2020 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.

2020 Cornell Pest Management Guidelines for Commercial Tree Fruit Production

Authors

Arthur Agnello (Department of Entomology, Geneva, NY; *Editor, insect and mite management, characteristics of crop protectants, general pest management*)

Bryan Brown (New York State Integrated Pest Management Program, Geneva, NY; *weed management)*

Julie Carroll (NYS IPM Program, Geneva, NY; *integrated pest management*)

Lailiang Cheng (Section of Horticulture, Ithaca, NY; *nutrient management*)

Kerik Cox (Section of Plant Pathology and Plant-Microbe Biology, Geneva, NY; *disease management, characteristics of crop protectants, general pest management*)

Paul Curtis (Department of Natural Resources, Ithaca, NY; *wildlife damage control*)

Amara Dunn (NYS IPM Program, Geneva, NY; *biological control*)

Michael Helms, (Pesticide Management Education Program, Ithaca, NY; *pesticide information*)

Terence Robinson (Section of Horticulture, Geneva, NY; *growth regulators, nutrient management*)

Special Appreciation

Special appreciation is extended to Robin Bellinder, Deborah Breth, David Kain, and Andrew Landers for their contributions to this publication. Additionally, the authors acknowledge the helpful assistance of the research staff of Cornell University at Geneva and Ithaca, as well as county fruit extension specialists and educators in preparing these guidelines.

Cover photo: Empire harvest, Milton, NY. (*Photo: Peter Jentsch, Cornell University Hudson Valley Research Laboratory, Highland, NY.*)

4 SPRAYER INFORMATION *(continued)*

10 NUTRIENT MANAGEMENT OF APPLE ORCHARDS *(continued)*

11 APPLES *(continued)*

13 CHERRIES *(continued)*

15 APRICOTS *(continued)*

17 APPENDICES *(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.___________

$$\text{MPH} = \underline{\hspace{2em}} \quad \frac{\text{ft traveled}}{\text{sec traveled}} \times \frac{60}{88} = \underline{\hspace{2em}}$$

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**)
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)**
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; (Captec) Micro Flo **(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)**
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)**
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)**

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) BASF **(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)**
metconazole – (Quash) Valent (**F**)
methomyl – (*Lannate) DuPont **(I)**
methoxyfenozide – (*†Intrepid) Dow AgroSciences **(I)**
metiram – (Polyram) BASF **(F)**
metrafenone – (Vivando) BASF **(F)**

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

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

Trifloxystrobin (Flint, Gem, Flint Extra) is a strobilurin fungicide. Like Sovran, Flint is an excellent protectant and should be used in this manner. Flint provides good control of apple scab and powdery mildew but is only moderately effective against cedar apple rust and is weak against quince rust. Flint also provides excellent control of sooty blotch and flyspeck and good control of black rot bitter rot. Gem is the formulation registered for control of stone fruit diseases such as cherry leaf spot, scab, and mildew on stone fruits.

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

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

Warning: *Procure is no longer effective against apple scab in many NY orchards because the pathogen has developed resistance to the SI fungicide group. *Procure may fail to control other disease where the pathogen populations have become resistant to SI fungicides.

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

5.3 Bactericides

Kasugamycin (Kasumin 2L) is a bactericide used for fire blight of apples and pears. It is formulated as kasugamycin hydrochloride in a 2.3% liquid solution. Kasugamycin is applied at bloom at the rate of 64 fl oz/100 gal for fire blight control, and it can be used in combination with wetting agents to enhance efficacy. It should be applied only in conjuction with disease forecasting models. It can be applied until 90 days prior to harvest, but Kasumin may not be applied after petal fall. Kasugamycin should not be applied in orchards that have been fertilized with animal waste/manure. Also, animal grazing in treated orchards is prohibited and posting of restriction sign around the application perimeter is required

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

Lifegard (*Bacillus mycoides* isolate J) is a natural systemic acquired resistance inducer labeled for apples against fire blight. The material acts by inducing natural plant defenses to protect against invasion and migration of the fire blight bacterium. Younger trees and young shoot tissue will respond better to the product than older trees with heart wood tissues. 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), which retards host growth. Lifegard is made as 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. Repeat application can be made throughout bloom and a petal fall to restrict the development of fire blight.

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

Streptomycin (Agrimycin, Streptrol, Streptomycin, Firewall) is a bactericide used for control of blister spot on 'Crispin' apples and fire blight of apples and pears. It is formulated as streptomycin sulfate in a 17% wettable

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	
flutriafol ()	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	—

Table continues on next page.

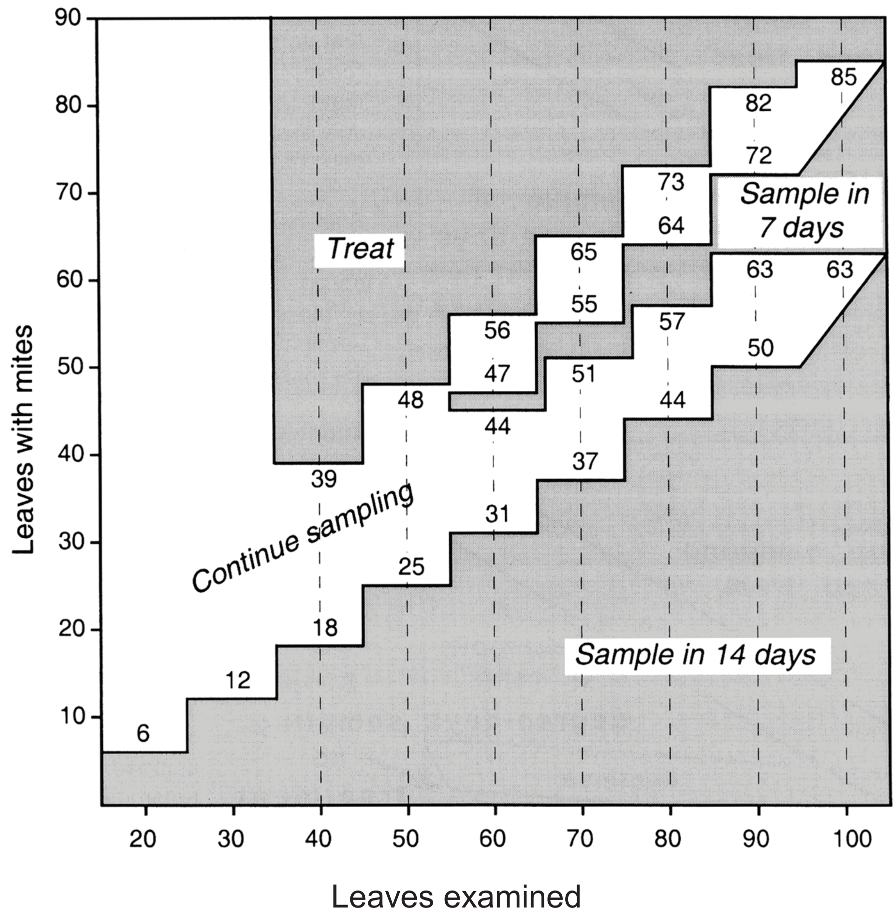
7 Insect and Mite Management

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
†Nexter (pyridaben)	21	—	0	—	—	—	2	—	—	3	—	—	—	—	—	—

Table continues on next page.

Figure 7.1.6. Mite Sampling Chart – Threshold = 7.5 Mites/leaf (August 1-15)



- This procedure involves examining middle aged leaves for motile mites (any stage except eggs). Use this chart, which corresponds to a mite density of 7.5 mites per leaf, from August 1-15. You will not be counting mites, but will only determine whether they are present or absent on each leaf sampled.

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

- Using a magnifier, examine the top and bottom surface of each leaf for motile mites, and keep track of the number of leaves containing motile mites. When all 20 leaves have been examined, compare this number with the numbers on the above decision guide. If the number of leaves with mites is equal to the values on the stairstep lines, the decision is the one shown in the area immediately below the value (example: For "39" after sampling 40 leaves, the decision is "Continue sampling"; for "18" the decision is to "Sample in 14 days"). When the counts fall into any of the shaded regions, sampling is stopped and a decision is made to either treat, or else re-sample in 7 or 14 days. If the counts fall in the .Continue sampling" zone, take and examine more leaf samples in batches of 10 (5 per tree) until the counts fall into one of the shaded regions. If you reach one of the resample zones, the population is below threshold, and should remain so for at least the number of days stated. Return at the designated time and conduct another sample. If the resample date falls after August 15, there should be no further need for additional samples or miticide sprays this season.

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.

NOTE: A more extensive list of weeds controlled by various tree fruit herbicides can be downloaded as a Microsoft Excel file at: http://lof.cce.cornell.edu/submission.php?id=321&crumb=pests|pests.

Trade Name(s) (*active ingredient*)	WSSA Group	AG	AB	PG	PB	WBV	YN	BW	HN	CT	SB	PW	RW
†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; **AB** = Annual broadleaves; **BW** = Bindweeds; **CT** = Canada thistle; **HN** = Horsenettle; **PB** = Perennial broadleaves; **PG** = Perennial grasses; **PW** = Pigweeds; **RW** = Ragweed; **SB** = Smooth bedstraw; **WBV** = Woody brush, vines; **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.

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

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]
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	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		50	12		[8.5]
		Kocide 3000 O	3.5-7.0 lb/acre 1.11-2.3 lb/100 gal water	HIG	48		
		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	
	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]
	M4	Captec 4L	0.5-1.0 qt/100 gal water	UDH	24		[2.1,2.2]
	M4	Captan 4L	1.0 pt/100 gal water	UDH	24		
	U12	Syllit FL	1.5 pts/acre				[2.15]
	9	Scala	7.0-10.0 fl oz/acre	72	12		

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.

[11.1c] *Danitol will also provide suppression of European red mite.

[11.1d] Movento must be used with a spray adjuvant that has spreading and penetrating properties.

[11.1e] *†Vydate applied in the summer against leafminer will also control apple aphid.

11.3.3 Apple Maggot

• Biology & Cultural

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

• Monitoring & Forecasting

Refer to the NEWA Apple Insect Models website (newa.cornell.edu/index.php?page=apple-insects) for current information on the occurrence, development and management of this pest in your specific location.

• 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.

[1.1] Do not apply this product while bees are foraging; do not apply until flowering is complete and all petals have fallen. If an application must be made when managed bees are at the treatment site, the beekeeper providing the pollination services must be notified no less than 48 hours prior to the time of the planned application so that the bees can be removed, covered or otherwise protected prior to spraying.

[1.2] Not registered for use in Nassau or Suffolk Counties.

[1.3] Must be applied in combination with a non-ionic surfactant or horticultural oil (not a dormant oil).

[12.1] *Asana and *Warrior applied against other pests during this period will also control apple maggot. Suggested action threshold: capture of 1 fly on red sphere trap hung in block, or of 5 flies on red sphere baited with apple volatiles.

[12.1a] 2-4 sprays at 14-day intervals beginning late June to early July.

[12.1b] *Danitol will also provide suppression of European red mite.

[12.1e] Suppression only; for best results, use the highest rate listed.

[12.2] Frequent applications (7-10-day intervals) of §Surround and maximal coverage (minimum of 100 gal/A) are advised while there is active foliar growth.

[15.4] Multiple applications of thiamethoxam-containing products in pome fruit require applicator to not exceed a total of 0.172 lbs a.i. per acre per growing season.

[17.1a] For suppression only; use 12.0 fl oz/A for best results.

[26.4d] For best performance, use *†Exirel with an effective adjuvant.

11.3.4 Apple Rust Mite

• Biology & Cultural

Occurs from late June to harvest, particularly on varieties with pubescent leaves; does not generally coincide with high red mite populations, as feeding tends to condition foliage to be less suitable for red mite development. Low numbers are valuable as prey for predator mites. Injury is a yellowish browning of leaves or white blotches on upper leaf surfaces.

• Pesticide Application Notes

[13.2] Use a maximum of 2 miticide applications per season; *†Envidor and Magister limited to 1 application per season. Suggested action threshold: >200 mites/leaf.

11.3.5 Black Stem Borer

• Biology & Cultural

A recent emergent pest, this is an ambrosia beetle that occurs throughout the season starting in mid- to late April, infesting apple trees that are physiologically stressed from flooding, drought, cold injury or disease; trees in low-lying, poorly drained sites are especially vulnerable. Adults often

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

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.

11.5.3 Variety Requirements

Materials and concentrations for the major apple varieties in New York are listed in Table 11.5.1. Important: DPA retards chlorophyll loss in Golden Delicious and, therefore, should not be used unless the apples have developed full yellow color at harvest.

The very low susceptibility of Empire to scald indicates that it can be safely stored without any preservative treatment. However, if preservative treatment is demanded, then use 1000 ppm DPA in the drench solution.

11.6 Growth Regulator Use In Apples

11.6.1 Chemical Thinning

Fruit thinning is a management practice that reduces yield in the current season but results in increased fruit size and also increased return bloom and yield in the next season. Large fruit size is best obtained with consistent cropload reductions each year through chemical thinning. The use of growth regulating chemicals to thin apple trees is not an exact science and each grower must weigh and evaluate the many factors that affect chemical thinning response in deciding on a thinning program. Although the recommendations in this section are based on research and experience, growers are cautioned that their success with chemical thinning depends on many factors and they should use these recommendations only as a guide.

11.6.2 Weather Factors That Affect Thinning Response

Frost. Frost before application of thinners can greatly increase the amount of thinning obtained from chemical thinners. Frost at bloom can damage fruitlets and reduce seed set, which can result in increased natural drop and greater chemical thinning response. Frost can also damage spur leaves, resulting in greater chemical uptake and thus greater thinning response. Wherever flowers and leaves have been damaged by frost, extreme caution should be used with chemical thinners. Typically, lower rates would be used in such cases. Surfactants and oil additives should be avoided following a frost and may cause overthinning.

Sunlight Levels before Application. The amount of sunlight for the 3-5 days preceding application of chemical thinners

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
Banter SC, WDG	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
Burkholderia spp. strain A396						
§Venerate XC	0	0	0	0	0	0
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
*†Besiege CS-SC	21	14	14	14	21	14
chlorpyrifos						
*Lorsban 4EC, *Lorsban Advanced 3.76EC	PB/28(A)	—	21	14	PB	PB
Lorsban 75WG	PB/28(A)	—	14 or 21(C)	PB	PB	PB
Chromobacterium subtsugae						
§Grandevo	0	0	0	0	0	0
clofentezine						
Apollo 4SC	45	21	21	21	21	—
cyantraniliprole/cyazypyr						
*†Exirel	3	3	3	3	3	3
cyantraniliprole/abamectin						
*†Minecto Pro	28	21	21	21	28	21
cyflumetofen						
Nealta	7	—	—	—	7	—
cyfluthrin						
*Baythroid XL 1E, 2EC, *Leverage 360	7	7	7	7	7	7

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
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	abch	cfhk
§Virosoft CP4	72898-4	insecticidal virus	4	abch	bchk
*†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	–
*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
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
Captec 4L	66330-239	captan	24	acfhi	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
§Cuprofix Ultra 40 Disperss	70506-201	basic copper sulfate	48	ac	efghj
Double Nickel 55	70051-108	*Bacillus amyloliquefaciens*	4	abcl	bck
Double Nickel LC	70051-107	*Bacillus amyloliquefaciens*	4	abcl	bck
Echo 720	60063-7	chlorothalonil	12	acfhl	cfhk
Echo 90DF	60063-10	chlorothalonil	12	acfhl	bchk
Elevate 50WDG	66330-35	fenhexamid	12	acf	cfk
Ferbam Granuflo	45728-7	ferbam	24	afl	cfk
Fireline	80990-1	oxytetracycline HCl	12	cdfhl	cdfh
Firewall	80990-4	streptomycin	12	acf	efg
Flint	264-777	trifloxystrobin	12	acf	cfk
Flint Extra	264-826	trifloxystrobin	12	acf	cfk
*†Fontelis	352-834 (NY SLN 130003)	penthiopyrad	12	ac	fck
GEM 500 SC	264-826	trifloxystrobin	12	acf	cfk
Indar 2F	62719-416	fenbuconazole	12	acfj	cfk