAYS TO HARVEST (A) | | | | | |
|---|---|---|---|---|---|---|
| | *Apples* | *Apricots* | *Cherries* | *Peaches* | *Pears* | *Plums* |
| ***Insecticides and Acaricides*** | | | | | | |
| abamectin/avermectin | | | | | | |
| *Agri-Mek 8SC | 28 | 21 | 21 | 21 | 28 | 21 |
| *Abba 0.15EC | 28 | 21 | 21 | 21 | 28 | 21 |
| *†Agri-Flex SC | 35 | — | — | — | 35 | — |
| *Gladiator EC | 28 | 21 | 21 | 21 | 28 | 21 |
| acequinocyl | | | | | | |
| Kanemite 15SC | 14 | — | — | — | 14 | — |
| acetamiprid | | | | | | |
| Assail 30SG | 7 | 7 | 7 | 7 | 7 | 7 |
| azadirachtin | | | | | | |
| §Neemix 4.5L, §Aza-Direct 1.2L, §Azatin XL 0.27EC | 0 | 0 | 0 | 0 | 0 | 0 |
| bifenazate | | | | | | |
| Acramite 50WS | 7 | 3 | 3 | 3 | 7 | 3 |
| bifenthrin | | | | | | |
| *Brigade 10WS, 2 EC *Fanfare 2EC | — | — | — | — | 14 | — |
| Bt (*Bacillus thuringiensis*) | | | | | | |
| §Deliver 18WG | 0 | 0 | 0 | 0 | 0 | 0 |
| §Dipel 10.3 DF | 0 | 0 | 0 | 0 | 0 | 0 |
| §Biobit 2.IFC | 0 | 0 | 0 | 0 | 0 | 0 |
| §Javelin 7.5WDG | 0 | 0 | 0 | 0 | 0 | 0 |
| §Agree 3.8 WS | 0 | — | 0 | 0 | 0 | 0 |
| buprofezin | | | | | | |
| *†Centaur 0.7WDG | 14 | 14 | 14 | 14 | 14 | 14 |
| carbaryl | | | | | | |
| Sevin 4F, 4EC, 80S | 3 | 3 | 3 | 3 | 3 | 3 |
| chlorantraniliprole | | | | | | |
| *†Altacor 35WDG | 5 | 10 | 10 | 10 | 5 | 10 |
| *†Voliam Flexi WDG | 35 | 14 | 14 | 14 | 35 | 14 |
| *†Voliam Xpress EC | 21 | 14 | 14 | 14 | 21 | 14 |
| cyantraniliprole/cyazypyr | | | | | | |
| *†Exirel | 3 | 3 | 3 | 3 | 3 | 3 |
| cyflumetofen | 7 | — | — | — | 7 | — |
| Nealta | | | | | | |
| granulosis virus | | | | | | |
| §Carpovirusine 0.99SC | 0 | — | — | — | 0 | — |
| §Cyd-X 0.06SC | 0 | — | — | — | 0 | 0 |
| §Madex HP | 0 | 0 | 0 | 0 | 0 | 0 |
| chlorpyrifos | | | | | | |
| *Lorsban 4EC, | PB/28(A) | — | 21 | 14 | PB | PB |
| *Lorsban Advanced 3.76EC Lorsban 75WG | PB/28(A) | — | 14 or 21(C) | PB | PB | PB |
| clofentezine | | | | | | |
| Apollo 4SC | 45 | 21 | 21 | 21 | 21 | — |
| cyfluthrin | | | | | | |
| *Baythroid XL 1E, 2EC, *Leverage 360 | 7 | 7 | 7 | 7 | 7 | 7 |

**Table 17.2.1 Insecticides and acaricides**

| Product | EPA Reg. No. | Common Name | REI (hrs) | Applicator PPE | Early Entry PPE |
|---|---|---|---|---|---|
| *Danitol 2.4EC | 59639-35 | fenpropathrin | 24 | acfh | cfhk |
| Delegate 25WG | 62719-541 | spinetoram | 4 | ac | cfk |
| §Deliver 18WG | 70051-69 | Bt | 4 | abc | bck |
| §Des-X 4.07LC | 67702-22-70051 | insecticidal soap | 12 | dfghij | dfghj |
| *Diazinon 50WP | 66222-10 | diazinon | 96 | abc | bcjk |
| *Dimethoate 4EC | 19713-231 | dimethoate | 10 days | afghjl | fghjk |
| *Dimethoate 400 | 34704-207 | dimethoate | 10 days | acfil | efgj |
| §Dipel 10.3DF | 73049-39 | Bt | 4 | abc | bck |
| *†Endigo ZC | 100-1276 | lambda-cyhalothrin, thiamethoxam | 24 | dfgij | dfgj |
| §Entrust 80WP | 62719-282 | spinosad | 4 | ac | bck |
| §Entrust 2SC | 62719-621 | spinosad | 4 | ac | cfk |
| †Envidor 2SC | 264-831 (NY SLN 140006) | spirodiclofen | 12 | abc | abc |
| Esteem 35WP | 59639-115 | pyriproxyfen | 12 | ac | bce |
| *†Exirel 0.83E | 352-859 | cyantraniliprole | 12 | acf | cfk |
| *Gladiator EC | 279-3441 | zeta-cypermethrin, avermectin B1 | 12 | acf | cfk |
| *Imidan 70W | 10163-169 | phosmet | 3-7 days(E) | abcjl | bcjk |
| *†Intrepid 2F | 62719-442 | methoxyfenozide | 4 | abc | beg |
| §Isomate-CM/OFM TT | 53575-30 | pheromone | 0 | b | — |
| §Isomate-PTB Dual | 53575-34 | pheromone | 0 | b | — |
| §Isomate OFM TT | 53575-29 | pheromone | 0 | b | — |
| §Isomate CM/OFM Mist | 53575-44 | pheromone | 0 | b | — |
| §Isomate DWB | 53575-40 | pheromone | 0 | b | — |
| §Javelin 7.5WDG | 70051-66 | Bt | 4 | abcl | bck |
| JMS Stylet-Oil | 65564-1 | parrafinic oil | 4 | acf | cfk |
| Kanemite 15SC | 66330-38 | acequinocyl | 12 | acf | cfk |
| §Kumulus 80DF | 51036-352-66330 | sulfur | 24 | abfh | bchk |
| *Lambda-Cy 1EC | 70506-121 | lambda-cyhalothrin | 24 | acfh | acf |
| *Lannate 90SP | 352-342 | methomyl | 48-96 (E) | acfhl | cfhk |
| *Lannate LV 2.4L | 352-384 | methomyl | 48-96 (E) | acfk | bchk |
| *Leverage 360 | 264-1104 | imidacloprid/beta-cyfluthrin | 12 | acf | cfk |
| *Lorsban 4EC | 62719-220 | chlorpyrifos | 96 | adfgijl | dfgj |
| Lorsban 75WG | 62719-301-10163 | chlorpyrifos | 96 | acefgij | dfgj |
| *Lorsban Advanced 3.76EC | 62719-591 | chlorpyrifos | 96 | acgfijl | dfgj |
| §Madex HP | 69553-1 | insecticidal virus | 4 | abc | bck |
| Magister SC | 10163-322 | fenazaquin | 12 | acf | bck |
| Malathion 57EC | 34704-108 | malathion | 12 | acfh | cfhk |
| Movento 240SC | 264-1050 | spirotetramat | 24 | acfh | acfh |
| §M-Pede 49L | 10163-324 | insecticidal soap | 12 | ac | bck |
| Nealta | 7969-336 | cyflumetofen | 12 | acf | cfk |
| §Neemix | 70051-9 | azadirachtin | 4 | acfh | cfhk |
| †Nexter 75WS | 81880-4-10163 | pyridaben | 12 | abchjl | bchjkl |
| Onager 1EC | 10163-277 | hexythiazox | 12 | abc | abc |
| Portal 0.4EC | 71711-19 | fenpyroximate | 12 | acfhj | dfgh |
| Portal XLO 0.4EC | 71711-40 | fenpyroximate | 12 | acfh | dfgh |
| *Pounce 25 WP | 279-3051 | permethrin | 12 | abc | bck |
| *Proclaim 5SG | 100-904 | emamectin benzoate | 12 | acef | cfhk |