Home Fruit Disease and Insects

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Overview

Growing fruits in the home orchard or garden can be an interesting and satisfying hobby, as well as a source of nutritious food for the home gardener. Tree fruits and small fruits require considerable care, and the needs of tree fruit plants and small fruit plants differ considerably. Generally, the flowers and fruit of most fruit varieties should be protected from diseases and insects by protective sprays from early pre-blossom time until near harvest. Gardeners who don't wish to maintain their fruit plantings on a weekly basis may be disappointed with their harvests.

There are no shortcuts to quality fruit production. Production of blemish-free fruit requires applying pesticides according to the manufacturer's label instructions. The number of protective sprays required per season varies, depending on the kind of fruit and the number of blemishes the grower will tolerate. It requires a greater number of protective sprays to grow a clean crop of apples or peaches than it does a crop of blackberries or strawberries. If a home grower is not interested in producing blemish-free fruit, but will tolerate a few disease or insect scars on the fruit surface, the number of protective sprays is reduced.

The spray schedules in this publication are designed to assist the home fruit gardener in producing fruit for home use, not necessarily of market quality. Thus, the number of suitable protective pesticides that are specified and the number of applications recommended are reduced to a minimum. Several pesticide manufacturers have one-package, general-purpose fungicide and insecticide mixtures on the market that are specially prepared for home fruit growers. If these mixtures are used in accordance with the recommendations on the label, they should provide satisfactory control of the pest for which they are recommended. For any protectant pesticide to be effective, it must be applied thoroughly at the proper time and cover all leaves and fruit, since protectants are meant to prevent disease and insect damage, not cure it.

Information on insect and disease identification and monitoring, including many color photographs, is available in the Mid-Atlantic Orchard Monitoring Guide. This is available from the Natural Resource, Agriculture, and Engineering Service, (607) 255-7654, as NRAES-75. Information may also be obtained on the Web at the Virginia Fruit website at http://www.virginiafruit.ento.vt.edu.

General Cultural Controls

- **Canopy Management (Grape) –** In-season canopy management (shoot thinning, shoot positioning, fruit thinning, leaf pulling) is a very important management tool, not only to control vigor and yield of the grape crop, but also to manage diseases. Many grape pathogens require moisture (rain water, high humidity, etc.) to have successful infection, thus, good air circulation can reduce the risk of infection. In addition, grape powdery mildew thrives under shaded conditions, thus, it is important for leaves to have good sun exposure.
- **Sanitation** – Remove mummified fruit from trees, and dropped fruit from the ground. These can harbor inoculums of fruit diseases (e.g. grape black rot), complicating later chemical control and increasing reliance on pesticides. Some insects are also fostered by allowing dropped fruit to remain, such as the apple maggot and spotted-wing drosophila. For some pests, it is important to harvest promptly, because these pests attack fruit as they approach ripeness, and infestations can worsen if ripe fruit are allowed to remain on the plant. Examples are spotted wing drosophila in berry crops, and strawberry sap beetle.
- **Host vigor** – Maintain proper levels of host vigor. Nutrient-deficient trees are more prone to some diseases and insects; conversely, overly vigorous trees are more vulnerable to other pests.
- **Pruning** – Improve spray coverage and shorten drying time through good pruning practices. Trees should be "opened up" to allow spray and sunlight penetration. Prune out all dead and decaying branches because such wood may harbor insects and diseases. Remove all healthy prunings from the tree because these can be colonized by rot fungi and increase inoculum levels of some rot diseases. Keep the height of the trees low to enable good coverage.
- **Thinning** – It is important to thin fruit properly to provide good disease and insect control. Thin all tree fruits so that the mature fruits will not touch each other. Protectant pesticides cannot effectively cover fruits that touch each other; hence, this provides a place for insects and diseases to become established.
- **Tree size** – It is almost impossible to produce high-quality fruit in the home orchard on old, large trees because the spray pressure commonly used is inadequate to force the pesticides to the tops of such trees. Therefore, old trees should be replaced with dwarf or semi-dwarf trees that are allowed to reach a height of no more than 12-15 feet.

- **Ground cover management –** Grape root borer is increasing in severity in Virginia grapes. If a weed-free strip is maintained in the vine row, most young larvae die of desiccation as they penetrate the soil surface to reach the roots (unless the vineyard is irrigated). Alternatively, if soil is pulled into a mound about 8-12" high along the vine row after pupae have formed and left until fall, adult moths are unable to escape the soil (the mound must be pulled down again in the fall).

General Biological Controls

Disease-resistant plant information – The varieties listed in nursery catalogs as "disease-resistant apples" are immune or highly resistant to scab, one of the most troublesome early season diseases. Many of them also have reduced susceptibility to powdery mildew and fireblight, but require protection against these diseases if disease pressure is high. Although they may be indicated as resistant to cedar apple rust, they are mostly untested against quince rust and would therefore require fungicide protection (with Immunox) from pink to first cover stages in rust-prone areas. All of the scab-resistant varieties are susceptible to the usual spectrum of insect pests, sooty blotch, fly speck, and fruit rots. Some scab-resistant varieties (not included below) are McIntosh types, which would not be expected to perform well in Virginia except at higher elevations.

The following scab-resistant varieties, listed in approximate order of ripening in central Virginia, are suggested for backyard trial in Virginia:

Table 3.1a - Some Suggested Scab-resistant Apple Cultivars for Virginia

Cultivar	Ripening Period Winchester, Va.	Disease rating[1]				Description/weakness
		PM	CAR	QR	FB	
Pristine	Mid- to late July	R	S	R	S	Very early, yellow apple, pleasant mild flavor with a smooth, waxy, attractive finish. Blooms heavily; must be thinned well for good size.
Williams Pride	Late July	R	S	?	MR	Early, dark red-purple apple. Large fruited, semi-tart flavor. Sometimes shows water-core or bitter pit.
Redfree	Early to mid-Aug.	S	VR	R	S	Early, sweet summer apple. Red crisp. Fruit hangs on tree well. Does not store well.
Dayton	Mid- to late Aug.	R	R	?	MR	A large attractive glossy red fruit with moderately tart flavor. An annual cropper and "grower- friendly" tree.
Scarlet O'Hara	Mid-September	S	S	S	HS	Fruit brownish red, round crisp with mild flavor; spreading growth habit.
Crimson Crisp	Early-Mid- Sept	HS	S	S	S	Fruit medium-sized with an attractive crimson red color. Firm, crisp texture with a tart, flavor. Tree is grower friendly with a spreading habit.
Jonafree	Mid- to late Sept.	R	HS	S	S	Mid-season firm red apple, slightly tart. Flavor improves after storage. Similar to Jonathan.
Liberty	Late September	R	VR	S	MR	Attractive red over yellow skin. High-quality dessert apple. Good well-balanced sweet-tart flavor which improves after storage. Annual bearer. Being planted for direct sales in the Northeast.
Sundance	Early to mid-October	HS	VR	R	MR	Late season, yellow fruit. Golden Delicious type.
Enterprise	Mid-October	R	VR	S	MR	Good quality, late season, large, smooth glossy red apple. Stores well. Susceptible to a fruit spotting disorder correctable with calcium sprays.
GoldRush	Mid-October	HS	HS	S	MR	Excellent quality fruit, good storage apple. Firm, Golden Delicious type. Fruit may crack.

All of these cultivars are immune to scab based on ratings in Winchester, Va., and Kearneysville, W.V.

[1] PM = powdery mildew; CAR = cedar apple rust, QR = quince rust; FB = fire blight
VR = very resistant. No control needed in a home orchard.
MR = moderately resistant. Control only needed with fire blight susceptible rootstocks or under high disease pressure.
R = resistant. Control only needed under high disease pressure.
S = susceptible. Control usually needed where disease is prevalent.
HS = highly susceptible. Control always needed where disease is prevalent.

Table 3.1b – Some Suggested Wine Grape Varieties for Virginia[1]

	Disease rating[2]					Sensitivity to chemicals[3]		
Cultivar	**BR**	**DM**	**PM**	**Bot**	**Phom**	**S**	**C**	**Description**
Cayuga white	MR	MS	MR	MR	MR	No	Slight	Early white variety with a vigorous, highly productive vine. A good cold hardiness.
Chambourcin	MS	MS	MS	MR	MS	Yes	No	A mid to late season red variety. Its loose cluster provides a good resistance to fruit rots.
Chardonel	MS	MS	MS	MR	?	No	?	Ripens early to mid-season, cold hardy white variety with high acidity and low pH.
Corot noir	MR	MS	MR	MR	?	No	No	A mid- to late-season red variety with moderate cold hardiness. It tends to have low acidity and low pH.
Noiret	MR	MS	MR	MR	?	Slight	No	A mid-season red variety with moderate cold hardiness. It tends to have low acidity and low pH. Sensitive to the strobilurin fungicides.
Norton/ Cynthiana	MS	MS	MR	MR	MR	Yes	No	A late- to very late season red variety. Good cold hardiness. Early bud break. High pH.
Traminette	MR	MS	MR	MR	?	Yes	?	A mid-season white variety with a good cold hardiness.
Vidal blanc	MR	S	MS	MR	MR	No	No	A mid- to late-season white variety with a good cold hardiness. Non-grafted vines are susceptible to tomato and tobacco ring sport virus.

[1] For more complete list of cultivars, please refer to this web site: http://www.fruit.cornell.edu/grape/index.html

[2] BR = Black rot, DM = Downy mildew, PM = Powdery mildew, Bot = Botrytis bunch rot, Phom = Phomopsis cane and leaf spot, MR = Moderately Resistant, MS, Moderately Susceptible, S = Susceptible, ? = Unknown.

[3] S = Sulfur, C = Copper

- **Friendly insects/animals/organisms** – Many insect and mite pests of fruit crops are naturally controlled by predatory or parasitic insects, unless these beneficial species are disrupted by certain sprays. Important beneficial groups are predatory mites, lady beetles (some specializing in aphids, some on mites), syrphid fly larvae, lacewings, minute pirate bugs, aphid midges, and parasitic wasps. Many of these are illustrated in the Virginia Fruit website, with the address given in the overview.
- **Companion planting** – This is an ongoing area of research. Some companion plants provide a beneficial nectar and pollen source for beneficial species. This is a complex area however, and some such plants can actually harbor pest species. Geraniums have been cited as useful for Japanese beetle control because of a paralytic effect after feeding. This is not useful in some crops, however, which are more attractive than the geraniums (e.g. raspberries). This area of the guide is subject to later updates.

General Mechanical Controls

Netting can keep birds from consuming ripening fruit. Another use for this approach is during outbreaks of periodical cicada (17-year cicada). Netting of appropriate mesh may be more effective than pesticides available to the home fruit grower. Growing berries under row covers or in greenhouses can help reduce injury by spotted-wing drosophila.

General Chemical Controls

Sprayers/spreaders – Various sprayers and dusters are available to the home fruit grower. Generally, however, dusters do not work well when applying pesticides to home fruit trees. Therefore, the home fruit grower is limited to a choice of small hand or power sprayers to protect his fruit crops. There is no one sprayer that works for all home fruit spray problems. Hence, the grower must make the decision on what type of sprayer to purchase for a particular planting.

If there are only a few trees (five to eight) to spray, along with a few strawberries and brambles, a hand sprayer of the compressed-air type would probably be adequate. However, the type of hand sprayer where the compressed air tank is pumped-up before one starts to spray is relatively poor because there is an uneven air pressure at different times during the application of the protectant pesticide. The "knapsack" type of sprayer which is hand pumped as the operator moves along, has the advantage

in that the pressure in the tank remains relatively constant as the spray is being applied. The overall reach of the hand sprayers can be extended somewhat by removing the short brass tube where the nozzle is attached, and replacing it with a 4- to 6-foot piece of copper tubing purchased at a hardware store. Have the copper tubing threaded with the same size threads as the brass tube so that the nozzle will fit properly. This inexpensive alteration of the hand sprayer facilitates coverage of trees up to 12 feet in height and also will help the operator avoid being covered by the spray mist that falls when spraying overhead.

For the home fruit growers who have 25-50 fruit trees, as well as home lawns and gardens to spray, a small power-driven sprayer would probably be more satisfactory. These sprayers are distributed by various dealers. They come with tank capacities of 15-50 gallons and pumps that will deliver from 50-350 pounds of pressure per square inch. Therefore, start an inquiry about three months before you plan to buy one of these sprayers and read all the information that you can obtain on the different types. Check with your nearest pesticide dealer, farm machinery distributors, large department stores, local extension staff, and an Extension Specialist at a land grant university with pest management expertise. After the correct size has been decided, purchase a standard brand so it is easier to obtain parts or have the sprayer repaired when necessary.

Tips on sprayer maintenance: Some pesticides are corrosive to metals; therefore, a sprayer must be properly cleaned after each use. For best results with any sprayer, study the owner's manual and follow instructions carefully. Keep hose clamps tight and the trigger mechanism working properly without dripping. At the end of the day or treatment, thoroughly wash the nozzle(s), hose pipes, and tank both inside and out. **Caution**: Never wash a sprayer where the water will puddle or stand where children or pets will play in it. There may be enough toxicant in the wash-water to cause serious injury to children or pets. Never store a sprayer where small children can play with it. There may be enough of the pesticide toxicant left on the sprayer, if a child rubs its hands over the sprayer then puts them in its mouth, to cause serious illness or even be fatal.

Garden hose sprayers: There are several types and models of the garden hose type sprayer. They attach to a garden hose and the pressure is derived from the water system rather than from a hand or motor pump. When tested, garden hose sprayers seem less effective than other types, but may be best suited to gardeners who cannot lift a 3- to 4-gallon sprayer. When purchasing, be sure that the sprayer is designed to use wettable powders. Since wettable powders do not dissolve in water, but remain in suspension, be sure that the screen over the end of the suction hose is not so fine that it will become clogged with pesticide particles. Read and follow the manufacturer's instructions.

When and How to Apply Home Fruit Pesticides

Timing: Proper timing and thorough application of pesticide sprays are essential for quality fruit production. Make certain that the spray reaches all parts of the tree and covers all of the foliage and fruit. If coverage is not uniform, it may be necessary to adjust or change the parts (disk) of the sprayer nozzle. It is difficult to determine the exact time or date to start the protective spray, since there are usually several kinds and varieties within a home fruit planting. A simple general rule, however, may be used for most home fruit plantings. Start the protectant pesticide spray program in the spring when the young foliage is approximately 1/4 inch long on the earliest variety to breakbud and spray all varieties at the same time. It is much easier to follow this procedure than it is to attempt to spray each variety according to its stage of growth. Some fruit varieties need spray application during the full blossom stage of some varieties. This spray usually will not interfere with pollination because no insecticides are included with the fungicides recommended for use at this time.

How much spray per tree: There is no accurate measure of how much spray to apply per tree. There are too many variables in the types of sprayers that are available, the wetability of the leaves and fruit of the different species, the amount of wetting agent (surfactant) contained in the different pesticides, and the extreme variability of the environment (wind blowing, dry, hot, wet, cool, etc., each of which influences wetting the foliage) when the protectant pesticide is being applied. A general rule of

Table 3.2 - How Much Spray Per Tree with Different Dimensions

Height in feet	Spread in feet	Gallons per application[1]
5-8	3-6	1
8-10	4-8	1-2
10-15	8-15	4-5
15-20	15-25	8-10
20-25	25-30	11-14
25-30	30-35	15-18

[1] As indicated in the text, these amounts are only for guidance. The environment at the time of spraying, as well as how the tree is pruned, will influence the amount of spray that will properly cover a tree.

thumb is to spray the foliage and fruits until droplets form and begin to run or drip off. For the beginner, the amount of pesticide suggested for coverage of different size trees (Table 3.3) will be helpful.

Protective equipment to be worn while applying chemicals: Long sleeves and gloves should be worn while applying pesticides. Specific requirements for Personal Protective Equipment (PPE) will be included on the product label. These vary with the pesticide.

Organic Chemical Controls

Contrary to the belief of many, organic crop production does not mean no pesticides are applied. It means that any pesticides applied must be natural products. These must be approved by OMRI (Organic Materials Review Institute). This designation will be included on the label. Many insecticides and fungicides based on natural products have a shorter residual life and so must be applied more frequently.

Precautions

- **Humans** – Generally, most pesticides are toxic or poisonous to animals and/or some plants. For the most part, however, pesticides recommended for homeowner use are selected from the least toxic of those available. Nevertheless, they should be kept in a locked container and kept out of reach of children and animals. Be safe, do not take pesticides lightly. When using pesticides, never breathe the dust or spray and always wear a pair of rubber gloves and goggles. Do not smoke or eat while using pesticides. Destroy pesticide containers as directed on the container label. Always change clothes and wash with soap and water immediately after completing the job and launder your clothes before they are worn again.
- **Bees** – Bees are important parts of the fruit arthropod community. Not only are they required for the production of the fruit crop, but careless spray practices can harm bees even after the fruit pollination period. Do not apply insecticides at bloom. Be conscious of the fact that blooming weeds also attract bees, and insecticides will harm these bees as well. Puddles near sprayed areas may become contaminated with spray material, and pose a threat to bees that come to the puddles for the water they need to cool the hive.
- **Animals (pets, birds, etc.)** – Keep pets away from pesticide preparations, and avoid spills that can result in puddles of pesticides. Some pesticide labels prohibit allowing livestock to feed on pomace or fallen fruit; check the label.
- **Water** – Many pesticides (including fungicides and herbicides) are toxic to fish. Use care around bodies of water.
- **Plants** – Do not use 2,4-D weed killing mixtures or other herbicides in the spray tank used to spray fruit, flowers, vegetables, or lawns. As a rule, herbicides cannot be satisfactorily removed from the spray tank; this may cause injury to cherished plants. Use herbicides in sprayers kept for that purpose only.

When to call a professional

- When a pest cannot be identified with resources available, or if plants decline despite control efforts, seek advice from your local VCE office. If you cannot treat plants adequately because of equipment limitations, seek a professional service.

Special Considerations

- **Invasive plants, animals or insects** – Regulatory agencies strive to prevent the establishment of exotic invasive insects and diseases. This is a difficult job in this era of increased international movements of humans and goods, and occasionally pests slip through. An example is the recent introduction of brown marmorated stink bug (http://www.virginiafruit.ento.vt.edu/BMSB.html), which was first detected in eastern Pennsylvania in 1996, and has since expanded throughout much of the United States, causing serious damage to fruit and other crops.
- **A new invasive insect:** In January 2018, a new invasive insect was found in Virginia. Spotted lanternfly came to Virginia from southeastern Pennsylvania, and had been expanding its range in the Shenandoah Valley and Piedmont. SLF feeds on more than 70 different hosts, and can cause significant injury on some. Some of our important fruit crops are on the host list: grape, caneberry, blueberry, stone and pome fruits, and hops; grape is the most vulnerable commercial crop. Populations can build to create a severe nuisance in residential areas as well. An eradication effort has been implemented in 2018, and a quarantine was established by VDACS in May 2019. More information on the quarantine program is posted (https://www.pubs.ext.vt.edu/ENTO/ENTO-319/ENTO-319.html). An online training is available to allow certification as part of the quarantine effort (https://register.ext.vt.edu/search/publicCourseAdvancedSearch.do?method=doPaginatedSearch&cspIndex=true&showInternal=false&courseSearch.courseDescriptionKeyword=slf). SLF is now beginning to cause economic loss in our agricultural crops, particularly grapes. Fruit growers should be aware of the pest's appearance, and how to handle finds you may make in your operations. For information on SLF appearance and management in vineyards, refer to our fact sheet (https://www.pubs.ext.vt.edu/ENTO/ENTO-323/ENTO-323.html). For updated information and updated distribution maps, visit the spotted lanternfly page in the Virginia Cooperative Extension web site (https:ext.vt.edu). For updated control information and updated distribution maps, visit the SLF page in Virginia Fruit (https://www.virginiafruit.ento.vt.edu/SLF.html). To report suspected discoveries, please contact your Virginia Cooperative Extension agent.

Guidance on How to Find Specific Recommendations

- Is it a disease or an insect or should both be checked?
- Timing of chemical applications

Links to Useful Sources of Information

- **Diagnostic keys or aids** – The Virginia Fruit website contains biological information, usually with photographs, of important fruit pests and beneficial species. Different sections of the website deal with apples, pears, stone fruits, grapes, and small fruits. The URL (web address) is: http://www.virginiafruit.ento.vt.edu/

General Information on Pesticides for Home Fruit Use

Fungicides

Captan is a 50% wettable powder fungicide used to control apple scab, peach brown rot, grape downy mildew, and other fungus diseases of orchard fruit and brambles. Note that Captan does not control powdery mildew or apple rust diseases, or grape black rot, which are common in Virginia. Do not use with spray oils or within one week of an oil application.

Chlorothalonil (Fung-onil) is registered for control of several early-season diseases on peach, nectarine, apricot, cherry, plum, and prune. Consult the label for disease control spectrum and use directions. Do not apply after petal fall on plums and prunes or after shuck-split stage (about two weeks after petal fall) on peaches, nectarines, apricots, and cherries. Chlorothalonil is not registered for grapes.

Copper materials There are numerous copper products available to home fruit growers. On apples and pears, copper can be used as a green-tip bud spray for fire blight suppression or a scab fungicide. On peaches and nectarines, coppers can be used in the fall at leaf drop or at bud swell in the spring for leaf curl control or bacterial spot suppression. On grapes, coppers can be used throughout the season, but many winemakers prefer not using coppers (or captan or sulfur) within 3-4 weeks of harvest. Some copper products are approved for organic production. However, if coppers are used in successive sprays at full rates during the growing season, they can cause fruit russetting and purple spots on apple leaves and shothole and defoliation of peach and nectarine leaves. Copper soaps, which tends to have a lower copper concentration, can be used on some grape cultivars which are known to be sensitive (cause burn on leaves) to coppers.

Fruit Tree & Plant Guard by Bonide is a multi-purpose product that combines two fungicides (pyraclostrobin and boscalid) and an insecticide (lambda-cyhalothrin). It is registered for control of a wide range of diseases and insects on pome fruits (apple, crabapple, loquat, mayhaw, oriental pear, pear, and quince) and on stone fruits (apricot, sweet cherry, tart cherry, nectarine, peach, plum, plumcot, and prune). Fruit Tree & Plant Guard should be especially useful on fruit rots and other summer diseases of apples, and fruit rots and leaf spots of pears, and fruit rots of stone fruits. It is of particular interest on pears, where the availability of products for home orchards is quite limited. Because lambda-cyhalothrin and similar insecticides may be toxic to orchard predators and cause an increase in mite populations which can be deleterious to pear foliage, it is suggested that timely oil sprays with thorough coverage be applied to pears in late winter and early spring to suppress both mites and pear psylla. Apply Fruit Tree & Plant Guard at the rate of 2 fl oz per gallon of mix. On pome fruits do not make more than four applications of per year, and do not apply it closer than 21 days to harvest. On stone fruits do not make more than five applications of Fruit Tree & Plant Guard per year, and do not apply it closer than 14 days to harvest.

Immunox (Spectracide Immunox Multi-Purpose Fungicide) is a 1.55% emulsifiable concentrate myclobutanil fungicide formulation registered for apples, stone fruits (peaches, nectarines, cherries, apricots, plums, and prunes), and grapes. The Immunox rate is 1/2 fluid ounce per gal on all tree fruit crops. On apples, it is particularly suggested as a supplement for control of cedar apple rust, quince rust, and powdery mildew and is also effective for scab. For management of these diseases it should be used on a 7- to 10-day schedule from green tip until about one month after petal fall. Do not apply Immunox to apples more than 10 times per season and do not treat within two weeks of harvest. On stone fruits, Immunox is registered for control of brown rot and powdery mildew. Treatments may be applied to stone fruits the day of harvest but no more than 7 times per season. On grapes, Immunox controls black rot, anthracnose, and powdery mildew. Mix 2 fluid ounces per gal of water and treat every two weeks. Do not treat within two weeks of harvest and do not apply to grapes more than six times per season. Immunox is also registered for numerous ornamental diseases. **Do not confuse Immunox with Immunox Plus, a formulation which is not registered for edible fruits.**

Mancozeb Flowable is a multi-purpose fungicide that is formulated as a 4 lb active ingredient per gallon of flowable product. It provides supplemental protective control against a broad range of apple and pear diseases including: apple and pear scab, cedar-apple rust and quince rust, black rot, bitter rot, sooty blotch and fly speck, and Fabraea leaf spot on pears. Mancozeb is comparable to Captan as a protective fungicide, but Mancozeb is registered for use on pears, is more effective against rusts and is compatible with oil and Immunox sprays on apple. Apply Mancozeb Flowable at the rate of 1.5 teaspoons per gallon of mix (equivalent to the label rate of 2.4 qt per acre at 300 gallons of water per acre). On pome fruits do not make more than four applications per year, and do not apply it after bloom. On grapes, mancozeb can be used to protect against downy mildew, black rot, and Phomopsis, but do not apply mancozeb closer than 66 days to harvest. **Mancozeb is not registered for use on stone fruits.**

Table 3.3a - Effectiveness[1] of Fungicides for Control of Tree Fruit Diseases

Disease	Captan[2]	Copper[3] (Bordeaux)	Fung-onil	Spectracide Immunox	Lime Sulfur	Sulfur	Fruit Tree & Plant Guard	Mancozeb Flowable
Apple								
Scab	G	-	-	E	G	F	E	G
Powdery mildew	-	-	-	E	G	G	E	-
Rusts	-	-		E	F	-	F-G	G
Sooty blotch, fly speck	G	-	-	-	F	-	E	G
Fruit rots	G	-	-	-	F	-	E	G
Peach and Nectarine								
Leaf curl	-	G	E	-	G	-	-	-
Scab	G	-	-	-	-	G	G	-
Brown rot	G	-	-	E	-	G	E	-
Plum								
Brown rot	G	-	-	E	G	G	E	-
Black knot	G	-	-	-	-	-	-	-
Cherry								
Brown rot	G	-	-	E	-	G	E	-
Leaf spot	G	-	G	-	-	-	E	-

[1] E = excellent; G = good; F = Fair; - = not recommended, not registered, or not applicable.

[2] Do not mix captan with any oil. The combination causes leaf-spotting damage.

[3] **Caution:** if coppers are used in successive sprays during the growing season, they can cause fruit russetting and purple spots on apple leaves and shothole injury of peach and nectarine leaves.

Note: Always check label for crop and disease, rate, timing, and minimum days to harvest.

Table 3.3b – Effectiveness[1] of Fungicides for Control of Grape Diseases

Disease	Captan[2]	Copper[3] (Bordeaux)	Immunox (Spectracide)	Lime sulfur[3, 4]	Mancozeb	Neem Oil	Phosphorus acid	Potassium bicarbonate	Sulfur[3]
Phomopsis	G	-	-	F	E	-	-	-	-
Black Rot	-	-	E	F	E	-	-	-	-
Downy mildew	G	G	-	F	E	-	E	-	-
Powdery Mildew	-	G	E	G	-	F	-	G	G
Botrytis	G	-	-	-	F	-	-	-	-
Anthracnose	F	-	F	G	-	-	-	-	-

[1] E = excellent; G = good; F = fair; - = not recommended, not registered, or not applicable

[2] Do not mix captan with any oil. It will cause damage to grapevines.

[3] Some varieties are sensitive to copper or sulfur; please check their sensitivity. Copper octanoate fungicides are less phytotoxic to grapevines.

[4] Rate will be different based on the target pathogen and time of application; please refer to the label

Note: Always check label for crop, disease, rate, timing, and minimum days to harvest.

Phosphorous acid (e.g., Agri-Fos) is a fungicide to control downy mildew of grape. It is best to be used with mancozeb or captan because these two provide protective effect and phosphorous acid provides kick-back activity. Do not use with copper spray or within a week of a copper spray.

Wettable Sulfur is a fungicide that is used for the control of apple scab, peach brown rot, powdery mildew, and other diseases. It is a finely-ground powder to which a small amount of wetting agent has been added. Do not use in high temperatures. Do not use with oil sprays or within two weeks of an oil spray.

Insecticides/Miticides

Carbaryl (Sevin) 80% soluble powder is recommended for control of Japanese beetle. Use separately as necessary about June 15 for Japanese beetle. Add to the spray beginning June 15 and continue at 10-14 day intervals for remainder of season for apple maggot control. Do not spray apples for six weeks after bloom with Carbaryl as it is a thinning agent and will cause some fruit to drop. Carbaryl reduces populations of beneficial predators; use alternative insecticides when available.

Dormant Spray Oil diluted with water is effective in suppressing scale insects and red mite egg hatch. It should be used only on dormant trees or with up to 1/2-1 inch of green showing. OMRI approved.

Malathion, an organophosphate, is used to control aphids, mites, and scale insects in the crawler stage. A 57% emulsifiable concentrate formulation and an 8 lb emulsion are the most commonly available for homeowners. Malathion does not persist long. Check label for fruit crops registered.

M-Pede is a potassium salt of fatty acids effective against soft-bodied insects and mites. It may be applied until the day of harvest, with a 12-hour restricted-entry interval. Apply to wetness; higher volumes can cause fruit injury. May cause marking of table grapes and pears. Do not apply after delayed dormant stage of pears. OMRI approved.

Specific Disease and Insect Biology

Apple Diseases

Apple Scab, a fungus disease of apples, is found in all countries where apples are grown. This disease causes almost as much loss to apple growers as all the rest of the apple diseases put together. The scab fungus attacks leaves, stems, and fruit. The apple scab fungus overwinters in the dead apple leaves under the trees. During the winter months, the fungus forms small, black, flask-like structures in the leaves called perithecia. The mature perithecia are filled with minute spores called ascospores. Spring rains cause the perithecia to discharge ascospores into the air where they are carried by the air current to the new green leaves and opening fruit buds of the apple tree. The first visible sign of infection is a light brown or olive colored spot. Depending on the temperature, first visible symptoms may show as soon as eight days after the initial penetration by the ascospore. Hundreds of new spores called conidia, or summer spores, are formed in the infection lesion. Rain disperses the conidia from the infection lesion to healthy leaves and to the young developing fruit, where they start a secondary infection. Thus, the fruit and foliage must be protected from greentip until harvest with protectant fungicides.

Powdery Mildew, a fungus disease, is of major importance on several apple varieties grown in Virginia. Varieties such as Ginger Gold, Idared, Jonathan, Rome, Granny Smith, and Stayman have been the most seriously affected. York, Fuji, and Delicious have been less severely attacked. The powdery mildew fungus attacks twigs, leaves, blossoms, and fruit. The disease appears with the opening of buds that were infected the previous season. The first symptoms are felt-like patches of fungus mycelium on the lower surfaces of leaves, which soon become crinkled and curled. The fungus spreads rapidly and soon covers the entire leaf surface with mycelium and a powdery coating of spores. The entire growing terminal may be affected. The terminals become stunted and may be killed as a result of the disease. Blossoms may become infected from the overwintering mycelium in the dormant buds. In this case, the floral parts are so badly deformed that no fruit is produced. Fruit infection occurs as early as pink stage and appears on the fruit as a net-type russet. Protectant sprays are required from early pink through mid-summer to suppress this disease.

Apple Rusts are serious apple diseases in the Appalachian area. There are two kinds of apple rusts, cedar rust and quince rust. Red cedar is the alternate host for both the cedar-apple and quince rusts and severity of these diseases is related to the distance of the apple tree from infected cedars in the area. Cedar rust, caused by a fungus, appears as orange or greenish yellow spots on the fruit and as yellowish to orange spots on the leaves. Leaf infection results in extensive defoliation and devitalization of the tree during dry periods. York Imperial, Rome Beauty, Golden Delicious, and Jonathan are among the most susceptible of the varieties grown in Virginia. Cedar-apple rust galls, or "cedar apples," are located on the twigs of cedar. They develop masses of gelatinous spore horns during rainy periods, early in the growing season, from which spores are discharged that infect the apple. Apple quince rust, incited by a fungus, has caused heavy fruit losses of Red Delicious, Stayman, Winesap, Rome, and York under Virginia conditions. The disease appears as sunken or deformed areas ranging from deep green to brown, usually on the calyx end of the fruit. The infection goes deep into the fruit and makes it worthless. Quince rust does not affect apple foliage. Starting in mid-summer, quince rust sometimes produces tufts of fluorescent orange spores that are conspicuous and may be incorrectly identified as cedar apple

rust. Protectant sprays are required from early pink through June 10 for control of the rust diseases. Immunox is the most effective fungicide listed here that adequately protects against rusts. In some years rust infection occurs later than petal fall. Where rust pressure is heavy, two or three sprays of Immunox may be required to cover the six-week period of fruit and foliage susceptibility from pink to four weeks after petal fall.

Black Rot of Apple, a fungus disease, occurs throughout the warmer regions of the world. The fungus attacks fruit, leaves, and limbs. Infection of the fruit may occur from the time the fruit is initiated until harvest. Also, the fungus may cause postharvest decay. The disease first appears as a small brown spot any place on the surface of the fruit. The black rot infection develops slowly, and complete decay of the fruit usually does not occur until the fruit is mature. As the rot progresses, the decayed tissue is firm and leathery. Eventually, the decayed fruit becomes shrunken and mummified. Finally, the rotted fruit turns black; hence, the common name black rot. Symptoms first appear on the leaves as small, dark purplish spots. As the spots enlarge, they are irregularly shaped. The margins of the lesions retain their purple cast while the centers become brown to yellowish brown; thus, the popular common name frogeye leaf spot. Some types of spray injury may also look like frogeye leaf spot.

Botryosphaeria Rot of Apple, caused by a fungus, is widespread and attacks many host plants. Fruit infection may occur from the time of initiation to harvest. The small lesions (rot infections) first appear as small, circular, brown spots surrounded by a conspicuous red area. The infections start slowly but progress rapidly as the fruit approaches maturity. The lesions on fruit of the red skinned varieties may bleach during the decaying process; thus, the disease has acquired the name "white rot." Completely rotted fruit exudes droplets of a clear gummy fluid and eventually mummifies.

Bitter Rot of Apple, caused by a fungus, is a serious disease of apples in Virginia. It is most serious during warm, moist summers. These conditions frequently exist in the eastern and southern sections of Virginia. Bitter rot begins on the fruit as small, light brown spots just under the skin. These spots grow rapidly in warm, moist weather. Masses of spores are formed in pustules arranged in concentric rings on the surfaces of the spots. Rain disperses spores to other fruit and branches below where they may start a new infection. The rotted fruit hangs on the tree and dries out. It is important that all mummified fruit and cankered branches be removed during the pruning operation, since they may supply inoculum for new infections.

Sooty Blotch and Fly Speck are a complex of surface blemish disease symptoms that commonly appear on apples in late summer and fall. A range of symptoms may appear together, and they are caused by as many as 60 different fungi. Sooty blotch appears as more or less sooty smudges or spots, not; while fly speck appears as small circular black spots that occur in groups and resemble true fly specks. The development of these diseases is favored by moderate temperatures and high humidity. Infection may occur as early as June, but late-summer infection is the major concern with these diseases. Both diseases are superficial and do not rot the fruit, although sooty blotch-affected fruit may shrivel in storage as a result of the ruptured cuticle.

Fire Blight, caused by the bacterium *Erwinia amylovora,* is one of the most destructive diseases of apple and pear in the United States. The fire blight bacterium may attack any part of the tree from the roots to the leaves. The disease usually appears in the spring as blossom, leaf, and twig blight. Infected blossoms suddenly wilt and soon turn light to dark brown. As the disease progresses down the pedicel, the tissue becomes water-soaked and dark green. If the infection moves beyond the pedicel, it invades the fruit spur and spreads out into the leaves. The leaves wilt and the entire spur growth turns brown on apple, or dark brown to black on pear, and dies. The blighted leaves remain attached throughout the growing season. The fire blight bacteria may move down the twig and into branches and limbs, where the infection becomes established. These infected branches and limbs may become entirely girdled with the infection, which spreads upward and downward. A severely infected apple or pear tree may have so many blighted terminals that it has the appearance of being scorched or burned by fire. Thus, the name fire blight was coined for the disease.

Twig blight begins with an infection of the young terminal shoots. The invading bacteria progress more rapidly down the shoots or twigs than in the fruit spur. Infected shoot tissue becomes watery, dark green, and has an oily appearance. The leaves on the blighted terminals, as in spur blight, turn brown on apple or dark brown to black on pear and remain attached throughout the growing season, and in many cases they remain attached after the healthy leaves have fallen in the fall. A characteristic symptom of twig-blight is the bending of the blighted terminal, which resembles a shepherd's crook.

Fruit infection may occur on apples and pears. The fruit becomes water-soaked with numerous exuding droplets of bacterial ooze. The diseased fruit is firm and later leathery. Still later, the fruit shrivels, turns brown on apple or black on pear and usually remains attached to the spur. Infection of some very susceptible dwarfing rootstocks such as M.9 and M.26 will cause death of trees younger than seven years. The newer "Geneva-series" apple rootstocks are more resistant to fire blight and collar rot and these are suggested for planting if available. The causal bacteria overwinter in living host tissue at the margins of cankers on the larger twigs, branches, and trunk. In the spring, highly infectious, milky-white to cream colored droplets of ooze containing tremendous numbers of bacteria are produced at the margins of active cankers. The bacterial ooze usually appears first when the trees are in the late-pink to early-bloom stage of development. Wind-blown rain and insects help spread the causal bacteria from the oozing cankers to the developing blossoms and young leaves where new infections may develop.

Fire blight control, like most bacterial diseases, is difficult and expensive. As a rule, fire blight is much worse on tissues that are succulent. Thus, home fruit growers should attempt to manage their trees so as to prevent extensive rapid growth of young shoots in varieties of pear and apple especially susceptible to blight. The excessive use of nitrogenous fertilizers and the cultivation of the orchard to promote excessive growth and excessive pruning should be avoided. Water sprouts or suckers should be removed as they are formed on susceptible varieties. Their removal will often prevent canker formation on limbs, trunks, and roots of the trees. Avoid any pruning during the blossom period and immediately thereafter. Large populations of sucking insects are present in the trees during bloom, and it has been demonstrated that sucking insects spread the bacteria to blossoms and open wounds. Thus, the use of effective insecticides "following bloom" to control such insects as aphids, plant bugs, and leaf hoppers is advisable when blossom blight occurs. Streptomycin sulfate, an antibiotic, is the most effective material for fire blight control. Use streptomycin at the rate of 60 ppm of dilute spray. The first application should be completed just before the center blossoms begin to open. Additional applications should be made at 5-day intervals until all petals have fallen. This will usually mean two or three sprays. CAUTION: Spray to wet only; antibiotics are usually locally systemic and over spraying may cause foliage chlorosis and reduce fruit set.

Boron Deficiency Corking is a cluster of dead cells, tan to brown in color, which is the most common symptom that indicates a lack of boron in an orchard. Aside from nitrogen, boron is the nutrient most commonly deficient in Virginia orchards. They may occur anywhere in the fleshy portion of the fruit, their location being affected by the variety and severity of the deficiency. Boron deficiency corking in apple fruit can be confused with other types of cork. A fruit analysis showing less than 10 ppm of boron is sometimes used to confirm the diagnosis. Affected fruit may ripen and drop prematurely. Boron deficiency can be corrected through the application of 0.5 lb of agricultural borax to each mature tree. This rate may be increased to a pound for very large trees and should be reduced to 0.25 lb for dwarf or young trees. The treatment to be effective during a given year should be applied during the preceding fall or winter. Applying boron every third year should control this disorder. Control also can be obtained by applying 1.0 lb of solubor per 100 gallons in two sprays during late bloom and early post bloom each year. If applied at too high a rate or too close to the trunk of young trees, soil applications of borax can cause injury. It should be applied in an area 3 to 6 feet from the trunk of young trees and near the drip line of older trees.

Table 3.4 - A Checklist of Major Apple Diseases in Virginia

Disease	Usual stage of occurrence[1]	Infection conditions
Early season		
Scab	Green tip to whenever conditions are favorable	Extended wet periods, 33º to 76ºF
Powdery mildew	Leaves; tight cluster, until shoot growth stops	Dry weather, 50º to 75ºF
Cedar apple rust	Tight cluster to 2nd cover	Extended wet periods above 56ºF
Quince rust	Pink to 1st cover	Extended wet periods above 56ºF
Fire blight	Bloom to mid-season	Open blossoms, daily mean above 60ºF, wetting
Mid-season		
Frogeye-leaf spot (Black rot)	Pink to harvest	Moderate and wet, optimum 80ºF
Moldy core	Bloom to petal fall	Moderate and wet
Brooks fruit spot	2nd to 4th covers	Moderate and wet
Sooty blotch	2nd cover to harvest	Moderate and wet, optimum 65ºF
Fly speck	2nd cover to harvest	Moderate and wet
Late season		
Black rot	Pink to late season	Warm and wet periods, hail
Bitter rot	Mid- to late season	insect or mechanical fruit injury
White rot	Mid- to late season	

[1]Refer to spray schedule for apples, Table 3.5 for spray timings.

Bitter Pit is a type of corking that is distinct from other types. It consists of small cork-like clumps of tissue just beneath the surface of the fruit. These spots appear as dark areas and are concentrated at the calyx end of the fruit. One distinctive characteristic of this type of corking is that it does not appear until near harvest time or during fruit storage. As with other types of corking, bitter pit is more common on some varieties than on others. Grimes Golden is more susceptible than most varieties grown in Virginia. The maturity of the fruit at harvest affects the occurrence of bitter pit. Early harvested fruit is more susceptible than fruit picked at maturity. Calcium chloride sprays have generally reduced the severity of bitter pit from 50-90%. This treatment might be justified where severe bitter pit has been experienced. To reduce bitter pit, use one-half ounce of calcium chloride per 1.0 gallon of water. Make four applications at two-week intervals starting 10 weeks before picking time.

Apple Insects

Aphids – Three species of aphid frequently cause problems: (1) Rosy apple aphid – This pink-bodied aphid causes severe puckering and knotting of the fruit. Infestations may be noted by the curling and wrinkling of leaves near young apples, but, by this time, much of the fruit will be lost. At weekly intervals, beginning when the leaves are about 1/4 inch long, look for aphids in the foliage. (2) Woolly apple aphid – This aphid affects the root systems primarily, but may be found in cracks and wounds on the upper portions of the trees. They produce a white, waxy mass over their reddish-purple bodies. On the roots, they cause galls and an increased number of secondary roots, which stunt the tree and reduce production. Rootstocks in the MM series will reduce root damage from woolly apple aphids. (3) Green aphids – This mix of spirea aphids and apple aphids is most commonly seen on apple trees. When aphids infest more than an average of 4 leaves per shoot, treatment is justified, especially if less than 20% of the colonies harbor natural enemies. A variety of predators assist in controlling green aphids.

Codling Moth – Presence of this pest is usually recognized by a hole bored into the side or blossom end of the fruit. This larva may completely destroy the infested fruit. It is a pinkish-white worm approximately 1/2 inch long with a brown head. At maturity, the larva leaves the apple and falls to the ground or climbs to the tree to pupate under the bark or in debris on the soil surface where it overwinters. There are two or three generations in Virginia. Oriental fruit moth may cause similar injury in apples, especially late in the season.

Plum Curculio – Injury is in the form of small crescent-shaped cuts in the skin of small fruits. An egg is deposited in a small hole at one end of the incision. Depressions in the fruit usually develop at such sites. Examination reveals a grayish-white worm inside with a brown head capsule and no legs. Infested fruits fall prematurely and are usually hard, knotty, and misshapen. In some years, there may be two generations east of the Blue Ridge Mountains.

Apple Maggot – This black-and-white fly is a pest in orchards in the northeastern states; in Virginia the headless, legless larva is found mainly in backyard trees and abandoned orchards. Picking up dropped fruit promptly will aid in its control by preventing entry into the ground for pupation. Maggots cause winding brown paths through the fruit. Most adults emerge the following season. For a small number of backyard trees, commercially available apple maggot traps (red spheres or yellow panels) can help reduce infestation, with one trap hung per tree.

Mites – Two species are frequently injurious to apple foliage, the two-spotted spider mite and the European red mite. They produce a stippling of the leaves by puncturing the cells of the leaf and sucking out the juices. The two-spotted mite spins a silk webbing over the infested area, which explains the origin of the name "spider mites." The two-spotted mite may be green or orange in color, depending on host plant, time of year, and maturity of the mites. They have two large dark spots on the lateral margins of their abdomens. The European red mite is dark red with dorsal hairs on humps of the body and has tan colored legs. A hand lens is required for accurate observation of these parts. **Do not apply miticides on a preventative basis.** Many predators of mites are native to Virginia and can help control this pest if not killed by sprays. More information on these predators can be obtained on the Virginia Fruit website, http://www.virginiafruit.ento.vt.edu/.

Leafrollers – There are several species of leafroller moths that affect fruit in Virginia, notably redbanded leafroller, tufted apple bud moth and variegated leafroller. The first-generation redbanded leafroller adults emerge during April. Adult moths are approximately 3/8 inch long and reddish-brown with silver and gray markings. The larvae, which cause the fruit damage, are slender, yellowish green worms that reach a length of 5/8 inch when full-grown. Several generations are found per year in Virginia. The second and third generations cause the most damage. Tufted apple bud moth and variegated leafroller appear somewhat later, and have two generations per year. Injury to fruit is caused by the feeding of the caterpillars on the skin and upper layers of flesh.

San Jose Scale – The San Jose scale overwinters as an immature scale on the bark of twigs and limbs of a wide variety of fruit trees. The scales mature rapidly in the spring. Young, called "crawlers," are produced in large numbers. They have legs and spread to all parts of the tree, or settle down, insert their beaks into the bark, and begin to secrete a waxy scale covering. Scales feed on the sap of trees. They may kill a young tree within two to three years when a heavy infestation exists. When scales set-

Table 3.5 - Spray Schedule for Apples

Time of Application	Materials to Use Fungicide or Insecticide per Gallon of Water[1]	To Control	Remarks
Green tip At bud swell	Copper + superior oil	Mites, scales, and scab	Follow manufacturer's recommendations as to amounts. Apply when a half-inch of green shows at buds.
Delayed Dormant When leaves are 1/2-3/4 inch long	1.3 tbsp Immunox 1.55% EC or 1.5 tsp Mancozeb 4F + 2.0 oz permethrin 2.5% or esfenvalerate (use label rates)	Scab, powdery mildew, rust, mites, aphids, leafrollers	Scab infection may occur at this time. Important spray for mites and aphids.
Pre-pink First pink in floral buds	Same as delayed dormant buds, plus 2.5 fl oz M-Pede	Scab, powdery mildew, rust, aphids, mites, leafrollers	Important for rust and powdery mildew control.
Pink When flowers have separated just before bloom	Same as delayed dormant + streptomycin 15W[2] 1.0 tsp	Scab, powdery mildew, rust, apple rot, fire blight, aphids, mites, green fruitworms, leafrollers	Add streptomycin for fire blight control according to manufacturer's recommendations.
Bloom	1.3 tbsp Immunox 1.55% EC or 1.5 tsp Mancozeb 4F + 1.0 tsp streptomycin 15W[2] **Protect Bees - Do Not Use Insecticide**	Scab, rust, powdery mildew, apple rots, fire blight	Follow label recommendations for rate of streptomycin.[2]
Petal Fall When most of the petals have fallen **First Cover** 10 days after petal fall and **Second Cover** 14 days after first cover	1.3 tbsp Immunox 1.55% EC + 1.5 tbsp Captan 50W or + 1.5 tsp Mancozeb 4F + 2.5 oz M-Pede or 2.0 fl oz permethrin 2.5% or esfenvalerate (use label rates) or 0.25-0.5 lb Surround at Home	Scab, rust, powdery mildew, rots, fire blight, curculio, codling moth, aphids, mites, boron deficiency[3]	If fire blight is present, add streptomycin to this spray. Important sprays for codling moth control. Surround at Home effective for plum curculio, not codling moth. Apply 3 sprays at 7 day intervals beginning at petal fall. Permethrin and esfenvalerate are toxic to orchard predators. Do not apply Mancozeb closer than 77 days to harvest, and do not make more than seven applications per year.
Third Through Fifth Cover Sprays At 14 day intervals	1.5 tbsp Captan 50W plus same insecticides as petal fall or 2 fl oz Fruit Tree & Plant Guard	Sooty blotch, flyspeck, Brooks spot, rots	If mites become a problem, add 5.0 tbsp of M-Pede (2% solution) to the spray. If Japanese beetles become a problem, add 2.0 tbsp Sevin 50W. (Do not use Sevin until 30 days after bloom unless fruit thinning is desired.) Do not make more than four applications of Fruit Tree & Plant Guard per year, and do not apply it closer than 21 days to harvest.
Sixth And Seventh Cover Sprays 2 week intervals, may not be required for early maturing varieties	1.5 tbsp Captan 50W plus same insecticides as petal fall or 2 fl oz Fruit Tree & Plant Guard	Apple rots, sooty blotch, flyspeck, apple maggots (AM), codling moth, bitter pit[4]	Same as 3rd-5th covers. Generally speaking, apply protectant sprays up to 25-30 days before harvest. Sticky sphere traps are available that can control AM on a few backyard trees. Pick up all drop fruit to help control AM. Do not make more than four applications of Fruit Tree & Plant Guard per year, and do not apply it closer than 21 days to harvest.

[1] Materials to use are given for one gallon, but the user can easily calculate the required amount of material to make five, ten, fifteen, twenty, or twenty-five gallons of spray (See Table 3.1).

[2] Streptomycin sulfate (15-21%) should be used at 60 PPM (approximately 1.0 tsp/gal).

[3] See Apple Disease section for discussion of boron deficiency and its control.

[4] See Apple Disease section for discussion of bitter pit and its control.

Table 3.6 - Spray Schedule for Pears

Time of Application	Materials to Use Fungicide or Insecticide per Gallon of Water[1]	To Control	Remarks
Dormant to green tip	Superior oil + copper	Mites, scales, psylla, fire blight	Follow manufacturer's recommendations as to amounts. Apply when a quarter-inch of green shows at buds.
Green cluster bud	Superior oil + 1.5 tsp Mancozeb 4F or esfenvalerate (use label rates)	Psylla	Scab infection may occur at this time. Important spray for mites and aphids.
Pre-pink First pink in floral	1.5 tsp Mancozeb 4F or Sulfur 90W 2.0-4.0 tbsp + 2.0 fl oz permethrin 2.5% or esfenvalerate (use label rates)	Scab, powdery mildew, psylla, aphids, mites, leafrollers	
Pink When flowers have separated just before bloom	Same as Pre-pink + streptomycin 1.0 tsp	Scab, powdery mildew, fire blight, aphids, mites, green fruitworms, leafrollers	Add streptomycin for fire blight control according to manufacturer's recommendations.
Bloom	1.5 tsp Mancozeb 4F or Sulfur 90W 2.0-4.0 tbsp + 1.0 tsp streptomycin 15W[2] **Protect Bees - Do Not Use Insecticide**	Scab, powdery mildew, apple rots, fire blight	Also follow label recommendations for rate of streptomycin. [2]
Petal Fall When most of the petals have fallen **First Cover** 10 days after petal fall and **Second Cover** 14 days after first cover	1.5 tsp Mancozeb 4F or Sulfur 90W 2.0-4.0 tbsp + 2.0 fl oz permethrin 2.5% or esfenvalerate (use label rates) or 0.25-0.5 lb Surround at Home	Scab, powdery mildew, rots, fire blight, curculio, codling moth, aphids, mites, boron deficiency	If fire blight is present, add streptomycin to this spray. Important sprays for codling moth control. Surround at Home effective for plum curculio, not codling moth. Permethrin and esfenvalerate are toxic to orchard predators. Do not apply Mancozeb closer than 77 days to harvest, and do not make more than seven applications per year.
Third Through Fifth Cover Sprays At 14-day intervals	Sulfur 90W 2.0-4.0 tbsp plus same insecticides as petal fall or 2 fl oz Fruit Tree & Plant Guard	Sooty blotch, flyspeck, leaf spot, rots	If mites become a problem, add 5.0 tbsp of M-Pede (2% solution) to the spray. If Japanese beetles become a problem, add 2.0 tbsp Sevin 50W. (Do not use Sevin until 30 days after bloom). Do not make more than four applications of Fruit Tree & Plant Guard per year, and do not apply it closer than 21 days to harvest.
Sixth and Seventh Cover Sprays 2-week intervals, may not be required for early maturing varieties	Sulfur 90W 2.0-4.0 tbsp plus same insecticides as petal fall or 2 fl oz Fruit Tree & Plant Guard	Fruit rots[3], leaf spot, sooty blotch, flyspeck, apple maggots (AM), codling moth	Same as 3rd-5th covers. Generally speaking, apply protectant sprays up to 25-30 days before harvest. Sticky sphere traps are available that can control AM on a few backyard trees. Pick up all drop fruit to help control AM. Do not make more than four applications of Fruit Tree & Plant Guard per year, and do not apply it closer than 21 days to harvest.

[1] Materials to use are given for one gallon, but the user can easily calculate the required amount of material to make five, ten, fifteen, twenty, or twenty-five gallons of spray (See Table 3.1).

[2] Streptomycin sulfate (15-21%) should be used at 60 PPM (approximately 1.0 tsp/gal).

[3] Fruit Tree & Plant Guard is more effective than Sulfur for rot control.

tle on the fruit, reddish rings occur around the insect on the fruit skin. There are two generations during the growing season, one occurring in late May or early June and the other in August. A third generation occurs after harvest.

Gypsy Moth – As the gypsy moth moves southward through Virginia, it will be seen on apple trees in outbreak years. It is susceptible to many spray materials, including Dipel. Time sprays to the end of the wave of immigration of first stage larvae. This is around petal-fall.

Peach, Nectarine, Cherry, Plum

Specific Disease and Insect Biology

Peach Leaf Curl, a fungus disease, is found throughout the world where peaches are grown. The disease is destructive and causes economic losses under Virginia growing conditions. Peach leaf curl is carried overwinter by tiny fungus spores lodged on the surfaces of twigs and buds of the peach or nectarine trees. With the coming of spring and the swelling of the buds, if conditions of moisture and temperature are suitable, the spores germinate, and those that come into contact with the young developing leaves cause an infection. The infected leaves are thickened, and, as they develop, the leaf becomes folded with edges curling inward, so that the undersurface of the leaf is a series of concaved chambers. Very shortly after leaf symptoms appear, it turns red to purple and becomes extremely obvious. The bright color soon fades into a yellowish brown to brown, and the leaf withers and falls off. One thorough application of lime sulfur, copper (Bordeaux), or Fung-onil during November or early spring before bud break will control this disease. If mid-season defoliation due to bacterial spot is a problem, use a copper product at leaf drop in the fall and/or in early spring before bud break for control of leaf curl and suppression of bacterial spot. However, if coppers are used in successive sprays at full rates during the growing season, they can cause shothole injury to peach and nectarine leaves.

Peach Scab, a fungus disease, is widespread in peach and nectarine growing areas of Virginia. The main loss from the disease is from the unsightly blotches on the fruit. The disease first appears on the fruit as small, poorly defined, olivaceous spots less than 1/16 inch in diameter, usually on the upper exposed surface of the fruit. The spots may be numerous on the upper surface of the fruit, more on the sides, and nearly absent on the protected lower surface. The spots may merge to form a uniform, dark-olivaceous, velvety blotch over the surface of the scabbed area. Since the cork area cannot expand with growth of the fruit, fissures or cracks appear in the fruit, providing avenues for brown rot infection.

Brown Rot, caused by a fungus, is the most destructive disease of cherry, nectarine, peach, and plum. The brown rot fungus may overwinter on old, decayed fruit, also called mummies, on the ground, mummies on the tree, and in twig cankers. The brown rot fungus becomes active about the time pink begins to show in the buds, provided there is sufficient rainfall. The brown rot fungus spores attack the blossoms, twigs, and fruit. Blossom blight and early twig infections establish centers of infection which may supply inoculum for fruit infection during periods of rainfall throughout the growing season. Therefore, it is important to control these early infections. Brown rot on the fruit becomes more evident as the fruit approaches maturity. The first evidence of the rot is the appearance of a small, circular, brown spot that enlarges very rapidly as the fruit approaches maturity. The rotted fruit soon becomes covered with ash colored tufts of conida. These masses of spores supply inoculum to infect other fruit. The greatest loss from brown rot occurs from fruit rot in the orchard, in transit, and in the market place. The fungus decays or rots a mature fruit very rapidly. Remove mummified fruit during the dormant season and use chemical sprays as suggested in the spray schedule for brown rot control.

Black Knot is the most conspicuous disease of plum, prune, and cherry trees. Most commercial and home-fruit growers, at one time or another, have observed the black, warty growth on twigs and branches of plum and cherry trees. Trees infected with black knot become almost worthless after a few years if no control practices are used. Twigs and branches may be girdled by the infection, and, with a large number of infections per tree, the trees go into a general decline. Black knot is caused by a fungus. It attacks many species of wild and cultivated plums and cherries including American, European, and Japanese varieties of plums and prunes and both sour and sweet cherries. The disease is destructive and widespread in Virginia. *Symptoms* – Infection occurs primarily on wood of the current season's growth. The infections are caused by small (microscopic) spores that attack the tree from bloom through late May to early June, depending on the climatic conditions. The first evidence of the disease is swelling of the infected twigs or branches during the late summer or fall of the year of infection. Ordinarily, the infected area swells rapidly and the bark is ruptured the following spring. The infection continues to develop throughout the second growing season and the life cycle is usually completed during the second spring after infection with the production of small spores (seed), called ascospores, which may start new infection centers. The elongated black swelling may be from less than an inch to more than a foot in length. The malformation may encircle the entire branch, but is usually one-sided. The cankered areas are greenish when they are first formed, but become black with age. Branches not killed by the disease may be killed by insects that enter the infected area. Infrequently, twigs or branches are deformed and turn right angles at the point of infection. *Control* – Sanitation is extremely important in controlling black knot. All the knots on small twigs and branches must be pruned out during the dormant season and burned. The cuts should be made four inches below the knots. Knots on one side of large limbs that need to be saved can be removed by cutting out the swellings. When knots are removed from a limb, the wound area should be painted with a good asphalt or oil-base paint. Close observation should be made annually during the pruning season to detect and remove any new black knot infections. Pruning alone, however, is not adequate control of the disease. The

use of a fungicide spray program (see section on recommended chemical control) along with the sanitation program will usually give good control of black knot.

Cherry Leaf Spot is a fungal disease that affects both sweet and tart cherries. The earliest symptom is a purple lesion and several lesions per leaf can cause the leaf to yellow and fall. Typically, defoliation is first noticed in the top of the tree. By midsummer all leaves are susceptible and, in a wet year, severe defoliation makes trees more prone to winter injury and death. Control is with suggested fungicides applied throughout the susceptible periods with the objective of holding the leaves on the tree until September.

Peach Insects

Scales – Four different scale insects may be found on this fruit: white peach scale, San Jose scale, terrapin scale, and European fruit lecanium. These are small insects that usually go unnoticed until they reach numbers sufficiently high that they begin to injure the tree and fruit. Terrapin scale and European fruit lecanium are usually small and shiny brown in color, whereas the San Jose scale is almost the same color as the tree bark and gives the tree a roughened appearance when the population is high. The white peach scale is easily recognized because the white females give a branch a white-washed appearance when they are abundant. All these scales have more than one generation a year on peach, reproduce rapidly, and can kill branches and even trees if uncontrolled. Terrapin and lecanium scales secrete honeydew that mars the fruit. These insects suck plant juices and gradually hinder tree development. The easiest times to control them are in the crawler stages (just after hatching from the egg). Where populations are found, make checks and spray for live scales throughout the growing season.

Shothole Borer – This small beetle is a serious pest of the young buds. They grow and reproduce in dead or dying wood in the trees. They are highly productive and have overlapping generations. They feed on the buds as well as the trunks and branches. Their common name was derived from the numerous little holes they make in the branches where emerge — resembling a branch shot by a shotgun. If the bark is removed, the wood beneath has numerous galleries and pockets with small white C-shaped larvae. Any dead or dying branch of trees should be removed as soon as possible and destroyed. Sap oozing from numerous buds and small holes in the branches is a good indication of infestation. The pest is a small black beetle about 1/16 inch long and round in shape.

Peachtree Borer – Partly grown to full grown grubs pass the winter beneath the bark of peach, cherry, plum, prune, nectarine, or apricot trees. The caterpillars are yellowish- white with brown heads, and are about 1 1/4 inch long when mature. The adult moths emerge from May to September. The adult female lays eggs on or near the tree trunk. The eggs hatch and the small grubs enter the trunk. The grubs, or "borers," feed in the tree trunk at or below ground level and will girdle and kill small trees in a single season if several borers are feeding. Borer injury is evident by masses of gum and sawdust-like "frass" occurring at the base of the tree. There is one generation per year.

Lesser Peachtree Borer – The lesser peachtree borer attacks many of the same trees as the peachtree borer. Again, this borer overwinters in various stages of development from young to full-grown larvae. After completing development in the spring, the adults can be found from April to October. The female moths may deposit eggs at any location on the tree but prefer injured areas. The larvae, or "borers," resemble those of the peachtree borer except that they are slightly smaller. The borers usually feed in the larger limbs and trunks of the trees. Injuries exude gum that contains sawdust-like particles. Limbs and trees are frequently killed by the feeding. There are two generations per year. Both peach tree borer and lesser peachtree borer may be monitored with pheromone traps. If a spray is needed, apply it two weeks after the first moth capture. Adults have slender, black bodies with white markings, and clear wings.

Oriental Fruit Moth – The larvae may severely damage new shoot growth or the fruit as they bore down the young shoots and into the fruit through the stems. They feed throughout the fruit and even into the seed. Some fruit may show no signs of damage until after picking. Trees should be examined for new or young terminals that die suddenly to determine if larvae tunneling in the shoots are the cause. There are several generations a year; the latter generations often bore into the sides of the fruit much like the codling moth in apples.

Plum Curculio – Injury is in the form of small crescent-shaped cuts in the skin of small fruits. An egg is deposited in a small hole at one end of the incision. Depressions in the fruit usually develop at such sites. Examination reveals a grayish-white worm inside with a brown head capsule and no legs. Infested fruits fall prematurely and are usually hard, knotty, and misshapen. In some years, there may be two generations east of the Blue Ridge Mountains.

Mites – See section under apples.

Brown Marmorated Stink Bug – Although there are several native stink bug species that can injure peaches and nectarines, in recent years most of this damage has been due to feeding by the invasive brown marmorated stink bug. Peaches appear to be an excellent host for brown marmorated stink bug and fruit injury from bug feeding may be found from the early stages of develop-

Table 3.7 - Spray Schedule for Cherries[1], Nectarines, Peaches, Plums[1], and Prunes[1]

Time of Application	Materials to Use Fungicide or Insecticide per Gallon of Water[2]	To Control	Remarks
Dormant Before buds begin to swell	Copper (see label for rate) + Superior oil Fung-onil 0.9 tsp	Peach leaf curl Scale, mites	Apply to nectarine and peaches only. All buds must be thoroughly covered. Follow manufacturer's recommendations. Remove and destroy all mummified fruit still hanging on the tree and on the ground. This will reduce inoculum that causes blight and the later fruit brown rot. Do not apply Fung-onil within one week before or after an application of oil.
Pink Spray Early pink to full pink	1.5 tbsp Captan 50W or Fung-onil 0.9 tsp + 1.0 tbsp Carbaryl 80S (Sevin)	Green aphids, tarnished plant bug, blossom blight, black knot	Plums and cherries are not pink, but apply spray at same stage of bud development. See comment on aphid under petal fall spray.
Blossom Sprays Apply just before first blossoms open, and when in full blossom	1.5 tbsp Captan 50W or Fung-onil 0.9 tsp **Protect Bees - Do Not Use Insecticide**	Brown rot, blossom blight, peach scab, powdery mildew, cherry leaf spot, black knot	This is an important spray, particularly late full bloom, as the deteriorating petals are susceptible to the brown rot fungus. Do not apply Fung-onil after shuck slit stage.
Petal Fall Through Fifth Cover Apply when all petals have fallen, then at 14 day intervals for 5 spray applications	1.5 tbsp Captan 50W + 1.0 tsp malathion 57EC + esfenvalerate, 1st-5th cover; use label rates or 2 fl oz Fruit Tree & Plant Guard 1.0 tbsp Carbaryl 80S	Mites, aphids, plum curculio, oriental fruit moth, Japanese beetle, brown rot, peach scab, cherry leaf spot. Cherries are vulnerable to spotted wing drosophila as they color and ripen. Spray for SWD weekly during this period, rotating insecticide groups.	Esfenvalerate is toxic to orchard predators. If mites build up, a 2.0% solution of JMS Stylet Oil may be applied at 10- to 14-day intervals against mite eggs, as long as mites persist, but do not use Captan in combination with JMS Stylet Oil or any type of oil. Malathion is not registered for aphids or oriental fruit moths on nectarines, but if used for other insects, aphid and oriental fruit moths will not be a problem. Do not make more than five applications of Fruit Tree & Plant Guard per year, and do not apply it closer than 14 days to harvest.
Pre-Harvest Apply 3 weeks and 1 week before harvest on all varieties	1.5 tbsp Captan 50W or 1.0 tbsp Immunox 1.55% **No Insecticide** (See Remarks)	Brown rot on fruit, spotted wing drosophila	If Japanese beetles are a problem, 2.0 tbsp of Sevin 50W can be added to the spray up to 1 day before harvest. Spotted-wing drosophila will often be a problem on cherry at this time. Rotate permethrin or other pyrethroid with Sevin, observing Pre-Harvest Intervals. See comments on this insect on pp. 3-19, 3-20, 3-21 and 3-23.
After-Harvest 2 weeks after harvest	1.5 tbsp Captan 50W	Cherry leaf spot	Cherries only.
Peachtree Borer Sprays These two sprays should be applied about July 15 and August 15-25 to all species and varieties	esfenvalerate, various formulations; use label rates	Peachtree borer, lesser peachtree borer	Apply esfenvalerate to trunks and large limbs only. Use according to label.

[1] Most fungicides are not specifically registered for black knot control on plums, prunes, or cherries in home fruit planting; however, where a good spray program for brown rot control is followed, black knot usually will not be a problem. To achieve effective control with fungicides, all knots should be removed and destroyed during the dormant period or when they first appear.

[2] Materials to use are given for one gallon, but the user can easily calculate the required amount of material to make five, ten, fifteen, twenty, or twenty-five gallons of spray (See Table 3.1)

ment through harvest. External injury appears as thin streams of whitish, jelly-like ooze from feeding sites, known as gummosis, and sunken, discolored and distorted areas on the surface. Internal feeding injury appears as whitish areas of corky, dead tissue that may or may not be associated with apparent external injury. There are two generations of brown marmorated stink bug in Virginia and bugs are present from about May through mid-October.

Grape Diseases

Black Rot – This is a widespread disease of grapes, and if it is not managed properly, it can cause greater loss to growers in Virginia than all other diseases combined. This disease is caused by a fungus that attacks the leaves, shoots, tendrils, canes, blossoms, and fruit. Only the youngest tissues are susceptible, and the fruits are susceptible from bloom to 4-5 weeks after bloom. The foliage infections appear in the spring as tiny, more or less circular spots. They are reddish-brown and are usually encircled by a dark brown ring. Through the coalescence of many spots, large areas of the leaf may become affected. Although spotting occurs on the foliage in the spring, the disease does not attract much attention until mid-summer when the nearly half- grown grapes begin to rot. The disease on the fruit appears as light-brownish, soft, circular spots, which enlarge rapidly, and after a few days the entire berry is discolored. The decaying berries soon begin to shrivel, and within a week they are transformed into black, hard, shriveled mummies, which may remain attached to the bunch for several weeks. The attached mummied fruit is covered with small fruiting bodies of the black rot fungus that exude infective spores during moist wet weather to start new infections on susceptible parts of the vines. These mummified fruit can serve as a source of inoculum for the next year, thus the removal of infected berries is highly recommended.

Botrytis Bunch Rot – This is a fungus disease of berries. It is often a late season disease; however, early season infection of flowers is known to be critical for the disease development. It is a common disease for tightly clustered white varieties, such as Chardonnay, but other varieties can be affected. Proper canopy management to open up the fruiting zone is a very effective means of control. You can remove 1-2 basal leaves from shoots or remove unnecessary lateral shoots to open up the canopy. Wounding events can increase the risk of Botrytis; therefore, insect management (especially, grape berry moth) and bird management (use of netting, visual, sound, etc.) can be a very effective tool. In addition, early season powdery mildew management is important for this disease because skin tissue damaged by powdery mildew can split open later in the season to create wounds.

Downy Mildew – This is a fungus disease, primarily of the grape foliage, but it can infect berries. If the disease occurs early in the season, however, the young bunches of berries may be entirely killed. The causal fungus is widespread in nature. The first evidence of the disease on the leaves often appears as light-yellow spots on the upper surfaces of the infected leaves. Later, a white moldy growth of the fungus mycelial threads and spores forms on the under surfaces of the leaves. Leaves of susceptible varieties can be defoliated in a few weeks and the clusters of fruit may be scalded by the sun. Also, vines defoliated before the ripening season cannot mature the fruit normally and the fruit is of inferior quality. As with black rot, a period between bloom to 4-5 weeks after bloom is the critical time for berry infection.

Powdery Mildew – This disease is caused by a fungus that is present in many vineyards. Because of extensive planting of French-American hybrids and *vinifera* type grapes, the disease has become one of the most economically significant diseases in Virginia. The fungus primarily attacks the foliage, cluster stems, and the berries. Powdery mildew infection appears as a superficial, grayish-white growth on the infected parts of the vine. Severely infected leaves turn brown and necrotic. If the berries are infected, the surfaces appear covered with a gray 'powdery' material. They fail to mature properly, and cracking of the fruit may allow entry of rot organisms. Mildew infection of the cluster stem may cause shelling if the fruit is not harvested immediately. As with black rot and downy mildew, a period between bloom to 4-5 weeks after bloom is the critical time for fruit infection.

Anthracnose, **or Bird's-eye Rot** – This disease is sporadic in nature and its occurrence is usually localized. Some of French-American hybrid cultivars (e.g., Vidal blanc, Marquette, etc.), and table grapes (e.g., Marquis , Mars, etc.) known to be more susceptible. The fungus overwinters in the infected canes and gives rise to infective spores during the spring. The fruit, young shoots, tendrils, petioles, leaf veins, and fruit stems may be attacked severely. Numerous spots will unite and cause girdling. Similar spots develop on the petioles and leaves. Badly infected leaves curl downward from the margins, becoming distorted and spotted and the diseased areas drop out so that the leaf appears ragged. On the fruit, the spots are circular, sunken, and ashy gray. In the late stages of the disease, the spots are surrounded by a dark margin. The name of bird's-eye rot, sometimes applied to this disease, is derived from the appearance of the spots on the berries.

Phomopsis Cane and Leaf Spot – This is a fungus disease of the leaves, trunks, and main branches of grape vines**.** The fungus can attack young leaves, shoots, fruit stems, and occasionally berries. The fungus overwinters in the infected cane or trunk tissues and produces spores April-June to cause new infections. The most easily recognized symptom is tiny yellow specs on infected leaves. When you recognize the leaf symptom, examine shoots for other symptoms. The disease occurs on new cane growth as small purple to black sunken lesions on the first 3-4 internodes. As the disease progresses, the vine either fails to put out shoots or the shoots die back after a few weeks, which is often referred as "dead-arm". These lesions may also occur on the leaf petioles or fruiting stems, which could cause premature fruit drops. The lesion on canes and trunks can exist for two to three years and cause more diseases. Apply sprays as suggested in the spray schedule for control of all grape diseases.

Table 3.8 - Spray Schedule for Grapes

Time of Application	Materials to Use Fungicide or Insecticide per Gallon of Water[1]	To Control[2]	Remarks
Dormant Before buds swell	8.0 tbsp copper sulfate + 8.0 tbsp hydrated lime (Bordeaux Mixture)	Anthracnose, Phomopsis	This spray is necessary only in vineyards where Anthracnose or Phomopsis has been a problem.
Bud Swell Spray	1.0 tbsp Sevin 80S	Grape flea beetle	Apply only if adult beetles are present in damaging numbers.
New Shoot Sprays When new shoots are 1- to 2-inches long, also when new shoots are 6- to 8-inches long.	1.0-1.5 tsp Captan + 1.0-3.0 tbs Sulfur	Black rot, downy mildew, Anthracnose, powdery mildew, Phomopsis	Rake up and destroy all mildew, dead arm, grape leaves, canes, dead twigs, and branches early in the spring to reduce disease and insect incidence. If a concern on Phomopsis is high, make sure to have a spray when shoots are 1 to 2 inches long.
Pre-bloom Spray Just before blossoms open	3.0-4.0 tsp Mancozeb flowable + 1.0 tbsp Sevin 80S + 1.25 fl oz Immunox + 1.0-3.0 tbs Sulfur	Same as new shoot spray plus berry moth, leafhopper	Important black rot spray, thorough coverage necessary for control. If there are many rain events, consider adding a Phosphorous acid (e.g., Agri-Fos) to the spray. Pre-bloom to pea size sprays are critical sprays to prevent developments of multiple grape diseases.
Post-Bloom Spray Immediately after bloom	3.0-4.0 tsp Mancozeb flowable + 1.0 tbsp Sevin 80S + 1.25 fl oz Immunox + 1.0-3.0 tbs Sulfur	Same as pre-bloom	Same as pre-bloom. If powdery mildew or black rot are problems, include Immunox. If there are many rain events, consider adding a Phosphorous acid (e.g., Agri-Fos) to the spray. You may substitute sulfur with an oil product to control powdery mildew. Make sure not to mix oil with sulfur or captan as the combination can cause damage to grapevines.
Pea Size Spray When berries are about pea size, but before they touch in clusters (7-10 days after postbloom spray)	3.0-4.0 tsp Mancozeb flowable + 1.0 tbsp Sevin 80S + 1.25 fl oz Immunox	Same as post-bloom	If Japanese beetles have appeared, use 2.0 tbsp Sevin 50W. Do not apply Mancozeb within 66 days of harvest.
Berries Touch In Cluster 10-14 days after pea size spray, and at 2 week intervals until harvest.	2.0 tbsp Captan 50W + 1.0 tbsp Sevin 80S or 0.5-2.0 fl oz Copper octanoate + 1.0 tbs Sevin 80S	Same as pea size spray plus Japanese beetle	Continue good coverage. Do not apply Immunox more than 5 times per season or within 2 weeks of harvest. Do not use Sevin XLR in combination with Captan.
Later Cover Sprays Apply at 2-week intervals until harvest	Same as berries-touch-in-cluster spray PLUS: label rate of malathion or spinosad, or pyrethrin, or zeta-cypermethrin.	Same as berries-touch-in-cluster spray plus ripe rots, spotted lanternfly	If you are concerned about Botrytis and downy mildew, keep either captan or copper spray at 2-week interval. Red varieties are vulnerable to SWD as they color and ripen. If SWD is an issue, spray weekly during this period, rotating among insecticides. Spotted lanternfly (SLF) may fly into vineyards around this time of the season. Both Sevin and spinosad are known to be effective against SLF. Do not overuse insecticides, but be prepared for re-invasion in late season.

Table 3.8 - Spray Schedule for Grapes (cont.)

Time of Application	Materials to Use Fungicide or Insecticide per Gallon of Water[1]	To Control[2]	Remarks
Grape Root Borer		In early July, mound soil 8-12 inches high around base of trunk, extending 2-3 feet from trunk crown. Pull mound down in fall or spring. Only necessary where grape root borer has been a problem. Control weeds in vine row.	Weed control near vine will cause larval mortality before caterpillars reach roots.

[1] Materials to use are given for one gallon, but the user can easily calculate the required amount of material to make five, ten, fifteen, twenty, or twenty-five gallons of spray (See Table 3.1).

[2] Captan does not control powdery mildew or black rot. If black rot is a serious problem, substitute captan with mancozeb. If powdery mildew is a serious problem, use a sulfur fungicide. If both powdery mildew and black rot are problem, consider using Immunox. Both captan and sulfur cannot be used within two weeks of an application of oil (e.g., Neem oil, and some insecticide such as Sevin XLR which contains oil). Imidan 12.5W 3.0 tbsp may be substituted for methoxychlor in the grape schedule.

Grape Insects

Grape Berry Moth – Presence of this pest is shown by berries with broad reddish spots, webbed clusters, shriveled fruit, or foliage with semicircular holes cut in foliage. Caterpillars will be found in berries, usually dark gray or gray-green. Each larva may attack several berries during its feeding period of 3-4 weeks. Clusters may also be sticky from juice from injured fruit. There are 3-4 generations per year. Removing fallen leaves in the autumn may reduce infestations.

Grape Root Borer – Adults of this species strongly resemble paper wasps flying through the vineyard. Eggs are laid on trunks and weeds, and after first stage larvae penetrate the soil they feed on grape roots for almost two years. If declining vines are seen, probe around roots within a foot of the trunk with a hand trowel. Large caterpillars may be found in or on hollowed roots. Soil may be mounded around trunks to a depth of 8-10 inches around July 1 to prevent emerging adults from reaching the surface. Pull the mounds down in the spring.

Rose Chafer – Adults emerge in late May or early June, near grape blossoming time, and are tan, long-legged beetles related to the Japanese beetle. For about two weeks, they may feed on blossoms or newly set fruit. Rose chafer is more prevalent in areas with light sandy soil.

Japanese Beetle – This is generally one of the most common insects feeding on Virginia's grapevines. On grapes, beetles feed mainly on leaves, rarely gouging fruit. Peak adult activity is in July, but begins in late June and may extend into September. Populations are generally lower in seasons following drought years. Leaf damage occurring in the first part of the Japanese beetle activity period has less effect on fruit quality. Young vines are especially vulnerable.

Grape Phylloxera - Both foliar and root forms occur, but the root form is rare in eastern states. The less damaging foliar form is commonly seen in the form of galls on the lower leaf surfaces.

Grape Tomato Gall - This is one of several types of galls formed on grape leaves, tendrils, and buds by small gall midges. Complete control by sprays is difficult. Removing galls by hand may reduce future populations.

Grape Flea Beetle - Adult beetles appear on the vines at about the time of bud swell. Beetles feed on buds; they make a large hole in the side and gouge out the bud interior. Larvae are seen during the summer, brown grubs making chain-like feeding marks on leaves. This larval feeding is insignificant.

Spotted-Wing Drosophila - This invasive fly established in our area in 2011. Unlike native drosophilid fruit flies, which lay eggs in rotting fruit material, SWD prefers to lay eggs in ripening fruit on the plant. Berry crops including grape are at risk. Spray weekly in red grapes during the final ripening period, alternating chemical mode of action if possible. Prompt harvest of ripe fruit will minimize impact of spotted wing drosophila. For more information, visit www.virginiafruit.ento.vt.edu/SWD.html.

Spotted Lanternfly - SLF is a new invasive pest in the state. While this insect feeds on more than 70 different host plants, grape is the most vulnerable. Please read the SLF section on page 3-5.

Strawberry Insects

Cyclamen Mite – These tiny, whitish mites may be found in crevices of leaves, along stems, and among the hairs of plants, but they are not visible to the naked eye. The young mites are concentrated near the centers or crowns of the plants where they feed on the young tender expanding leaves. Their feeding causes severe distortion and stunting, often accompanied by a bronze discoloration. They reproduce rapidly and often reach populations dense enough for the feeding to reduce yields severely. Insecticides such as malathion remove natural predators and allow the mites to reproduce unchecked. A hot water treatment of plants as they are planted will give control.

Spider Mites – Two-spotted spider mite is the main species on strawberries. Hot, dry weather is favorable to their development. The time from egg hatch to adult may be five days at 75°F. Ten generations per season have been recorded in the Blacksburg area. Predatory mites may give control, but they are sensitive to certain pesticides (e.g. Sevin).

Table 3.9 - Spray Schedule for Strawberries

Time of Application	Materials to Use Fungicide or Insecticide per Gallon of Water[1]	To Control	Remarks
When Blossom Buds Are Visible In The Crown	2.0 tbsp Captan 50W + 2.0 tsp malathion 57EC + 1.0 tbsp Sevin 80S	Weevil, spittlebug, spider mites, leaf aphids, fruit rots, and leaf spots Strawberry rootworm	Good thinning and mulching of plants during late February to early March is important for fruit rot control. Spray Sevin for rootworms if adults are seen feeding on leaves in the spring in high numbers (10/sq ft).
Pre-bloom When flowers have pushed	Same as above. 1.25 fl oz Immunox	Same as above, cyclamen mite; powdery mildew	Include Immunox for improved powdery mildew and leaf spot control.
Bloom When most blossoms are full open	1.25 fl oz Immunox 2.0 tbsp Captan 50W **No Insecticide**	Fruit rots, leaf spots, powdery mildew	Be sure of complete coverage for future fruit rot control. Then include Immunox for improved powdery mildew and leaf spot control. Immunox may be applied up to day of harvest. Do not apply more than six times per season. Do not plant a new crop in the same place as the crop that was treated within 30 days of the last application of Immunox.
Post-bloom Apply 10 days after bloom and continue at 7- to 10-day intervals until harvest	2.5 tsp Captan 50W[2] + 2.0 tsp malathion 57EC 1.25 fl oz Immunox	Fruit rots, leaf spots, aphids, root weevils, spotted wing drosophila	Spraying for strawberry pests must be thorough to get good coverage. Use 40-50 pounds of pressure in the tank and hold nozzle close enough to force spray between foliage. If spotted wing drosophila is an issue, do not extend intervals between sprays longer than 7 days.

[1] Materials to use are given for one gallon, but the user can easily calculate the required amount of material to make five, ten, fifteen, twenty, or twenty-five gallons of spray (See Table 3.1).

[2] Captan 50W 2.5 tsp/gal can be used during harvest for fruit rot control.

Note: AGRI-FOS is registered for control of red stele and leather rot of strawberries caused by ***Phytophthora*** sp. As a pre-planting dip, dip planting material in 1/3 fl oz of AGRI-FOS/gal of water for 30 minutes, then plant within one day. After planting as a foliar spray to perennial crops, make the first application 14 to 21 days post planting, and repeat at 1- to 2-month intervals when disease is evident.

For leather rot control, use 2 to 3 tsp of AGRI-FOS/gal of water and apply at 10% bloom and early fruit set, then at 1- to 2-week intervals as required for disease control.

Aphids – Two species may cause problems on strawberries: strawberry aphid and strawberry root aphid. The former is a small, pale, yellow aphid widely distributed in the U.S. Wingless females overwinter around the bases of the plants. In the spring, winged forms develop and disperse to other plants. These give rise to several overlapping summer generations, all of which are females, which give birth to living young. Nymphs feed on the foliage (not the roots), mainly on the undersides of the leaves. As they feed on plant sap, honeydew is excreted, which may support a fungus growth on the leaves. Nymphs mature in about ten days, depending on temperatures, and adults may live 2-3 weeks while producing 20 to 25 nymphs. One of the main causes for damage is the transmission of viruses to the strawberry, notably "yellows." Certified plant stock and pulling out diseased plants may be useful in virus control. An insecticide may be applied when aphids first appear in late May and two weeks later.

Spittlebugs – Adults resemble robust leafhoppers, but this group of pests is better known from the mass of "spittle" produced by nymphs. There are several species involved, but the meadow spittlebug is common and ranges from light brown to almost black. Eggs overwinter after being laid in rows of 1-30 between sheaths and stumps near the soil surface. These hatch in April. Nymphs are initially yellow but turn green as they grow. The nymphs feed on plant sap, and excretion products are mixed with air from a specialized "air canal." This creates the spittle, a white frothy mass, which protects the nymphs from desiccation and possibly predation. The adult stage is reached in 30-45 days, depending on temperature and other factors. After mating, females oviposit in late August or early September. There is only one generation per year. Spittlebugs are general feeders but may be particularly damaging to strawberry. Plant growth and yield may be reduced. They are also a source of annoyance to pickers.

Spotted-Wing drosophila - This invasive fly established in our area in 2011. Unlike native drosophilid fruit flies, which lay eggs in rotting fruit material, SWD prefers to lay eggs in ripening fruit on the plant. Berry crops including strawberry are at risk, especially when strawberries are grown as a summer or fall crop. For more information, visit www.virginiafruit.ento.vt.edu/SWD.html.

Strawberry Root Aphid – This insect is a blue-green species found in the eastern U.S. The winter is spent as shiny black eggs on stems and foliage. In early spring, females hatch and begin feeding on new leaves. Ants carry some to the strawberry roots where several generations of wingless females occur. Winged females are produced in October; they then return to the foliage. These give birth to males and females that mate, producing overwintering eggs. In mild winters, wingless females may persist. Fruit on infested plants dries up and falls. An infestation may not be detected until the plants are already low in vigor and have pale foliage. Another sign is the presence of many ants in the beds. When setting a new bed, use uninfested plants, and give the ground thorough cultivation in early spring to reduce ant populations. Injury may be reduced if aphids are controlled early enough.

Strawberry Rootworm – This is a shiny oval beetle with four dark blotches on the wings, about 3 mm long. Larvae feed on roots, but the most damage results from adult foliar feeding, especially in late summer. It is impractical to control larval populations. Adults may be controlled before egg laying begins when the weather warms in the spring.

Strawberry Root Weevil – Adult root weevils are light brown to black, ranging from a quarter to a half inch in length. The wing covers are marked by rows of punctures. Adults feed on strawberry leaves, but the main injury is caused by larval root feeding. Larvae are cream-colored, legless grubs with a brown head capsule. Adults may be controlled when actively feeding. Avoid planting strawberries after sod. If plowing of old beds can be delayed until fall, the old planting can serve as a trap crop.

Strawberry Weevil – This is a small (about 3 mm) brown weevil with a black patch on each elytron (wing cover). It feeds on wild and cultivated strawberries, brambles, and several other plants. Adults overwinter in debris and emerge in early spring. When strawberry blossom buds are formed, a single egg is deposited in a feeding puncture there. Then, below this site, the weevil cuts partly through the plant and the bud wilts, hangs, or drops to the ground. White, legless, curved grubs develop in these buds. The larvae pupate and emerge as adults in mid-summer. After feeding for a short time, the adults enter hibernation. There is only one generation per year. This insect is also referred to as the strawberry clipper.

Blueberry Diseases and Insects

The diseases listed below are representative of a much larger group of problems that affect highbush and rabbiteye blueberry cultivars. While these are the most common problems, local conditions may occasionally result in severe damage from less common pathogens. The key to control and management of blueberry diseases is prevention. Start with the best plants or cuttings available. Insist upon virus-free certification. Follow plant selection with proper site selection and preparation. Finally, use recommended cultural practices and carefully monitor your planting for abnormal growth or appearance of plants.

Mummy-Berry Disease – The fungus causing this disease overwinters in dropped, infected fruit. In early spring, small cups grow from the dropped fruit and discharge spores to infect new leaves and, ultimately, flowers and fruit. Direct crop losses and reduced plant size and vigor result. White or pale-red berries among normal blue fruit are often the first sign of this important disease.

Table 3.10 - Spray Schedule for Blueberries[2]

Time of Application	Materials to Use Fungicide or Insecticide per Gallon of Water[1]	To Control	Remarks
Dormant	None	Insect stem gall, scale insects, twig blight	Prune out insect- or disease-infested canes or parts of canes and destroy prunings by burning or burying in a land-fill.
Delayed Dormant	3.0 fl oz superior oil	Scale insects	This spray is not necessary if no scale insects are present.
From Time Of Bud Break Until Blossoms Open	See Remarks	Mummy berry cups on soil	Use clean culture between rows and around the plants. Rake or hoe around plants to bury (2 inches) fungus cups that form on the mummified berries.
Leaf Bud Break Through Petal Fall (7-10 day intervals)	2.0 tbsp Captan 50W	Phomopsis twig blight, Mummy berry twig/ flower infection	Twig blight affects top several inches of the twig tops. This schedule will control both mummy berry and Phomopsis twig blight.
When 3/4 Of Blossoms Have Fallen (Repeat in 10 days)	1.0 tbsp Carbaryl 80S (Sevin)	Cherry fruit worm, Cranberry fruit worm,	Use good coverage.
When Berries First Turn Blue (Repeat at 10- to 14-day intervals through harvest)	0.15 lb Surround at Home or 1.0 tbsp Carbaryl 80S (Sevin) or malathion 57EC 2 tsp + 2.0 tbsp Captan 50W	Blueberry tip borer Blueberry maggot, blueberry tip borer, fruit rot, spotted wing drosophila	Sevin will control Japanese beetles and fruit worms. Do not extend spray intervals longer than 7 days if there is pressure from spotted wing drosophila. Open pruning will aid in SWD management, as will prompt harvest of ripe berries. Addition of table sugar at the rate of 1/5 oz per gal will aid in efficacy of chemical control of SWD.
Post Harvest	2.0 tbsp wettable sulfur	Phomopsis twig blight	Prune out all diseased canes and destroy by burning.

[1] Materials to use are given for one gallon, but the user can easily calculate the required amount of material to make five, ten, fifteen, twenty, or twenty-five gallons of spray (See Table 1).

[2] Blueberries thrive best when the pH of the soil where they are growing is between 4.3 and 4.8. If the acidity needs to be increased, sulfur is a safe and economical chemical compound to use. It usually will require 1.0 lb of sulfur per plant to lower the pH (increase the acidity) one pH number. Work the sulfur lightly in the soil on a 15- to 18-inch radius around each bush.

Phomopsis Twig Blight – Conditions in Virginia and North Carolina favor twig die-back disease rather than the stem canker caused by Phomopsis fungi in northern areas. Buds and tips die first, followed by a downward spread of blighted tissue.

Stem Cankers – Several fungi enter stems and destroy the bark tissues. The resulting cankers are often first noticed when large branches "flag," or wilt, with off-colored foliage. These branches usually have one or more cankers part way down the stems. Severe damage to plants and whole fields can result.

Leaf Spots – Fungal-caused leaf spots can defoliate plants and eventually reduce their vigor. They also may be the first stages in a disease that affects stems and fruit. This is particularly true in the case of Anthracnose, which causes leaf, stem, and fruit problems.

Root Rots – Most root-rots are associated with poor site selection or planting practices. Cuttings placed too deep in soil or planted in heavy, poorly-drained sites seem especially prone to fungi that destroy the roots and, of course, the entire plant.

Viruses – Virus infected plants are poor producers and have short lives. They also serve as reservoirs of disease for passing insect or nematode vectors. A number of virus and virus-like diseases occur in blueberries. The most severe problems are shoestring and stunt (a virus-like disease). Other diseases are mosaic, red-ring spot and witches-broom. Virus-free plants and cuttings are the key to control of these problems.

Spotted-Wing Drosophila – This invasive fly established in our area in 2011. Unlike native drosophilid fruit flies, which lay eggs in rotting fruit material, SWD prefers to lay eggs in ripening fruit on the plant. Berry crops including blueberry are at risk. Spray weekly during the final ripening period, alternating chemical mode of action if possible. Get harvest berries into refrigeration as soon as possible. For more information, visit www.virginiafruit.ento.vt.edu/SWD.html

Caneberry (Raspberry and Blackberry) Diseases and Insects

Anthracnose – The fungus attacks the leaves and canes of both raspberries and blackberries. Anthracnose symptoms first appear on the canes as light grayish spots about 1/8 inch in diameter. The spots enlarge and develop rather conspicuous borders (dark in color) with gray centers. Infected canes may become girdled or cracked, causing either decline or death. Spots on the leaves are small with gray centers and purple margins. Leaf infection rarely causes defoliation. The infected tissue, however, may drop out and give the leaf a shot-hole appearance. In general, fruit on infected canes ripens abnormally.

Cane Blight – The disease is widespread in areas of raspberry culture. The causal fungus enters the canes only through wounds. Dark-brown cankers appear at the wound site, and, as the disease progresses, they extend down the cane and may encircle it. The lateral branches of infected canes wilt and die during warm weather.

Leaf Spot – The disease occurs throughout the United States and is of economic concern in Virginia. Symptoms are first noticed on raspberry as tiny greenish-black spots on the upper surfaces of the leaves. The spots turn gray as the leaves mature. The infected areas may drop out to leave a shot-hole appearance. Symptoms may be slightly different on blackberry, where spots with whitish centers and purple or brown borders occur on both the leaves and canes.

Blackberry Psyllid – These are small winged insects about 1/8 inch long. Wings have three reddish stripes running lengthwise. Adults appear on the blackberry (but not raspberry) plants in the spring and are most common when near conifers. They jump when disturbed. Adult feeding causes leaves to be tightly curled and stunts the growth of the plant.

Japanese Beetles – These beetles usually appear in large numbers and feed on the leaves and fruit of many plants. They may cause defoliation, stunting, and reduced production or death if defoliation is too severe.

Spotted-Wing Drosophila — This invasive fly established in our area in 2011. Unlike native drosophilid fruit flies, which lay eggs in rotting fruit material, SWD prefers to lay eggs in ripening fruit on the plant. Open pruning to aid air movement will help minimize SWD infestation, as well prompt harvest of ripe berries. Berry crops, especially caneberries, are at risk. Spray weekly while ripening berries are present, alternating chemical mode of action. Get berries into refrigeration as soon as possible. For more information, visit www.virginiafruit.ento.vt.edu/SWD.html.

Borers – Three species may bore into brambles. These differ in controls required. Consult your Extension agent for identification and recommendations.

Visit www.virginiafruit.ento.vt.edu/small-fruit-ipm.html#canepests for more information.

Table 3.11 - Spray Schedule for Blackberries and Raspberries

Time of Application	Materials to Use Fungicide or Insecticide per Gallon of Water[1]	To Control[2]	Remarks
Delayed Dormant When buds begin to break	8.0 tbsp copper sulfate + 8.0 tbsp hydrated lime (Bordeaux Mixture)	Anthracnose, cane blight, spur blight	A good thinning, pruning and general clean-up and removal of dead canes will help control Anthracnose as well as cane and spur blight.
New Cane Spray When new canes are 6-12 inches high	1.3 tbsp Immunox	Same as delayed dormant except no cane blight	Good coverage is important since the canes and foliage are hard to wet.
Pre-bloom Just before blossoms open	1.3 tbsp Immunox + 1.5 tsp malathion 57EC or 2.0-4.0 tbsp esfenvalerate 0.425%	Same as new cane spray plus thrips, strawberry weevil, blackberry psyllid	Coverage is a must to be sure of insect control. Fruit worms may or may not be present.
Post-bloom Until Harvest At 10- to 14-day intervals	1.3 tbsp Immunox + 1.5 tsp malathion 57EC + 1.0 tsp Sevin 80S	Same as pre-bloom spray plus Japanese beetles, spotted-wing drosophila and fruit rot	Malathion is necessary if sap beetle appears as fruit begins to color. Observe 7-day pre-harvest interval for Sevin. Do not apply Immunox more than four times. Caneberries are at great risk from spotted-wing drosophila during the ripening period. Spray at least weekly, alternating any over the counter pyrethroid insecticide (bifenthrin, zeta cypermethrin) with malathion, observing maximum number of applications per season, and days-to-harvest.
After Harvest Apply in 14 days	1.0 tbsp Sevin 80S	Anthracnose, Japanese beetles	Various borers cause problems in the canes of brambles.[2]

[1] Materials to use are given for one gallon, but the user can easily calculate the required amount of material to make five, ten, fifteen, twenty, or twenty-five gallons of spray (See Table 3.1).

[2] Canes with borer damage, wilted, and with galls, should be cut and burned. Also control weeds because they harbor insects and disease. Three main borer species differ in additional control measures required. Consult your Extension agent for identification and recommendation.

Weed Management in Home Fruit Plantings

Jeffrey F. Derr, Extension Weed Scientist, Hampton Roads AREC

Overview

Weed management is necessary for fruit plantings. Weeds compete with crop plants for water, nutrients, and light, and they can harbor insect and disease pests. Bees may prefer weed flowers, like dandelions, over fruit blossoms. Poison ivy and wild brambles interfere with harvest and other operations. Develop a year-round control for managing both summer and winter weeds. Preventing weeds from flowering helps reduce the amount of weed seed in the soil over time. Eliminate perennial weeds, especially perennial broadleaf weeds, before establishing a new fruit planting, as selective control is more difficult after planting. Generally, the tree row is maintained weed-free while the areas between the rows are mowed. Possible groundcovers to plant between the tree rows include tall fescue, fine fescues, Kentucky bluegrass, and perennial ryegrass. These grasses reduce soil erosion. For large plantings, one acre or more, read the Spray Bulletin for Commercial Tree Fruit Growers (Virginia Cooperative Extension Publication 456-419).

Additional References

- Highbush Blueberry Production Guide. Natural Resource, Agriculture, and Engineering Service Publication NRAES-55, Ithaca, NY.
- Mid-Atlantic Orchard Monitoring Guide. Natural Resource, Agriculture, and Engineering Service Publication NRAES-75, Ithaca, NY.
- Raspberry and Blackberry Production Guide for the Northeast, Midwest, and Eastern Canada. Natural Resource, Agriculture, and Engineering Service Publication NRAES-35, Ithaca, NY.
- Strawberry Production Guide for the Northeast, Midwest, and Eastern Canada. Natural Resource, Agriculture, and Engineering Service Publication NRAES-88, Ithaca, NY.
- Wine Grape Production Guide for Eastern North America. Natural Resource, Agriculture, and Engineering Service Publication NRAES-145, Ithaca, NY.
- Website for these publications: *http://www.nraes.org*

General Cultural Controls

Cultivation/Hoeing/Hand weeding: It is important to till areas before putting in a new fruit planting because it controls annual weeds like common chickweed and spotted spurge. Tilling also controls or suppresses perennial weeds. Repeated tilling helps control troublesome weeds like bermudagrass, quackgrass, yellow nutsedge, and other creeping perennials. Be sure that crop roots are not damaged when using cultivation after planting. Hoe weeds out of areas around fruit plants, but cut annual weeds at or slightly below the soil surface to minimize the amount of soil disturbance. Deeper hoeing brings weed seed from greater depths in the soil to the surface where they can germinate. Controlling weeds before flowering reduces weed populations in future years by gradually depleting the weed seed reservoir in the soil. Hoeing or hand pulling weeds controls annual weeds but will not control creeping perennials, like yellow nutsedge, which spread by underground structures such as rhizomes and tubers.

Organic mulches: Pine bark, hardwood bark, pine straw, sawdust, straw, and wood chips are all good for mulching. Monitor soil fertility as nitrogen tie-up can occur for some mulches, like sawdust. Organic mulches are a good choice because they conserve soil moisture and cool the soil. Spread mulch two to four inches deep and avoid over-mulching. Place newspaper on the soil surface before applying mulch to help suppress weeds. Organic mulches suppress annual weeds, but not perennial weeds, and organic mulches may attract rodents. Shredded mulches encourage weed growth more than larger particle mulches. Use mulches that are free of weed seed and that do not have a rotten egg or ammonia odor. Improperly composted mulch can have a low pH and may contain chemicals that injure crop plants. Some pesticides can be carried in the grass clippings and may affect the growth of the plants in the mulched area or result in undesirable chemical residues in the fruit itself. Do not use grass clippings from a lawn or pasture recently treated with a broadleaf herbicide.

Synthetic mulches: Use solid black plastic or a landscape fabric to improve weed control compared to organic mulch alone. Solid black plastic is more effective for weed control than landscape fabrics, but water cannot pass through it. Place drip irrigation under solid black plastic to allow water to reach plant roots. Landscape fabrics allow air and water to move but weed roots or shoots can penetrate through openings in the material. Place plastic or fabric on the soil surface, then cut an X or a hole into

the material for fruit plants. Use organic mulch above the fabric or plastic. If organic mulch is placed over the landscape fabric, weeds may germinate in the mulch layer and send roots through the fabric. Be sure to hand weed the mulch layer when weeds are small. Black plastic and landscape fabrics control annual weeds and suppress perennial weeds like yellow nutsedge. Control perennial weeds before using synthetic mulch. Monitor for rodents under the fabric and films since these materials may provide cover for voles and other nuisance animals.

General Biological Controls

There currently are no biological control options for weed control in fruit plantings.

General Chemical Controls

Organic

Preemergence: none recommended at this time

Postemergence: Acetic acid (Weed Pharm 20% acetic acid or other labeled formulation). Contact nonselective herbicide. Do not use unlabeled forms of acetic acid. Wear eye protection, a long-sleeved shirt, long pants, shoes, socks, and waterproof gloves since this product is corrosive. Cover the weed foliage thoroughly. Treat weeds when small, as large annual weeds may require retreatment. Perennial weeds need retreatment, as this is a contact herbicide and does not affect underground plant parts such as roots, bulbs, and rhizomes. Keep the spray off the foliage and stems of desired plants by using a shield. No residual control.

Chemical Control

Measures considered practical weed control by the homeowner on a small area are quite different from those employed by the commercial producer. Homeowners often have a very limited area that may make a precise pesticide application difficult. Thus, some of the materials recommended for commercial use are excluded from homeowner recommendations because they are highly toxic, not readily available in small quantities, or require rather precise applications.

If your need for use of these materials is sufficient, you may consult the information designed for commercial production. Some of the materials used by commercial growers require that the applicator be certified as a pesticide applicator.

If you are not familiar with the application of pesticides, consult a knowledgeable individual before proceeding. Used correctly, herbicides can be very effective, but if misused they may kill the desirable crop plant.

Rates of application are given in ounces of both active ingredient and commercial product per 1000 sq ft. These are extremely small quantities and very careful measurement and application are required.

Dry products cannot be measured on a volume basis because products vary in density. Even a given product will vary depending upon whether it is loose or compressed.

You can make the conversion to a volume basis by weighing a given volume of product and measuring the volume occupied. For instance, 10 oz weight of a given wettable powder, loosely compacted, might occupy 20 oz on a volumetric basis. Once you determine a volumetric conversion factor, you can proceed to measure the product volumetrically (teaspoons or tablespoons) rather than by weight.

Small Sprayer Calibration

To determine the output of a manually-pressurized sprayer, fill the sprayer with water, measure a 1000 sq ft area (8 x 125 ft) and, using the same procedure that you would use to spray the orchard floor, spray the entire 1000 sq ft area. Then measure the number of cups of water required to refill the sprayer. Then divide by 16 (16 cups/gallon) to get the number of gallons. Usually, adequate coverage for ground sprays can be obtained with 1–2 gallons per 1000 sq ft. Next, determine the amount of herbicide needed for 1000 sq ft and add this to the volume of water required to spray the area.

During application, do not make a circle around a tree, because this would result in a heavier application near the tree trunk and may result in injury. To obtain uniform distribution of material on an 8 x 8 area, apply a 4 x 8 ft strip on both sides of the tree.

Table 3.13 - Relative Effectiveness of Preemergence Herbicides in Fruit

(E=Excellent ; G=Good ; F=Fair ; P=Poor; N=None; – =Unknown)

	Dichlobenil (Casoron)	Napropamide (Devrinol)	Norflurazon (Solicam)	Oryzalin (Surflan)
Annual Grasses				
Barnyardgrass	G	G	E	G
Cheat	G	G	G	G
Crabgrass	G	E	E	E
Fall panicum	F	G	E	G
Foxtails	G	E	E	E
Goosegrass	F	E	G	E
Johnsongrass (seedling)	F	P	G	F-G
Annual Broadleaf Weeds				
Annual fleabane	E	G	F	G
Annual morningglory	G	N	F	P-F
Black nightshade	G	N	F-G	P-F
Carpetweed	G	G	G	G
Common chickweed	G	G	G	G
Common lambsquarters	G	F-G	G-E	G
Common ragweed	G	F	F	P
Hairy galinsoga	G	G	-	P
Henbit	G	F	-	G
Horseweed	G	P	G	F
Knotweed	G	G	F	G
Mustards	G	P	F	P-F
Pennsylvania smartweed	G	P	-	P-F
Pigweeds	G	G	F	G
Prickly lettuce	G	G	-	F
Prickly sida	F-G	N	P	P-F
Purslane	G	G	G	G
Shepherds' purse	G	F	G	G
Speedwells	-	-	-	-
Velvetleaf	-	N	-	P-F
Virginia pepperweed	G	F	G	G
Perennial Grasses And Sedges				
Bermudagrass	N	N	P	N
Dallisgrass	-	N	P	N
Fescues	G	N	F	N
Johnsongrass (rhizome)	-	N	P	N
Nimblewill	-	N	F	N
Orchardgrass	G	N	F	N
Purpletop, Redtop	-	N	F-G	N
Quackgrass	G	N	P	N
Yellow nutsedge	P-F	P	P	N

Table 3.13 - Relative Effectiveness of Preemergence Herbicides in Fruit (cont.)

(E=Excellent ; G=Good ; F=Fair ; P=Poor; N=None; – =Unknown)

	Dichlobenil (Casoron)	Napropamide (Devrinol)	Norflurazon (Solicam)	Oryzalin (Surflan)
Broadleaf plantain	G	N	P	N
Buckhorn plantain	G	N	P	N
Canada thistle	P-F	N	N	N
Chicory	G	N	N	N
Common mallow	G	N	N	N
Common milkweed	-	N	N	N
Common yarrow	-	N	N	N
Dandelion	E	N	N	N
Docks (broadleaf, curly)	G	N	N	N
Goldenrod	F-G	N	N	N
Ground ivy	E	N	N	N
Hemp dogbane	N	N	N	N
Horsenettle	N	N	N	N
Mugwort	G-E	N	N	N
Red sorrel	G	N	N	-
Thistles (bull, musk, curl)	F	N	N	N
White flowered aster	G	N	N	N
Wild carrot	G	N	F	N
Wild strawberry	G	N	P	N
Yellow rocket	G	N	F	N
Yellow woodsorrel	G	N	F	N
Special Perennial Weed Problems				
Bigroot morningglory	N	N	N	N
Brambles (*Rubus* spp.)	N	N	N	N
Common greenbriar	N	N	N	N
Japanese honeysuckle	N	N	N	N
Poison ivy	N	N	N	N
Virginia creeper	N	N	N	N
Wild garlic	F	N	N	N

	Oxyfluorfen (Goal)	Simazine (Princep)
Annual Grasses		
Barnyardgrass	F	F-G
Cheat	-	G
Crabgrass	F	F-G
Fall panicum	-	F-G
Foxtails	F	G
Goosegrass	F	E
Johnsongrass (seedling)	-	N

Table 3.13 - Relative Effectiveness of Preemergence Herbicides in Fruit (cont.)

	Oxyfluorfen (Goal)	Simazine (Princep)
Annual Broadleaf Weeds		
Annual fleabane	G	G
Annual morningglory	G	E
Black nightshade	G	E
Carpetweed	G	E
Common chickweed	G	E
Common lambsquarters	G	E
Common ragweed	F	E
Hairy galinsoga	G	E
Henbit	G	E
Horseweed	F	E
Knotweed	G	E
Mustards	G	G
Pennsylvania smartweed	G	E
Pigweeds	G	E
Prickly lettuce	G	E
Prickly sida	G	G
Purslane,	G	E
Shepherds'purse	-	E
Speedwells	G	-
Velvetleaf	G	G
Virginia pepperweed	-	E
Perennial Grasses And Sedges		
Fescues	N	P
Johnsongrass (rhizome)	N	N
Nimblewill	N	P
Orchardgrass	N	P-F
Quackgrass	N	P-F
Yellow nutsedge	N	N
Purpletop, Redtop	N	N
Dallisgrass	N	N
Bermudagrass	N	N
Perennial Broadleaf Weeds		
Broadleaf plantain	N	G
Buckhorn plantain	N	G
Canada thistle	N	N
Chicory	N	P-F
Common mallow	N	N
Common milkweed	N	N
Common yarrow	N	-
Dandelion	N	P-F

Table 3.13 - Relative Effectiveness of Preemergence Herbicides in Fruit (cont.)

	Oxyfluorfen (Goal)	Simazine (Princep)
Docks (broadleaf, curly)	N	N
Goldenrod	N	N
Ground ivy	N	N
Hemp dogbane	N	N
Horsenettle	N	P
Mugwort	N	N
Red sorrel	N	N
Thistles (bull, musk, curl)	-	N
White flowered aster	N	N
Wild carrot	-	N
Wild strawberry	-	N
Yellow rocket	-	P
Yellow woodsorrel	G	F
Special Perennial Weed Problems		
Bigroot morningglory	N	N
Brambles (*Rubus* spp.)	N	N
Common greenbriar	N	N
Japanese honeysuckle	N	N
Poison ivy	N	N
Virginia creeper	N	N
Wild garlic	N	N

Table 3.14 - Relative Effectiveness of Postemergence Herbicides in Fruit

(E=Excellent ; G=Good ; F=Fair ; P=Poor; N=None; – =Unknown)

	Fluazifop-P-Butyl (Fusilade)	Glufosinate (Rely)	Glyphosate (Various)	Sethoxydim (Poast)	2,4-D
Annual Grasses					
Barnyardgrass	E	G	E	E	N
Cheat	G	-	E	G	N
Crabgrasses	E	G	E	E	N
Fall panicum	E	G	E	E	N
Foxtails	E	G	E	E	N
Goosegrass	E	G	E	E	N
Johnsongrass (seedling)	E	-	E	E	N
Annual Broadleaf Weeds					
Annual fleabane	N	-	E	N	G
Annual morningglory	N	G	G	N	E
Black nightshade	N	G	E	N	F-G
Carpetweed	N	-	E	N	E
Common chickweed	N	G	E	N	P
Common lambsquarters	N	G	E	N	G
Common ragweed	N	G	E	N	G
Hairy galinsoga	N	-	E	N	G
Henbit	N	G	E	N	P
Horseweed	N	G	E	N	G
Knotweed	N	-	E	N	F
Mustards	N	G	E	N	G
Pennsylvania smartweed	N	G	E	N	P
Pigweeds	N	G	E	N	G
Prickly lettuce	N	G	E	N	P
Prickly sida	N	G	E	N	G
Purslane	N	G	E	N	F
Shepherds' purse	N	G	E	N	G
Speedwells	N	-	E	N	P
Velvetleaf	N	G	E	N	G
Virginia pepperweed	N	-	E	N	G
Perennial Grasses and Sedges					
Bermudagrass	G	P	G	G	N
Dallisgrass	G	-	E	G	N
Fescues	P-F	F	E	P-F	N
Johnsongrass (rhizome)	G	P	E	G	N
Nimblewill	F-G	-	G-E	F-G	N
Orchardgrass	F	P	E	F	N
Purpletop, Redtop	G	-	E	G	N
Quackgrass	G	P	G	G	N
Yellow nutsedge	N	P	G	N	N

Table 3.14 - Relative Effectiveness of Postemergence Herbicides in Fruit (cont.)

(E=Excellent ; G=Good ; F=Fair ; P=Poor; N=None; – =Unknown)

	Fluazifop-P-Butyl (Fusilade)	Glufosinate (Rely)	Glyphosate (Various)	Sethoxydim (Poast)	2,4-D
Perennial Broadleaf Weeds					
Broadleaf plantain	N	F	E	N	G
Buckhorn plantain	N	F	E	N	G
Canada thistle	N	-	F-G	N	F-G
Chicory	N	-	E	N	G
Common mallow	N	-	E	N	-
Common milkweed	N	-	G	N	P-F
Common yarrow	N	-	G	N	F
Dandelion	N	G	E	N	G
Docks (broadleaf)	N	-	G	N	G
Docks (curly)	N	-	E	N	F-G
Goldenrod	N	-	E	N	P-F
Ground ivy	N	G	G	N	P-F
Hemp dogbane	N	-	F	N	P-F
Horsenettle	N	F-G	F-G	N	P
Mugwort	N	-	F	N	P
Red sorrel	N	G	G	N	P
Thistles	N	-	G	N	F
(bull, musk,curl)	N	-	G	N	G
White flowered aster	N	-	E	N	N
Wild carrot	N	-	E	N	G
Wild strawberry	N	-	E	N	P-F
Yellow rocket	N	-	E	N	P-F
Yellow woodsorrel	N	G	E	N	F
Special Perennial Weed Problems					
Bigroot morningglory	N	-	F-G	N	F-G
Brambles (*Rubus* spp.)	N	F-G	G	N	P
Common greenbriar	N	-	P	N	N
Japanese honeysuckle	N	-	F-G	N	P-F
Poison ivy	N	-	G	N	F
Virginia creeper	N	-	F-G	N	F
Wild garlic	N	G	F	N	F

Table 3.15 - Spray Schedule for Weed Control in Home Fruit Orchards

Crop	Herbicide Active Ingredient/1000 sq ft (Product/1000 sq ft)	Remarks
Apples and Pears	dichlobenil 0.1 lb (Casoron 4G 3.4 lb)	Apply granules in the late winter or early spring. Shallow incorporation may improve weed control, especially if application is made during warm temperatures. Do not apply to newly planted trees until 4 weeks after transplanting. Will not give season-long weed control. Do not make more than one application/year. Do not apply within one month of harvest. Do not allow livestock to graze treated area. Especially effective for many herbaceous perennial weeds.
	fluazifop-P-butyl 0.19 oz (Fusilade DX 0.75 fl oz + 1.5 fl oz crop oil concentrate or 0.5 fl oz nonionic surfactant in 1.0 gal of water)	Spot treatment for emerged grasses. Use in non-bearing orchards only. Use as a directed spray on actively growing grasses. Treat annual grasses with lower rate before tillering or heading. Treat perennial grasses according to the following stages of growth: johnsongrass, field paspalum, and purpletop before boot stage; bermudagrass, 4–8 inch runners; quackgrass, 3–5 inch leaves and not more than 10 inches tall. Perennial grasses such as bermudagrass, paspalums, and quackgrass need to be treated with Fusilade when regrowth is evident. Do not treat trees to be harvested within one year after application.
	glufosinate (Rely 280)	Controls annual weeds and certain perennial weeds. Apply when weeds are actively growing. Mix 1.7 fl oz Rely 280/gal. Ensure thorough coverage of weed foliage. Do not allow spray to contact desired foliage or bark. Do not apply within 14 days of harvest.
	glyphosate (Roundup and various other formulations. See label for rates)	Apply as a directed spray. Do not contact bark or foliage of trees or severe injury may result. Extensive care must be exercised to avoid contact of spray, drift, or mist with green foliage, green bark or bark of trees established less than two years, suckers, or fruit of desirable trees. Spray contact with other than mature bark on main trunk can cause serious localized or systemic injury. Injury may become increasingly severe the second season. WARNING: Do not mix, store, or apply Roundup spray solution in galvanized metal or lined steel tanks. Chemical reaction produces hydrogen gas, which is very explosive.
	norflurazon 0.75-1.5 oz (Solicam DF 1.0-1.9 oz)	Apply as a directed spray to weed-free soil and avoid contact with fruit or foliage. May be applied under new plantings if there are no depressions or large cracks which allow the herbicide to accumulate around the root system. Pears must be established one year before treatment. Use the lower rate on sandy soils and the higher rate on clay and loamy soils.
	oryzalin 0.75-2.3 oz (Surflan 4AS 1.5-4.5 fl oz)	For use under newly planted or established trees. Areas to be treated should be free of weeds. Remove or thoroughly mix trash into the soil before application. Use lower rate for short-term control (4 months) and higher rate for long-term control (6–8 months). Apply as a directed spray and avoid spray contact with leaves, branches, or trunks of trees. Do not apply to newly transplanted trees until soil has settled and there are no cracks present. Make only one application/growing season.
	oxyfluorfen 0.2-0.7 oz (Goal 2XL 0.7-2.9 fl oz)	Apply to dormant trees only. Will control certain small seedling weeds plus provide soil residual control of annual broadleaf weeds and certain annual grasses.
	sethoxydim 0.21 oz (Poast 1.5E 1.25 fl oz + 1.25 fl oz crop oil concentrate in 1.0 gal of water)	Do not apply within 14 days of harvest. Spot treatment for emerged grasses. Apply lower rate to annual grasses up to six inches, apply higher rate to annual grasses up to 12 inches tall and to perennial grasses.

Table 3.15 - Spray Schedule for Weed Control in Home Fruit Orchards (cont.)

Crop	Herbicide Active Ingredient/1000 sq ft (Product/1000 sq ft)	Remarks
Apples and Pears (cont.)	simazine 0.8-1.6 oz (Princep 4L 1.5-3.0 fl oz)	Apply to weed-free soil around trees established 1 year or more. Best results are obtained with winter or early spring applications. Adjust rate of application to soil type. Do not use on sandy or gravelly soils. Do not make more than one application/year.
	2,4-D 0.5 oz (Weedar 64, Orchard Master 1.1 fl oz)	Apply as a directed spray to actively growing broadleaf weeds. Gives good control of annual broadleaf weeds and partial control of perennials. Keep spray off tree foliage and fruit or serious injury may result. Use a coarse spray and low pressure to avoid spray drift. Do not harvest within 14 days of application.
Peaches	dichlobenil 0.1 lb (Casoron 4G 3.4 lb)	Apply granules in the late winter or early spring. Shallow incorporation may improve weed control, especially if application is made during warm temperatures. Do not apply to newly planted trees until four weeks after transplanting. Will not give season-long weed control. Do not make more than one application/year. Do not apply within 1 month of harvest. Do not allow livestock to graze treated area.
	fluazifop-P-butyl 0.19 oz (Fusilade DX 0.75 fl oz + 1.5 fl oz crop oil concentrate or 0.5 fl oz nonionic surfactant in 1.0 gal of water)	Do not harvest within 14 days of application. Use as a directed spray on actively growing grasses. Treat annual grasses with lower rate before tillering or heading. Treat perennial grasses according to the following stages of growth: johnsongrass, field paspalum, and purpletop, before boot stage; bermudagrass, 4–8 inch runners; quackgrass, 3–5 leaves and not more than 10 inches tall. Perennial grasses such as bermudagrass, paspalums, and quackgrass need to be treated with Fusilade when regrowth is evident.
	glufosinate (Rely 280)	Controls annual weeds and certain perennial weeds. Apply when weeds are actively growing. Mix 1.7 fl oz Rely 280/gal. Ensure thorough coverage of weed foliage. Do not allow spray to contact desired foliage or bark. Do not apply within 14 days of harvest.
	glyphosate (Roundup and various other formulations. See label for rates.)	Wick or wiper application only. Use on emerged annual and perennial weeds with fully expanded leaves.
	norflurazon 0.75-1.5 oz (Solicam DF 1.0-1.9 oz)	Apply as a directed spray to weed-free soil and avoid contact with fruit or foliage. May be applied under new plantings if there are no depressions or large cracks which allow the herbicide to accumulate around the root system. Use the lower rate on sandy soils and the higher rate on clay and loam soils.
	oryzalin 0.75-2.3 oz (Surflan 4AS 1.5-4.5 fl oz)	Areas to be treated should be free of weeds. Remove or thoroughly mix trash into the soil before application. Use the lower rate for short term control (4 months) and the higher rate for long-term control (6–8 months). Apply as a directed spray and avoid contact with leaves, branches, or trunks of trees. Do not apply to newly transplanted trees until soil has settled and there are no cracks present. Make only one application/growing season.
	oxyfluorfen 0.2-0.7 oz (Goal 2XL 0.7-2.9 fl oz)	Apply to dormant trees only. Will control certain small seedling weeds plus provide soil residual control of annual broadleaf weeds and certain annual grasses.
	sethoxydim 0.21 oz (Poast 1.5E 1.25 fl oz + 1.25 fl oz crop oil concentrate in 1.0 gal of water)	Spot treatment for emerged grasses. Apply lower rate to annual grasses up to 6 inches. Apply higher rate to annual grasses up to 12 inches tall and to perennial grasses. Do not apply within 25 days of harvest.

Table 3.15 - Spray Schedule for Weed Control in Home Fruit Orchards (cont.)

Crop	Herbicide Active Ingredient/1000 sq ft (Product/1000 sq ft)	Remarks
Peaches (cont.)	simazine 0.8-1.6 oz (Princep 4L 1.5-3.0 fl oz)	Apply to weed free soil around trees established 1 year or more. Best results are obtained with winter or early spring applications. Adjust rate of application to soil type. Do not use on sandy or gravelly soils. Do not make more than one application/year.
	2,4-D 0.5 oz (Weedar 64, Orchard Master 1.1 fl oz)	Apply as a directed spray to actively growing broadleaf weeds. Gives good control of annual broadleaf weeds and partial control of perennials. Keep spray off tree foliage and fruit or serious injury may result. Use a coarse spray and low pressure to avoid spray drift. Do not harvest within 40 days of application.
Blackberries, Blueberries, and Raspberries	dichlobenil 1.4 oz (Casoron 4G 2.3 lb)	Apply dry granules in late winter or early spring. Use only on established plantings and do not apply during new shoot emergence.
	fluazifop-P-butyl 0.19 (Fusilade DX 0.75 fl oz + 1.5 fl oz crop oil concentrate or 0.5 fl oz nonionic surfactant in 1.0 gal of water)	Spot treatment for emerged grasses. Do not harvest within 1 day of application to highbush blueberry, blackberries or raspberries. Use as a directed spray on actively growing grasses. Treat annual grasses with lower rate before tillering or heading. Treat perennial grasses according to the following stages of growth: johnsongrass, field paspalum, and purpletop before boot stage; bermudagrass, 4 to 8 inch runners; quackgrass, 3 to 5 leaves and not more than 10 inches tall. Perennial grasses such as bermudagrass, paspalums, and quackgrass need to be retreated with Fusilade when regrowth is evident.
	glufosinate (Rely 280)	Blueberries only. Controls annual weeds and certain perennial weeds. Apply when weeds are actively growing. Mix 1.7 fl oz Rely 280/gal. Ensure thorough coverage of weed foliage. Do not allow spray to contact desired foliage or green bark. Do not apply within 14 days of harvest.
	glyphosate (Roundup and various other formulations. See label for rates.)	Use lower rate to control annual weeds and higher rates for perennial weeds. Can be applied preplant or as a spot treatment after planting. Do not allow spray to contact desired stems or foliage.
	napropamide 1.5 oz (Devrinol 50DF 3.0 oz)	Apply to the soil surface in the fall through early spring prior to weed emergence. Do not apply to frozen ground. Does not control existing weeds. Use as a directed spray and avoid contact with fruit or foliage. Do not apply when fruit is on the ground during the harvest period. Do not graze treated areas. Make only one application/season.
	oryzalin 0.75-2.3 oz (Surflan 4AS 1.5-4.5 fl oz)	Apply in early spring for control of annual grasses and certain broadleaf weeds. Apply to new plantings after rainfall has firmed the soil. May be tank-mixed with simazine for increased broadleaf weed control.
	sethoxydim 0.21 oz (Poast 1.5E 1.25 fl oz + 1.25 fl oz crop oil concentrate in 1.0 gal of water)	Do not apply within 45 days of raspberry or blackberry harvest or within 1 day of highbush blueberry harvest.. Apply as spot treatment for emerged grasses. Treat emerged annual grasses prior to tillering. Perennial grasses may require retreatment.
	simazine 0.8-1.2 oz (Princep 4L 1.5-3.0 fl oz)	Apply for control of annual grasses and broadleaf weeds in the early spring or as a split treatment with 1/2 applied in the spring and 1/2 applied in the fall. Do not use more than 1/2 rate on new plantings less than 6 months old. Do not apply to foliage or while fruit is present.
Grapes	dichlobenil 1.4-2.2 oz (Casoron 4G 2.3-3.4 lb)	Apply granules in winter or early spring. Do not apply until four weeks after transplanting.

Table 3.15 - Spray Schedule for Weed Control in Home Fruit Orchards (cont.)

Crop	Herbicide Active Ingredient/1000 sq ft (Product/1000 sq ft)	Remarks
Grapes (cont.)	fluazifop-P-butyl 0.19 oz (Fusilade DX 0.75 fl oz + 1.5 fl oz crop oil concentrate or 0.5 fl oz nonionic surfactant in 1.0 gal of water)	Spot treatment for emerged grasses. Do not apply within 50 days of harvest. Use as a directed spray on actively growing grasses. Treat annual grasses before tillering or heading. Treat perennial grasses according to the following stages of growth: johnsongrass, field paspalum, and purpletop, before boot stage; bermudagrass, 4–8 inch runners; quackgrass, 3–5 leaves and not more than 10 inches tall. Perennial grasses such as bermudagrass, paspalums, and quackgrass need to be retreated with Fusilade when regrowth is evident. Do not treat vines to be harvested within one year after application.
	glufosinate (Rely 280)	Controls annual weeds and certain perennial weeds. Apply when weeds are actively growing. Mix 1.7 fl oz Rely 280/gal. Ensure thorough coverage of weed foliage. Do not allow spray to contact desired foliage or green bark. Do not apply within 14 days of harvest.
	glyphosate (Roundup and various other formulations. See label for rates.)	Use as a directed spray in established vineyards or for site preparation prior to transplanting new vines. Do not apply when green shoots or canes or foliage are in the spray zone. Do not allow spray, drift, or mist to contact green foliage, green bark, suckers, or vines and renewals less than three years of age. Spray contact, other than with mature bark on the main trunk, can result in serious localized or systemic injury.
	napropamide 1.5 oz (Devrinol 50DF 3.0 oz)	Apply to soil surface in the fall through early spring prior to weed emergence. Do not apply to frozen ground. Does not control existing weeds. Use as a directed spray and avoid contact with fruit or foliage. Do not apply when fruit is on the ground during the harvest period. Do not graze areas. Make only one application/season.
	oryzalin 0.75-2.2 oz (Surflan 4AS 1.5-4.5 fl oz)	Areas to be treated should be free of weeds. Remove or thoroughly mix trash into the soil before application. Use lower rate for short-term control (4 months) and higher rate for long-term control (6–8 months). Apply as a directed spray and avoid contact with leaves, branches, or trunks of vines. Do not apply to newly transplanted vineyards until soil has settled and there are no cracks present. Make only one application/growing season.
	oxyfluorfen 0.2-0.7 oz (Goal 2XL 0.7-2.9 fl oz)	Dormant application only. Will control certain small seedling weeds plus provide soil residual control of annual broadleaf weeds and certain annual grasses.
	sethoxydim 0.21 oz (Poast 1.5E 1.25 fl oz + 1.25 fl oz crop oil concentrate in 1.0 gal of water)	Do not apply within 50 days of harvest. Spot-treatment for emerged grasses. Treat annual grasses prior to tillering. Perennial grasses may require repeat treatment.
	simazine 0.8-1.6 oz (Princep 4L 1.5-3.0 fl oz)	Apply a single application in fall or early spring to weed-free soil. Vineyards must be established at least three years.
Strawberries	napropamide 1.5 oz (Devrinol 50DF 3.0 oz)	Use on established strawberries. Delay application until the desired number of daughter plants has become established. Do not apply from bloom to harvest. Make only one application/season. Does not control established weeds.
	sethoxydim 0.21 fl oz (Poast 1.5E 1.25 fl oz + 1.25 fl oz crop oil concentrate in 1.0 gal of water)	Do not apply within 7 days of harvest. Spot-treatment for emerged grasses. Treat annual grasses prior to tillering. Perennial weeds may require retreatment.

Table 3.15 - Spray Schedule for Weed Control in Home Fruit Orchards (cont.)

Crop	Herbicide Active Ingredient/1000 sq ft (Product/1000 sq ft)	Remarks
Strawberries (cont.)	2,4-D amine 0.4 oz (Formula 40 0.7 fl oz)	Apply for control of emerged broadleaf weeds in established beds. Apply in late winter or early spring when strawberries are dormant, or apply immediately after last picking. Do not apply during bud, flower, or fruit stage or during runner formation. Some foliar injury is to be expected.

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