2021 Cornell Pest Management Guidelines for Commercial Tree Fruit Production

Cornell 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.

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Cover photo: Gala on slender spindle along the Shawangunk Ridge. Dressel Orchard, New Paltz, NY. (*Photo: Peter Jentsch, Cornell University Hudson Valley Research Laboratory, Highland, NY.*)

11 APPLES *(continued)*

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 www.newa.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 action threshold*** is used in this publication to denote

2 Organic Tree Fruit Production in New York State

2.1 Introduction

A large number of both native and introduced pest species attack apples and other tree fruits grown in commercial orchards. Control of this pest complex is particularly challenging in N.Y., because unlike more arid production regions in the country, fruit orchards in N.Y. are commonly in close proximity to semi-wooded areas with an abundance of naturalized and wild host species that can harbor populations of certain tree fruit pests. Traditionally, conventional fruit orchards in N.Y. have been treated heavily with pesticides to control this extensive pest complex.

In the past, very few growers in the northeast have attempted to produce apples and other tree fruits organically because of the practical difficulties involved in controlling pests in this region without using conventional, broad-spectrum pesticides. However, during the last 10-15 years, studies have been conducted to develop management programs that may be able to replace current strategies that rely primarily on these pesticide applications. For example, recent studies have shown that the predaceous mite, *Typhlodromus pyri*, which is native to apple production regions in western N.Y., can successfully control populations of the key mite pest, European red mite, in commercial apple orchards so that no applications of miticides are required for seasonal control. Recent research in N.Y. and elsewhere has also shown that pheromones can be deployed in orchards to disrupt mating of key lepidopteran species such as oriental fruit moth, and borer species, and substantially reduce fruit damage from this complex of pests. In addition to some of these newer types of organically compatible pest control technologies, traditional control methods such as selective fruit thinning, pruning, sanitation (frequent removal of dropped fruit and/or vegetative tissue infested or infected with pests), removal of wild hosts near commercial plantings, and exclusion of pests with biological or physical barriers near or around trees, have also been shown to reduce populations of many types of pests in fruit plantings in this region.

Ideally, organic fruit production is the synthesis of an entire suite of practices intended to take advantage of natural ecosystem interactions and minimize synthetic inputs. Such a system might start with the selection of disease-resistant cultivars, to circumvent the need for the majority of normal disease sprays. This one tactic could eliminate or substantially reduce the need to manage apple scab, powdery mildew, cedar apple rust, and fire blight (Ellis et al., 1998). In lieu of resistance, a combined strategy of orchard sanitation and frequent applications of elemental sulfur and copper throughout most of the season would be the next practical alternative.

2.2 Fungicide Options in Organic Tree Fruit Production

Organic approved fungicides and bactericides are often not as effective and the conventional fungicides and antibiotics in temperate apple production regions such as NY and New England. In recent years, organic copper and sulfur products, and biopesticide products have greatly improved in terms of formulation and efficacy. In drier seasons and against lower disease pressure situations (e.g. low level of inoculum & among less susceptible cultivars), organic-approved products can provide a level of control comparable to conventional products. That being said, organic-approved products may need to be applied at higher rates and frequencies to match the activity of convention products. In field trials conducted at Cornell and other regional institutions, applied plant pathologists are achieving greater success in managing fire blight and summer diseases with biopesticides based on *Bacillus subtilis*, *B. amyloliquefaciens*, *B. mycoides*, and *Reynoutria sachalinensis*, and new low MCE copper products formulated to reduce risk of phytoxicity. In many instances, biopesticides and organic copper and sulfur products are being used in conventional production as means of resistance management or to avoid exceeding seasonal tolerances for key conventional fungicides. Biopesticides based on natural oils, such as white mineral oil or oil of thyme have similar potential for controlling fungal and bacterial diseases, but the use of oils complicates the use of other agrichemicals as oils act as intensifiers and could lead to problems with phytoxicity in tank mixes. Biopesticides based on potassium bicarbonate and peroxides have utility against fungal diseases, particularly, powdery mildew and sooty blotch fly speck. However, these would be need to be applied every 3-5 days or at each wetting event for maximum efficacy. Phosphorous acid fungicides are biopesticides and can be fairly effective against fire blight, powdery mildew, and flyspeck sooty blotch when applied at model recommendations and short intervals (e.g. 3-7 days). However, these products are not approved for organic agriculture. Additional biopesticides and organically approved copper and sulfur products are being developed and improved every year. While some of these products have been evaluated, many are either not commercially available or have yet to be thoroughly evaluated by multiple experts in the region. Products designated with the section symbol "§" indicate that they are suitable for organic production. A provisional program for managing the major diseases of apples covering might resemble:

- **Apple scab** [silver tip through midsummer] – copper [silver tip & green tip]; sulfur, *Bacillus sp,* potassium bicarbonate, and peroxides [tight cluster to midsummer]

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 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.

Information about pesticide certification and classification is available from your Cornell Cooperative Extension office (cce.cornell.edu/localoffices), regional NYSDEC pesticide specialist (www.dec.ny.gov/about/ 558.html), the Pesticide Applicator Training Manuals (https://www.cornellstore.com/books/cornell-cooperative-ext-pmep-manuals), 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 protect their health and that of others and to protect the environment. Keep in mind 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 preparing a container for disposal. 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.*** The required PPE are based on the pesticide's toxicity, route(s) of exposure, and formulation. Label required PPE are the minimum that must be worn during the pesticide's use. Pesticide users can always wear more protection than the label requires.

The type of protective equipment used depends on the type and duration of the activity, where pesticides are being used, and exposure of the handler. Mixing/loading procedures often require extra precautions. Studies show you are at a greater risk of accidental poisoning when handling pesticide concentrates. Pouring pesticide concentrates from one container to another is the most hazardous activity.

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. Consult the product label for more information on using engineering controls in place of PPE.

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 minimize drift and runoff hazards. See product labels for specific application and equipment requirements.

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

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

Distance Between Rows (feet)	Tree Width (feet)	Tree Heigh (feet)	Dilute spray Per acre[1] (gal/acre)
40	28	20	427
40	28	16	342
30	20	15	305
25	16	14	273
22	14	13	252
20	12	12	220
18	10	12	203
16	8	10	152
14	6	10	131
12	5	10	127
11	4	10	111
10	3	9	82

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

4.4.8 Travel Speed Calibration

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

Factors that will affect travel speed include:

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

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

Set up test course at least 100 feet long, measure the course with a tape measure. Do not pace the distance. The longer the course the smaller the margin of error. Run the course in both directions.

Use an accurate stop watch to check the time required to travel the course in each direction. Average the two runs and use the following formula to calculate the speed in MPH.

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

Your figures:

Tractor gear _____ Engine revs._____

$$\text{MPH} = \_\_\_\_\_ \quad \frac{\text{ft traveled}}{\text{sec traveled}} \times \frac{60}{88} = \_\_\_$$

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

4.5 Rate of Output (GPM)

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

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

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

[1]Linear feet of row per acre = 43,560 divided by distance between rows.
[2]Minutes per acre = linear feet of row per acre divided by speed in feet per minute. Speed in feet per minute = mph x 88.

4.5.1 Example for Calibrating Rate of Output:

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

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.

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**)
afidopyropen – (*†Versys Inscalis) BASF **(I)**
azadirachtin – (§Aza-Direct) Gowan; (§Neemix 4.5) Certis **(I)**

Bacillus subtilis – (§Serenade products) Bayer **(B, F)**
Bacillus amyloliquefaciens – (§DoubleNickel prodcucts) Certis **(B, F)**
Bacillus mycoides isolate J– (§LifeGuard) Certis **(B, F)**
benzovindiflupyr (*Aprovia) Syngenta (F)
bifenazate – (Acramite) Chemtura **(A)**; (Banter) UPI **(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)**
Burkholderia spp. strain A396 – (§Venerate XC) Marrone Bio Innovations **(I)**

captan – (Captan) Micro Flo, Drexel, Makhteshim Agan **(F)**
carbaryl – (Carbaryl) Drexel; (Sevin) TKI (**I**)
chlorantraniliprole – (*†Altacor) DuPont; (*†Voliam Flexi, *†Beseige) Syngenta **(I)**
chlorpyrifos – (Lorsban) Dow AgroSciences, Gowan **(I)**
chlorothalonil – (Bravo) Syngenta; (Echo) Sipcam Agro; (Equus) Makhteshim Agan **(F)**
Chromobacterium subtsugae – (§Grandevo) Marrone Bio Innovations **(I)**
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 40 Disperss) United Phosphorus **(B, F)**
cyantraniliprole – (*†Exirel) DuPont **(I)**
cyantraniliprole/abamectin – (*†Minecto Pro) Syngenta **(I)**
cyclaniliprole – (*†Verdepryn) Summit Agro **(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) Valent **(I)**
etoxazole – (Zeal) Valent **(A)**

fenazaquin – (Magister) Gowan **(A)**
fenbuconazole – (Indar) Dow AgroSciences **(F)**
fenbutatin-oxide – (*Vendex) United Phosphorus **(A)**
fenhexamid – (Elevate) Arysta **(F)**
fenpropathrin – (*Danitol) Valent BioSciences **(I)**
fenpyroximate – (Portal) Nichino America **(A,I)**
flonicamid – (Beleaf) FMC **(I)**
flupyradifurone – (*†Sivanto Prime) Bayer **(I)**
flutriafol – (†Rhyme) FMC **(F)**
fluopyram + pyrimethanil (*†Luna Tranquility) Bayer (**F**)
fluopyram + trifloxystrobin (*†Luna Sensation) Bayer (**F**)
fluopyram + tebuconazole (*†Luna Experience) Bayer (**F**)
fluxapyroxad (*†Sercadis) BASF (**F**)
fluxapyroxad + pyraclostrobin) (*†Merivon) BASF (**F**)
ferbam – (Ferbam Granuflo) Taminco **(F)**
fludioxonil – (Scholar) Syngenta **(F)**
fosetyl-Al – (Aliette) Bayer **(F)**

GS-omega/kappa-Hxtx-Hv1a – (Spear-Lep) Vestaron **(I)**

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;(§Virosoft CP4) BioTEPP **(I)**
iprodione – (Rovral) Bayer; (Iprodione) MicroFlo **(F)**

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

lambda-cyhalothrin – (*Lambda-Cy) United Phosphorus; (*Warrior; *†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)**

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, blister spot, and summer diseases, like sooty blotch and fly speck. 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. Research trials in Geneva and the Hudson Valley have demonstrated that the combination of captan 80 and phosphorus acid or phosphite fungicides (e.g. Helena ProPhyt) can provide a commercially acceptable level of control of fly speck and sooty blotch. Trials conducted outside of NY suggest that these products can also provide moderate to good control of these diseases alone or in rotation with other products. 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 does not have direct antibiotic activity against the fire blight bacteria, rather it prevents invasion from the site of initial infection. This growth regulator will not protect against initial infection of flowers, but it may slow the invasion of bacterial within infected floral tissues and prevent spread to subsequent tissues. For this use, early applications of prohexadione calcium may be applied at "Pink" as described in the 2EE labeling. Pink application may also reduce bitter pit in 'Honeycrisp'. Prohexadione calcium will reduce the severity of shoot blight if applied 10-14 days in advance of infections. For maximum reduction in fire blight susceptibility, For shoot blight management, 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 Opti (*Bacillus subtilis* strain QST 713) is a biofungicide labeled for control of fire blight, apple scab, powdery mildew, and some other fungal diseases. Serenade Opti 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 Optimay be less effective than conventional fungicide for controlling fungal diseases under the favorable climatic conditions that exist in New York. When used alone, Serenade Opti provides only some control of fire blight. In alternation with streptomycin, it sometimes provides control approaching that of a full streptomycin program. Serenade Opti should be applied as a preventive and can be applied up to and including the day of harvest.

5.5 Insecticides

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

Notes on Materials

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

5.5.1 Organophosphates

Most organophosphate insecticides are highly toxic to warm-blooded animals when inhaled, swallowed, or absorbed through the skin. Persons handling or applying these materials should take every precaution for their own safety and for that of others. Although the organophosphates in general are less persistent than the chlorinated hydrocarbons, their toxicity often prohibits their use close to harvest (see following materials). Organophosphates are contact insecticides as well as stomach poisons. Therefore, they are useful for a quick kill of all insect forms present at the time of application, as well as for reasonable residual protection. When used alone or in combination with other materials, some organophosphates cause phytotoxicity on fruit varieties. Check this reference 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 prebloom period on apples, pears, peaches, and plums. Application during this period will also control rosy apple aphid. This material can be used alone or in combination with oil. It is also registered for use on peaches and cherries to control peachtree borers and in apples as a trunk spray to control a variety of borers. A 75 WG (water dispersible granule) formulation is available for all tree fruits except

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 post-infection activity. When applied following an infection period, but beyond the time limits of its post-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 Suppres-sion(a)*
§*Bacillus amyloliquefaciens* strain D747 (Double Nickel 55/LC)	Microbial	44	—	—	—	—	2	—	—
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	
fluopyram + pyrimethanil (*†Luna Tranquility)	SDHI and Anilinopyrimidine	7 & 9	4[i]	3	1	3	3	3	—
fluopyram + trifloxystrobin (*†Luna Sensation)	SDHI and Strobilurin (QoI)	7 & 11	4[i]	4	1	3	3	3	—
flutriafol (†Rhyme)	DMI (SI)	3	4[c]	4	4	2	2	2	—
fluxapyroxad (*†Sercadis)	SDHI	7	4[i]	3	2	3	4	3	—

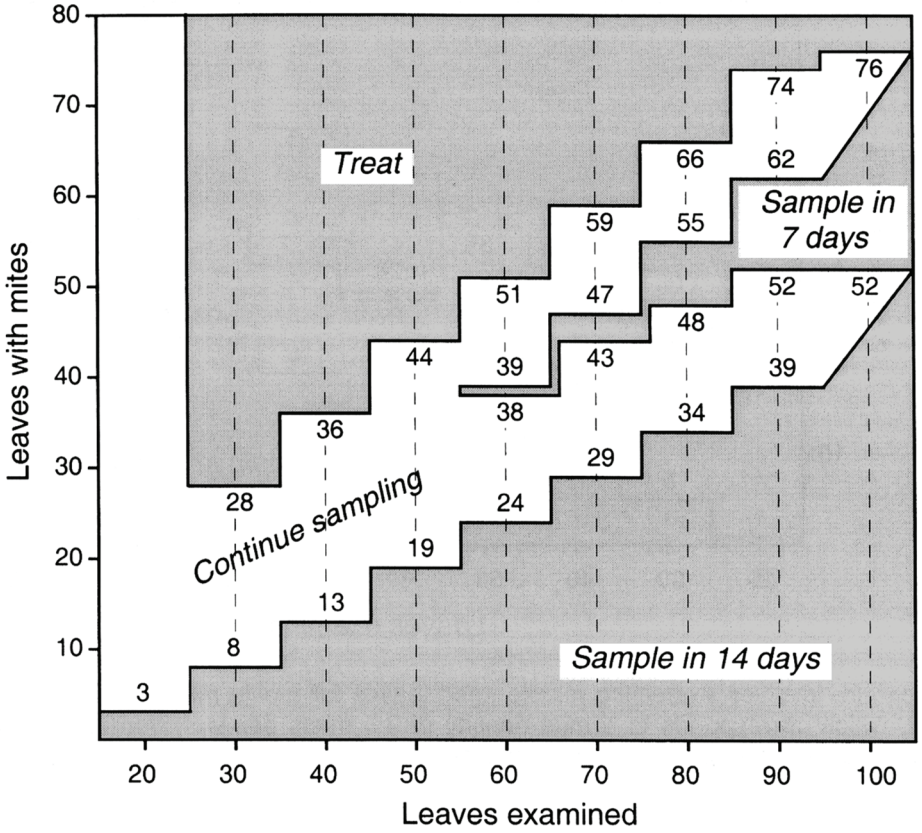
7 Insect and Mite Management

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	—
*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	18B	—	2	1	2	—	2	—	0	—	2	—	—	3	—	—
§B.t, (§Agree, §Biobit, §Deliver, §Dipel, §Javelin)	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
*†Besiege (chlorantraniliprole/ lambda-cyhalothrin)	3A/28	3	2	3	3	3	3	3	3	2	2	3	2	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
*†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
§Grandevo (*Chromobacterium subtsugae*)	—	—	—	—	2	—	—	2	—	—	—	—	—	—	—	—
*Imidan (phosmet)	1B	3	1	3	3	1	1	1	3	0	1	3	2	1	1	—
*†Intrepid (methoxyfenozide)	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	—
Magister (fenazaquin)	21	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—
Malathion	1B	2	2	2	2	1	1	1	2	0	1	2	—	1	1	—
*†Minecto Pro (cyantraniliprole/abamectin)	28/6	2	0	0	3	3	3	3	3	3	3	3	0	3	0	0
Movento (spirotetramat)	23	—	3	—	—	—	—	—	—	3	—	—	3	—	—	3
*Mustang Maxx (zeta-cypermethrin	3A	3	2	2	2-3	3	3	2-3	2	2	2	3	—	3	3	—

Table continues on next page.

Figure 7.1.5. Mite Sampling Chart – Threshold = 5.0 mites/leaf (July 1-31)



- This procedure involves examining middle aged leaves for motile mites (any stage except eggs). Use this chart, which corresponds to a mite density of 5.0 mites per leaf, from July 1 until July 31. You will not be counting mites, but will only determine whether they are present or absent on each leaf sampled.

- Starting with a random tree and sampling every other tree, collect 4 leaves in a plastic bag from each of 5 trees, choosing from each quadrant of the canopy. To make sure the leaves are of an intermediate age, pick them from the middle of the fruit cluster or foliar terminal.

- Using a magnifier, examine the top and bottom surface of each leaf for motile mites, and keep track of the number of leaves containing motile mites. When all 20 leaves have been examined, compare this number with the numbers on the above decision guide. If the number of leaves with mites is equal to the values on the stairstep lines, the decision is the one shown in the area immediately below the value (example: For "36" after sampling 40 leaves, the decision is "Continue sampling"; for "13" the decision is to "Sample in 14 days"). When the counts fall into any of the shaded regions, sampling is stopped and a decision is made to either treat, or else re-sample in 7 or 14 days. If the counts fall in the "Continue sampling" zone, take and examine more leaf samples in batches of 10 (5 per tree) until the counts fall into one of the shaded regions. If you reach one of the resample zones, the population is below threshold, and should remain so for at least the number of days stated. Return at the designated time and conduct another sample. If the "7 day" resample date falls during the 7.5 mites/leaf threshold period, you can wait for a total of 14 days before resampling.

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.

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.

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

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

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

8.1.2 Definition of Terms

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

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

Example:
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 8.4.2. Effectiveness of herbicides in tree fruit crops.

Trade Name(s) (*active ingredient*)	WSSA Group	AG	AB	PG	PB	WBV	YN	BW	HN	CT	SB	PW	RW
Chateau SW (*flumioxazin*)	14	G	G	P	P	P	P	P	P	P	P	G	G
†Fusilade (*fluazifop*)	1	G	—	F	—	—	—	—	—	—	—	—	—
Goal (*oxyfluorfen*)	14	F	G	—	—	—	—	—	—	—	—	G	G
*Gramoxone (*paraquat*)	22	G	G	F	F	F	G[3]	F	F	F	—	G	F
Karmex (*diuron*)	7	G	G	F	—	—	—	—	—	—	—	G	G
Kerb (*pronamide*)	3	G	—	G	—	—	—	—	—	—	—	—	—
Matrix (*rimsulfuron*)	2	G	G	P	P	P	F	P	P	F	P	G	F
Poast (*sethoxydim*)	1	G	—	F	—	—	—	—	—	—	—	—	—
*†Princep (*simazine*)	5	F	G	—	—	—	—	—	—	—	—	G[4]	—
Prowl, Prowl H20 (*pendimethalin*)	3	G	F	—	—	—	—	—	—	—	—	G	—
†Rely 280 *(glufosinate-ammonium)*	10	G	G	F	F	P	G	F	F	F	—	G	G
Roundup, Touchdown (*glyphosate*)	9	G	G	G	G	G[1]	G[2]	G	G[1]	G[1]	F	G	G
Sandea *(halosulforon-methyl)*	2	P	G	—	P	—	G	—	G	P	—	G	G
*Sinbar (*terbacil*)	5	G	G	F	F	—	F	—	F	—	—	F	G
*†Solicam (*norflurazon*)	12	G	F	F	—	—	F	—	—	—	—	F	—
*†Stinger [5] (*clopyralid*)	4	—	F[5]	—	F[5]	—	—	—	F	G	—	—	F
Surflan (*oryzalin*)	3	G	F	—	—	—	—	—	—	—	—	G	P
*†TreeVix *(saflufenacil)*	14	—	G	—	—	—	—	P	—	P	—	G	G
Venue (*pyraflufen-ethyl*)	14	—	G	—	F-P[6]	—	—	P	—	P	F	G	G

Key: G = good; **F** = fair; **P** = poor

* Restricted-use pesticide.

† Not for use in Nassau or Suffolk Counties.

[1] Combination with 2,4-D amine has improved effectiveness.
[2] Best results with late-summer (after August 1) applications.
[3] Best results with early mid-summer (before July 15) applications.
[4] Resistant types may require use of alternative materials.
[5] Not broad spectrum; see label for specific weed targets.
[6] Requires tank mix.

Abbreviations:
AG = Annual grasses; **PG** = Perennial grasses;
AB = Annual broadleaves; **PW** = Pigweeds;
BW = Bindweeds; **RW** = Ragweed;
CT = Canada thistle; **SB** = Smooth bedstraw;
HN = Horsenettle; **WBV** = Woody brush, vines;
PB = Perennial broadleaves; **YN** = Yellow nutsedge.

Table 8.4.3. Weed control guidelines for tree fruit.

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

Crop						*Tree Age*				
Apples	Pears	Cherries	Peaches	Apricots	Plum/Prune	Planting Year	1 year plus	2 years plus	3 years plus	**PRODUCT NAME** (*active ingredient, weight of active per unit of herbicide*) *Notes:*
X	X	X	X	X	X		X	X		***2,4-D AMINE, *WEEDAR 64, or other labeled formulation** (*2,4-D, 3.8 lb/gal*) *Weeds Controlled:* broadleaves, *Rate (per acre):* 3 pt. *AI per acre (lbs/acre):* 1.4 *Days to harvest:* Apples and pears: 14; apricots, cherries, peaches, and plums: 40 *REI (hours):* 48 *Comments:* Established perennials, woody brush and vines can also be controlled by using in tank mix with glyphosate. To control dandelions and other broadleaf weeds in sod cover under cherry trees, apply in the fall (best) or early spring BEFORE TREES OR DANDELIONS BEGIN TO BLOOM. Yearly application is needed to control dandelions. Avoid contact with fruit, foliage, stems, or limbs of trees. Not all products labeled for all crops. See labels.

Table continues on next page.

10 Nutrient Management of Apple Orchards

10.1 Introduction

When developing mineral nutrient management programs for tree fruits, it is important to consider the nutrient demand-supply relationship throughout the season.

10.2 Nitrogen

Early season canopy development and fruit growth require large amounts of nitrogen (N), while fruit quality development and the acquisition of adequate cold hardiness by the tree later in the season require only a minimum supply of N. Thus, an ideal seasonal pattern of tree nitrogen status should be to start the season with relatively high nitrogen status to promote rapid leaf development and early fruit growth. As the season progresses, nitrogen status should decline gradually to guarantee fruit quality development and wood maturity before the onset of winter. There are three sources of nitrogen supply tree fruits can use. First is reserve nitrogen that has accumulated in the tree from the previous growing season. This source of nitrogen is readily available for initial growth during the spring. In fact, spur leaf development and early fruit growth are mainly supported by the reserve N. The second source is the natural N supply from the soil mineralization process. This process provides substantial amounts of nitrogen for trees growing on soils with high organic matter. The third is nitrogen fertilizers applied to the soil or to the foliage. To determine the amount of fertilizer nitrogen needed, we need to know the total tree demand and the amounts the other two nitrogen sources can provide. However, there is not enough information currently available on this demand-supply relationship to make this approach practical. Instead, soil and leaf analyses have been developed over the years to help growers diagnose tree nutrient status and soil nutrient availability and make adjustments on their fertilization programs accordingly.

10.3 Soil Analysis

Soil analysis is very useful for determining lime requirement and mineral availability in the soil before orchard establishment. For existing orchards, it provides information necessary for interpreting leaf analysis results and modifying fertilization programs.

A soil nutrient analysis should be performed before planting a new orchard and every 2 to 3 years after orchard establishment. The soil sample taken should be representative of the soil type and conditions within the orchard. Generally, the area included in any one-sample collection should not exceed 10 acres. Scrape away the surface 1-inch of soil, then collect samples from the 1 to 8 inch depth, and separate samples from 8 to 16 inches. In a 10 acre orchard, a minimum of 10 to 20 subsamples is suggested. Thoroughly mix the 1-8 inch subsamples together to provide a representative sample for the topsoil, and treat the 8 to 16 inch subsamples similarly to get a representative sample for subsoil. Soil samples can be sent to Agro-One, 730 Warren Road, Ithaca, NY 14850.

10.4 Preplant Soil Preparation

New York soils are classified into 5 management groups on the basis of texture and parental materials (Table 10.4.1). Percentage of clay, buffering capacity, and potassium supply power decrease from group I to V.

10.4.1. Liming

The pH values of orchard soils should be maintained in the range of 6.0 to 6.5 throughout the soil profile to optimize plant growth and nutrient availability. For preplant soil preparation, we recommend the pH of topsoil (0-8 inch depth) be adjusted to 7.0 and that of subsoil to 6.5. Most soils in New York have pH values lower than optimum and need liming to raise the pH prior to planting a new orchard. This also ensures adequate calcium and magnesium supplies in the soil.

The amount of lime required to adjust topsoil pH to 7.0 and subsoil pH to 6.5 is determined by the current pH values of the topsoil and subsoil (determined from a soil analysis) and the buffering capacity of the soil, i.e. exchange acidity or cation exchange capacity, (CEC), of topsoil and subsoil (also determined from a soil analysis). Using these values, the lime requirement can be determined from Table 10.4.2 for topsoil and from Table 10.4.3 for subsoil. The amount of lime to be added is the sum of topsoil plus subsoil requirement. When complete soil tests are not available, Table 10.4.4 may be used to estimate lime requirement.

Table 10.4.1. Soil management groups

Soil group	Texture	Examples
I	Clayey soils, fine-textured soils.	Vergennes, Kingsbury, Hudson, Rhinebeck, Schoharie, Odessa.
II	Silty loam soils with medium to moderately fine texture.	Cazenovia, Hilton, Honeoye, Lima, Ontario, Lansing, Mohawk, Chagrin, Teel.
III	Silty loam soils with moderately coarse texture.	Barbour, Chenango, Palmyra, Tioga, Mardin, Langfor, Tunkhannock.
IV	Loamy soils, coarse- to medium-textured soils.	Bombay, Broadalbin, Copake, Empeyville, Madrid, Sodus, Worth.
V	Sandy soils, very coarse-textured soils.	Alton, Colton, Windsor, Colonie, Elmwood, Junius, Suncook


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		[8.4]
	M1	Badge X2	3.5-7.0 lb/acre	0	48		[8.4]
Blister Spot	33	Phostrol	2.5-5.0 pts/acre	0	4	High	[5.1]
Crown rot	4	Ridomil Gold SL	2 qt/acre 0.5 pt/100 gal water		48		[7.2]
	33	Aliette WDG	2.5-5 lb/acre 0.5-1 pt/100 gal water	14	24		
	33	Phostrol	2.5-5.0 pts/acre	0	4	High	
	33	Prophyt	2-4 pt/acre	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	8-16 oz/acre	50	12		[8.5]
		Kocide 3000 O	3.5-7.0 lb/acre 1.11-2.3 lb/100 gal water	HIG	48		
	M 01	Previsto	2-4 qt/acre	See label	48		
	M1	Badge SC	3.5-7.0 pts/acre	0	48		[8.4]
	M1	Badge X2	3.5-7.0 lb/acre	0	48		[8.4]
Phytophthora Rots	33	Phostrol	2.5-5.0 pts/acre	0	4	High	[7.3]
	33	Prophyt	2-4 pt/acre	0	4	High	[7.3]
Green Tip							
Apple scab	7	*†Sercadis	4.5 fl oz/acre	0	12	High	
	7	*Aprovia	5.5-7.0 fl oz/acre	30	12	High	
	M1	Badge SC	3.5-7.0 pts/acre	0	48		[8.4]
	M1	Badge X2	3.5-7.0 lb/acre	0	48		[8.4]
	M3	Manzate ProStik	3.0-6.0 lb/acre 1.0-2.0 lb/100 gal water	BL, 77(A)	24		[1.3,2.2]
	M3	Penncozeb 75DF	3.0-6.0 lb/acre 1.0-2.0 lb/100 gal water	BL, 77(A)	24		[1.3,2.2,2.8]
	M3	Polyram 80DF	3.0-4.5 lb/acre	BL, 77(A)	24		[1.3,2.2]
	M4	Captan 50WP	8.0 lb/acre 1.0-2.0 lb/100 gal water	0	24		[2.1,2.2]
	M4	Captan 80WDG	5.0 lb/acre 0.65-1.25 lb/100 gal water	UDH	24		[2.1,2.2]
	U12	Syllit FL	1.5 pts/acre	7	48		[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	*†Luna Sensation	4.0 to 5.8 fl oz/acre	14	12	High	
	11 + 7	*†Merivon	4-5.5 fl oz/acre	0	12	High	

[9.3] JMS Stylet Oil also provides mite control but has incompatibility problems with several other pesticides, including captan and sulfur. Refer to label for specific restrictions.

[9.4] Do not delay powdery mildew applications beyond pink.

[9.5] Vivando provides excellent control of apple powdery mildew, but needs to be mixed with another fungicide to manage the other concurrent diseases of apple. Vivando can be applied only three times a season and no more than two consecutive applications can be made prior to rotating to a chemical with a different mode of action. Also, crop response has been reported on 'Macoun', 'Baldwin', and 'SnowSweet'.

11.2.10 Sooty Blotch And Fly Speck

• Pesticide Application Notes

[2.8] It is illegal to use the 6 lb/A rate of the EBDC fungicides after bloom. It also is illegal to use the reduced rate (3 lb/A) after bloom if the rate for any of the sprays prior to petal fall exceeded 3 lb/A.

[2.14] Fungicide resistance to *†Sovran and Flint is beginning to develop in populations of several fungal pathogens in the Northeastern US. The primary strategies for reducing this risk of resistance are to rotate the strobilurins with unrelated fungicides, to limit the number of seasonal applications of strobilurin fungicides (e.g., 3-4 per year), and to tank mix strobilurins with captan when treating trees with visible scab lesions.

[2.16] Research trials in Geneva and the Husdon Valley have demonstrated that the combination of Captan 80 and phosphorus acid or phosphite fungicides (e.g. Helena ProPhyt) can provide a commercially acceptable level of control of fly speck and sooty blotch. Similarly, the combination of a bacillus based biopesticide (e.g. Double Nickel 55) mixed with a low MCE organic copper product (e.g Cueva) applied at the requisite level of wetting needed for infection.

[10.1] Sooty blotch and fly speck develop gradually during periods of very high humidity; thus they are favored by frequent showers, prolonged cloudy weather, poor air circulation, dense tree canopies, and clustered fruit. These diseases are particularly damaging when rainy weather persists through summer and allows repeated cycles of secondary spread. Inoculum for sooty blotch and flyspeck often comes from alternate hosts in adjacent woods and hedgerows, such as trees, shrubs, vines, particularly wild brambles. Removal of these plants to whatever extent possible (e.g., bush-hogging fencerows or ditchbanks) will aid in disease control. Summer pruning, which increases air movement through the tree canopy, also aids in control of these diseases. After spores land on unprotected fruit, 270 hr of accumulated wetting are required before flyspeck will become evident on fruit.

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

[10.2] Ascospores of the flyspeck fungus can be blown into orchards beginning near petal fall, but fungicides applied for scab control are usually adequate to control these early season infections. The real risk of flyspeck infection escalates when secondary spores become available in woodlots and hedgerows. This occurs after approximately 270 hours of accumulated wetting (rains and dew periods) counting from petal fall. The threshold for 270 hours of accumulated leaf wetness was based on recordings from a string-activated leaf wetness meter and our best approximation for the equivalent using estimated leaf wetness hours based on relative humidity as predicted by a NEWA station would be 170-190 hr of accumulated wetting from petal fall. Topsin M, *†Sovran, Flint, Inspire Super, *†Merivon, and Pristine all arrest development of flyspeck infections on fruit if they are applied after infections have occurred, but the infections resume growing after fungicide residues are depleted. Applications of Topsin M, *†Sovran, Flint, Inspire Super, *†Merivon, or Pristine should then be renewed at 14-21 day intervals. If all fungicide coverage is removed by heavy rains (> 3 inches after the last spray) during late August or early September, a late-season spray may be needed to control disease on cultivars that will not be harvested within 25-30 days after fungicide coverage is depleted. Effectiveness of late-season sprays is largely dependent on spray coverage within the tree.

11.3 Apple Insect and Mite Notes

11.3.1 American Plum Borer

• Pesticide Application Notes

[17.1] One coarse spray of Lorsban to trunk burr knots between half-inch green and petal fall. Alternatively, if fresh borer activity is noted in early July, apply one spray of Lorsban in early July. Only 1 application of any chlorpyrifos material allowed per year in apples. PHI = 28 days.

11.3.2 Apple Aphid, Spirea Aphid

• Pesticide Application Notes

[1.0] For best effectiveness and insecticide resistance management, the use of pre-mixes 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.

[11.1] Suggested action threshold: 30-40% of all terminals infested, OR 50% or more of the terminals with at least 1 aphid and less than 20% of the terminals with predators, OR 10% of fruit with honeydew or aphids.

[11.1a] Multiple applications of *†Agri-Flex or *†Voliam Flexi in pome fruit require applicator to not exceed a total of 0.172 lbs a.i. of thiamethoxam containing products per acre per growing season.

[11.1b] Movento applied at petal fall and 1st cover will also provide control of apple leafcurling midge.

Table 11.5.1 Recommended diphenylamine concentrations for varieties in New York subject to scald.

Variety	Diphenylamine (ppm)	Variety	Diphenylamine (ppm)
Baldwin	1000-1500	Idared	1000
Braeburn	1000	Jonagold	1000
Cortland	2000	McIntosh	1000
Delicious	1000-1500	Mutsu	2000
Empire	1000	Rome	1500
Golden Delicious	1000	Stayman	1500

Penbotec, Scholar, and Academy are effective against both blue mold (P. expansum) and gray mold (B. cinerea). Both are compatible with DPA and calcium chloride. Both are recommended for use as the sole fungicide in postharvest drenches (i.e., they do not need to be combined with captan).

To slow selection of pathogens with resistance to Penbotec and Scholar, it is recommended that storage operators alternate use of these products from one year to the next. Given that Academy contains both fludioxonil and difenoconazole, which are in different chemical classes, it may be the preferable choice for resistance managment for post harvest pathogens. Much of the inoculum for P. expansum recycles from one year to the next on apple bins. By using Penbotec in one season and Scholar or Academy the next (or Scholar or Academy the first year and Penbotec the next year), spore populations on bins will not be subjected to selection pressure by the same fungicide in successive years.

Some countries that import apples from the US may not accept fruit treated with Penbotec, Scholar, Academy, or Captan. For the latest information on maximum residue levels (MRL's) that have been established in various countries, check the following website: mrldatabase.com.

None of the postharvest treatments will control pinpoint scab, latent bitter rot or black rot infections that are present at harvest, or postharvest decays caused by Alternaria.

Chlorinated water can also be used to disinfect fruit after harvest. Numerous commercial formulations of calcium hypochlorite and sodium hypochlorite are available with postharvest labels. However, chlorine only kills spores in the treatment solution and on the fruit surface at the time of treatment. It does not provide any residual protection.

Chlorine is not compatible with diphenylamine. Thus, chlorination is most useful for disinfesting flume water on apple packing lines rather than as postharvest treatment prior to storage. Follow directions on the product label for maintaining appropriate levels of chlorine in treatment solutions.

11.4.2 Storage Scald

• Pesticide Application Notes

[38.1] Active ingredient may vary according to manufacturer: use label instructions to check rate required to obtain desired concentration. See Table 11.5.1 for varietal requirements.

11.4.3 Senescent Breakdown (McIntosh)

• Pesticide Application Notes

[39.1] The addition of calcium chloride to the postharvest scald and storage rot treatment is effective in reducing McIntosh breakdown. Only calcium chloride that meets Food Chemical Codex specifications can be used in postharvest treatment of apples. Calcium treatment will be of little benefit to apples harvested after the projected optimum harvest date. Fruit injury from calcium chloride has been found to be associated with iron in the solution. Coat steel tanks or use plastic tanks and piping to minimize this problem.

11.5 Notes on Scald Control

11.5.1 Materials

All DPA (diphenylamine) formulations are suspensions and become weaker with use. Replenishment with full-strength material does not replace the DPA removed by the apples. Test kits are available to determine concentrations of make-up material. Do not exceed 30 bins or 750 bushels/100 gal of made-up DPA; empty the reservoir tank and start again with fresh material.

Cartons containing apples that have been treated postharvest with DPA and fungicide must be so labeled.

11.5.2 Application Equipment

Bins of apples are sometimes dipped into a tank containing postharvest preservatives, but more often the bins are moved by conveyors, rollers, or truck bed under a cascade of the preservatives. The bins should be moved slowly under the cascade, with 35-40 gal of preservatives being delivered into each bin. The pump should be sized to deliver 35-40 gal of preservatives/bin at the desired rate of bin movement under the cascade. If stacked bins are moved under the cascade, the top bins should receive 35-40 gal and side nozzles should be positioned to deliver additional gallonage to the lower bins, even though drainage holes are provided in the bin floors. Application equipment is commercially available, but operators usually fabricate their applicators to meet the needs of their own operation. Dirty truckloads should be rinsed with clean water before treatment to minimize the accumulation of dirt in the reservoir tank.

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*
Fungicides and Bactericides *(continued)*						
sulfur						
Microthiol Disperss	—	*NR*	—	—	—	—
Wettable sulfur						
thiophanate-methyl						
Topsin M WSB, 70WP	1	1	1	1	1	1
Topsin 4.5L	1	1	1	1	*NR*	1
thiram						
*Thiram Granuflo	*NR*	*NR*	*NR*	7	*NR*	*NR*
trifloxystrobin						
Flint	14	*NR*	*NR*	*NR*	14	*NR*
Gem 500 SC	*NR*	1	1	1	*NR*	1
triflumizole						
*Procure 480SC	14	*NR*	1	*NR*	14	*NR*
ziram						
Ziram 76DF	14	30	14	14	14	*NR*

Key:

BL Do not apply beyond bloom.
BS Do not apply between budswell and final harvest
GT Do not apply beyond green tip.
HIG Do not apply beyond 1/2-in green.
NB Non-bearing
NL None listed
PB Prebloom applications only.
PF Do not apply beyond petal fall.
PH Postharvest applications allowed. In the case of herbicides, apply after harvest before soil freezes.
SS Do not apply beyond shuck split.
UDH Up to day of harvest.
2C Do not apply after 2d cover spray.
(A) If more than one value is given, depends on rate, method and/or number of applications; check label.
(B) Nonbearing trees only.
(C) Tart cherries only.
(D) Sweet cherries only

[1] peaches/nectarines

NR Not registered for use on crop
— Follow REI as described on label.
* Restricted-use pesticide.
† Not for use in Nassau and Suffolk Counties.

Table 17.1.2. Common names, product names, formulations, and days-to-harvest for growth regulators.

Product Name	Common Name	Formulation	EPA Reg. No.	Crop	Preharvest Interval
Amid-Thin W	naphthalene-acetamide	8.4 WP	5481-426	Apple, pear	—
Apogee	prohexadione calcium	27.5% DF	7969-188	Apple	45 days
Ethephon	ethephon	2 lb/gal	various	Apple, cherries	7 days
Exilis 9.5 SC	cytokinin	9.5% liquid	6209733-82917	Apple	86 days
Falgro 4L	gibberellin 3	4.0% liquid	62097-2-82917	Cherry, stone fruit, prune	0 days
Fruitone L	naphthalene-acetic acid	3.5% liquid	5481-541	Apple, pear	2 days
Fruitone N	naphthalene-acetic acid	3.5% WP	5481-427	Apple, pear	2 days
Harvista	1-MCP	1.3% SC	71297-17	Apple, pear	3 days
Maxcel	cytokinin BA	1.9%	73049-407	Apple, pear	86 days
Novagib	gibberellin 4+7	1.0% liquid	62097-7-82917	Apple	—
Perlan	cytokinin BA+gibberellin 4+7	1.8% + 1.8% liquid	62097-6-82917	Apple, pear, sweet cherry	—
Pomaxa	naphthalene-acetic acid	3.5% liquid	73049-487	Apple, pear	2 days
Pro-Gibb 4%	gibberellic acid 3	4% liquid	73049-15	Cherry, stone fruit, prune	0 days
Promalin	cytokinin BA+gibberellin 4+7	1.8% + 1.8% liquid	73049-41	Apple, pear, sweet cherry	—
Pro-Vide 10SG	gibberellin 4+7	10% SG	73049-409	Apple	—

Table 17.2.1 Insecticides and acaricides

NOTE: *Always read product label to confirm required PPE.*

Product	EPA Reg. No.	Common Name	REI (hrs)	Applicator PPE	Early Entry PPE
*Pounce 25 WP	279-3051	permethrin	12	abc	cfk
*Proclaim 5SG	100-904	emamectin benzoate	12/48(E)	acef	cfhk
§PyGanic 1.4EC	1021-1771	pyrethrins	12	acf	cfk
*Rimon 0.83EC	66222-35-400 (NY SLN 10-0001)	novaluron	12	acfh	cefh
Savey 50DF	10163-250	hexythiazox	12	abc	abc
§Seduce Insect Bait	67702-25-70051	spinosad	4	ac	bck
Senstar	59639-243	pyriproxifen/ spirotetramat	24	acf	cef
Sevin XLR Plus	61842-37	carbaryl	12	acfj	cfjk
*†Sivanto Prime 1.67SL	264-1141	flupyradifurone	4	acf	fgk
Spear-Lep	88847-6	biological peptide	4	abch	bchk
SPLAT OFM 30M-1	80286-1	pheromone	4	acfh	afhk
§Surround 95WP	61842-18	kaolin	4	acl	ac
*Vendex 50WP	70506-211	hexakis	48	dfghijl	cfhk
§Venerate XC	84059-14	*Burkholderia* spp. strain A396	4	abchl	cfhk
*†Verdepryn 100SL	71512-34-88783	cyclaniliprole	4	acf	cfhk
*†Versys Inscalis	7969-389	afidopyropen	12	acf	cef
§Virosoft CP4	72898-4	insecticidal virus	4	abch	abch
*†Voliam Flexi WDG	100-1319	thiamethoxam, chlorantraniliprole	12	acf	cfk
*†Vydate 2L	352-372	oxamyl	48	dfghijl	dfghj
*Warrior II 2.08 CS	100-1295	lambda-cyhalothrin	24	acfh	cfk
Zeal Miticide1 72WS	59639-138	etoxazole	12	acf	acf

Table 17.2.2. Fungicides and bactericides

NOTE: *Always read product label to confirm required PPE.*

Product	EPA Reg. No.	Common Name	REI (hrs)	Applicator PPE	Early Entry PPE
Academy	100-1529	difenoconazole & fludioxonil	–	abc	–
Actigard 50WG	100-922	actibenzolar-s-methyl	12	abc	cfk
*Agri-mycin 50	55146-98	streptomycin	12	acfhl	cfhk
Aliette WDG	264-516	fosetyl-Al	24	abch	cfhk
Apogee 27.5%	7969-188	prohexadione calcium	12	acf	cfk
*Aprovia	100-1471	benzovindiflupyr	12	dfghij	dfgh
Badge SC	80289-3	basic copper chloride & copper hydroxide	48	acf	dfgjh
Badge X2	80289-12	copper oxychloride & copper hydroxide	48	acfh	dfgjh
Bravo Weather Stik	66222-276	chlorothalonil	12	acf	cfhk
Bravo Ultrex	66222-277	chlorothalonil	12	dfghijl	dfghj
Cabrio EG	7969-187	pyraclostrobin	12		cfk
Captan 50WP	66330-234	captan	24 (E)	achil	cfhk
Captan 80WDG	66222-58	captan	24(E)	acfhil	cfhk
§Champ Formula-2 4.6F	55146-64	copper hydroxide	48	acfh	cfhk
C-O-C-S WDG	34704-326	copper oxychloride & basic copper sulfate	48	acfh	efghj
Cueva Fungicide	67702-2-70051	octanoic acid	4	acf	acf