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UK UNIVERSITY OF KENTUCKY College of Agriculture

Disease and Insect Control Programs for Homegrown Fruit in Kentucky

Including Organic Alternatives

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Many homeowners in Kentucky grow a variety of fruits in their garden and are rewarded for their effort. One distinct advantage homeowners have over commercial orchardists is the diverse ecosystem of the home landscape (vegetable gardens, flower and fruit plantings intermixed with turf and landscape plants). Diversity often reduces the spread of insect and disease organisms and tends to keep their populations at lower, more manageable levels.

General Practices

Arrangements for pest control should be incorporated into plans for any home fruit planting. However, if the home grower is a careful observer and knows what to look for, pest control can be used as needed, instead of on a rigorous preventative schedule. Failure to understand and carry out insect and disease control measures is an invitation to disaster. On the other hand, use of cultural and biological controls such as sanitation and resistant varieties combined with well-applied sprays of proper materials as needed can bring success in home fruit production.

Cultivar selection, health and vigor of individual plants, managed tree and plant size, good pruning, and weed, grass and rodent control are very important practices for success of home fruit plantings.

Planting site. Where you plant trees or plants can have a strong influence on future disease problems. Choose a site with good air circulation and sunlight (e.g., away from walls and shade trees) to allow fruits and foliage to dry after periods of rain or dew. Make sure that the soil in your planting site has good drainage. A site where water stands for long periods or collects after a rain is likely to lead to root rot diseases.

Planting size. Avoid too large a planting. A common mistake for new growers is to make the home planting too large, often leading to neglect and discouragement. For a family of four, the following tree and bush numbers are usually sufficient: apples (2); peaches (2); tart cherries (1); plums (2); red or black raspberries (5 plants each of 2 varieties that have different maturity dates); pears (2); grapes (3 vines); thornless erect blackberries (5); thornless semi-erect blackberries (2); blueberries (3); gooseberries (1); and strawberries (25).

Many people find small fruits such as blueberries, strawberries, blackberries, raspberries, and gooseberries more rewarding than tree fruits. Small fruits come into bearing sooner, need less space, bloom reliably, and require fewer sprays for pest control. However, grapes are an exception: they require a rigorous spray schedule and take three years to bear.

Cultivars. In general, the home fruit gardener has a much better chance for success when early ripening varieties are used. Early varieties require less spraying and are generally harvested before serious pest problems develop. Use of disease-resistant varieties also helps. For example, several new apple varieties have resistance to some diseases (Table 1).

Plant health. Healthy trees and plants yield more fruit than either less vigorous or more vigorous ones. A reasonable supply of mineral nutrients provided by the application of fertilizers and/or organic matter helps assure a harvest. It is important, however, not to apply too much nitrogen to fruit plantings because fruit set is reduced and succulent growth is more susceptible to diseases such as fire blight of apples and pears. A normal fertility program for a lawn usually meets the fertilizer requirements for fruit trees.

Pruning. Dwarf or semi-dwarf trees are attractive to home fruit growers because they are easy to spray, prune, and harvest. Pruning at planting is very important. Once this is done correctly, prune young trees only enough to shape them until they come into bearing. As trees get older, pruning should be increased.

Prune and thin large trees to improve foliage drying and spray coverage of all parts of the tree. With large trees, you may need an extension spray rod and stepladder to get good spray coverage. Remember that with very large trees, the tops can be lowered by removing heavy limbs; the remainder can then be sprayed more easily. All sprouts or suckers that arise at the base of trees should be removed.

Late winter or early spring is the best time to prune. Fruit trees should be pruned in the following order to avoid injury from late spring freezes: apples, pears, cherries, plums, and peaches. On trees subject to frequent frost loss, pruning may follow bloom and/or fruit set. Limited summer pruning reduces vegetative growth the following spring, so it is a recommended practice on very vigorous trees.

Rodents. Field mice (actually voles) of two types often kill many fruit trees. The meadow mouse, a surface worker, gnaws bark from trees at the soil surface or above. The pine mouse tunnels under soil, destroying roots and below-ground trunk. An area clear of vegetation and debris a foot or so around the tree base helps keep mice away. An 18-inch-high cylinder of hardware cloth placed around the tree base and extending 2 inches into the soil gives much better protection. Cats and dogs may help with the mouse problem.

Birds. Birds that consume ripening fruit can be a significant problem for home plantings of cherries, raspberries, blackberries, blueberries, currants, gooseberries, strawberries, grapes, and sometimes apples, peaches, and plums. Some of the more

Table 1. Disease-resistant apples.[1]

Variety	Resistance To				Comments	Harvest	Stores Until	Skin Color
	AS	CR	FB	PM				
Pristine[2]	VR	S	S	R	Good quality for season, not as tart as Lodi, makes excellent applesauce	mid-July	short storage	Light yellow with red blush
Williams Pride	VR	S	MR	R	Good quality for season, corkspot frequently observed, subacid, yellow flesh	mid-July	short storage	70-80% dark red
Redfree[2]	VR	VR	S	S	Firm, summer apple, juicy	early Aug.	Oct.	90-100% dark red on yellow
Dayton[2]	VR	R	MR	R	Similar to Prima	mid-Aug.	Sept.	Up to 90% bright medium red
Liberty[2]	VR	R[3]	R	R	Fruit similar to Macoun, crisp, juicy, yellowish flesh, tart at harvest	late Aug.	Dec.	90% dark red stripes on green yellow
Nova Easygro	VR	VR	R	S	Fruit similar to Cortland, fair quality	early Sept.	Dec.	80% dark red on green yellow
Spartan[2]	MR	R	MR	R	Firm McIntosh type, needs thinning to develop size	early Sept.	Jan.	Dark red to pale red depending on weather
Jonafree[2]	VR	S	S	R	Fruit similar to Jonathan but less acid	early Sept.	Dec.	90% red stripes
Pixie Crunch[2]	VR	—	—	—	Small, sweet flavored, super crisp, kids' apple	early Sept.	Dec.	Deep red
Macfree	VR	VR[3]	MR	S	Similar to McIntosh, mealy under hot conditions	mid-Sept.	Dec.	75% medium red over green yellow
Priscilla[2]	VR	VR[3]	VR	R	Tart, firm, somewhat coarse textured, crisp, juicy, small fruit size	mid-Sept.	Nov.	70-90% dark red blush over yellow green
WineCrisp	VR	MR	VR	MR	Medium-sized, very firm, juicy and crisp, sweet-tart, spicy flavor, stores well.	mid-Oct	Feb.	Deep purple-red.
CrimsonCrisp	VR	MR	S	S	Medium-sized red fruit, firm, crisp, tart, stores very well	mid-Sept.	March	95% red
Enterprise[2]	VR	VR[3]	MR	R	Sprightly, subacid, slightly aromatic and spicy, crisp, fine-grained juicy flesh, stores well	mid-Oct.	Feb.	Washed, 90% light to medium red
GoldRush[2]	VR	S	MR	S	Fruit very crisp, firm, tart at harvest and sweetens up after storage, very susceptible to black rot. Will store for 11 months.	mid-Oct.	April	Deep yellow with red blush
Sundance[2]	VR	VR	VR	VR	Excellent quality with fruity flavor like mild pineapple, fruit does not drop	mid-Oct.	March	Yellow, occasionally russets in stem cavity

AS = apple scab, **CR** = cedar apple rust, **FB** = fire blight, **PM** = powdery mildew.
VR = very resistant, **R** = resistant, **MR** = moderately resistant, **S** = susceptible, **—** = insufficient information.
Note: All apples require cross-pollination by a different variety. Winesap and Sir Prize cannot serve as pollinizers because they have sterile pollen.
[1] Resistance to diseases other than scab has not been fully evaluated and may differ in some locations from that reported here.
[2] Produces high-quality apples in Kentucky.
[3] Although these cultivars are resistant to cedar apple rust, they are susceptible to cedar quince rust.

devastating birds are robins, flickers, red-winged blackbirds, crows, cedar waxwings, blue jays, common grackles, and European starlings. Federal laws prohibit capture or kill of all species except starlings, house sparrows, and feral pigeons. All other birds are protected.

Hanging aluminum pie tins that blow in the breeze, stretching Mylar reflective tape over tops of plants, placing rubber snakes and owls on or above plants, using bird scare balloons with large eyes on their sides, and several other techniques all work to some extent depending on bird populations and amount of other food available in the area at the time. The devices are more effective when employed before the bird problem develops and if they are moved and repositioned frequently. However, birds eventually become accustomed to the scare devices. Thus, they are effective in slowing down losses to birds but not in eliminating them.

The most effective means of controlling birds is to exclude them with netting. Several brands of bird netting on the market may be reused for several years. University of Kentucky researchers have had good success on thornless blackberries, grapes, and blueberries with several finer-meshed nets that also exclude Japanese beetles and green June beetles.

Organic Pesticides

Organic culture of fruit crops is a rewarding and often a very challenging undertaking. **Organic production is not a passive means of pest control but a production system in which a variety of cultural practices, organic pesticide controls, and beneficial insects are used.** Considerable care must be taken in determining the planting location, layout, pest control, and cultural practices. The correct cultural practices are extremely important to follow when growing fruit using organic techniques. See the recommendations for the specific fruit crop of interest throughout this publication. Picture-perfect fruit may not be consistently possible with the extremes of climate and the pests encountered in Kentucky. Follow the proper management techniques, scout for problems before economic thresholds are met, and keep informed of the latest cultural information. Generally, the small-fruit crops, excluding grapes, are much easier

Table 2. Organic insect and mite control for fruit.

Fruit Type	Insects	Control Method[1]	Cultural Practices/Comments[9]
all	aphids	**1.** citrus peel oil[4], insecticidal soaps, Pyrethrum, sticky traps[5] (yellow trap for monitoring only) **2.** Neem oil	
	Japanese beetle	**1.** fine netting for some crops	
	spider mite	**1.** citrus peel oil[4], dormant oils[3], insecticidal soaps, Pyrethrum, Surround Crop Protectant	alternative spray type
apple	appletree borers	**1.** sticky band around trunks[9]	
apple, pear	codling moth	**1.** barriers[6] (fruit bags), Carpovirusine, Entrust, Pyrethrum **2.** Neem oil	pick up and destroy fallen fruit
apple, grape, plum, pear	leafroller	**1.** Bt types[2], Entrust, Pyrethrum **2.** Neem oil	
apple, peach	oriental fruit moth	**1.** Entrust, barriers[6] (fruit bags) **2.** Pyrethrum	
apple, blueberry, cherry, peach, plum, pear	plum curculio	**1.** Surround Crop Protectant **3.** Pyrethrum	pick up and destroy fallen fruit
apple, cherry, peach, plum, pear	fall webworm	**1.** Bt types[2], Entrust **2.** Neem oil	submerge tents in soapy water
	San Jose scale	**1.** dormant oils[3], citrus peel oil[4], sticky traps[5], barriers[6], d.e.[7] (use double-sided tape to monitor crawlers) **2.** insecticidal soaps	insecticidal soaps for crawlers
	tent caterpillar	**1.** Bt types[2], Entrust, barriers[6] (fruit bags) **2.** Neem oil	submerge tents in soapy water
apple, blackberry, peach, pear, raspberry	stink bug	**2.** Neem oil, Pyrethrum	
	tarnished plant bug	**1.** Pyrethrum, sticky traps[5]	
blackberry, raspberry	raspberry crown borer	**1.** d.e.[7]	
	raspberry cane borer		cut out infected canes and burn
	red-necked cane borer		cut out swollen areas in canes and burn
grape	flea beetles	**1.** d.e.[7], Pyrethrum	
	grape leafhopper	**1.** insecticidal soaps **2.** Neem oil	
cherry, peach, plum	peachtree borer	**1.** sticky bands at tree base[9] **2.** Neem oil	carefully kill borers with wire or knife
pear	pear psylla	**1.** d.e.[7], Pyrethrum, Surround Crop Protectant	
cherry, peach, plum	scale	**1.** dormant oils[3] **2.** insecticidal soaps	insecticidal soaps for crawlers
strawberry	strawberry rootworm	**1.** Bt types[2] **2.** Neem oil, d.e.[7]	
	strawberry crown borer		destroy old beds as soon as harvest is over, set new plants in Feb-Mar to avoid egg laying
	strawberry root weevil	Pyrethrum	

[1] **Control method:** 1 = the primary control method, 2 = secondary control method, 3 = somewhat effective method.
[2] **Bt types** are different strains of the Bt bacteria (*Bacillus thuringiensis*) that attack certain groups of insect larvae. Bt var kurstaki controls some moth and butterfly larvae, and Bt var tenebrionis controls some beetle larvae.
[3] **Dormant oils** are specially refined oils that are meant to smother the insect pests while not injuring the plants. Read labels carefully to be sure that no other chemicals have been added and that these oils comply with Organic Certification Standards.
[4] **Citrus oil spray** is a very successful contact insecticide that immobilizes insects in a few minutes. It is nonselective and can be harmful to some beneficial insects. Chop orange peels and place in a pan with just enough water to cover. Simmer for 5 minutes. Drain off the liquid after cooling and use.
[5] **Sticky traps** attract insects with color and catch them on sticky resin. While these are available commercially, they can be made at home. Use wooden squares, plastic sheets, or heavy waxed cardboard sprayed or painted with glossy yellow, red, or white colors depending on the pest. Spread on mineral oil or petroleum jelly mixed with kitchen detergent. Hang traps near the fruit crop.
[6] **Barriers** can be netting or finely woven poly cloth which lightly covers plants and physically separates them from the insects. All sides must be securely fastened to the ground. It will raise the temperature and humidity under the cover, so care must be taken to avoid overheating the plants on hot days. It can be quite expensive to purchase, but the high-quality material will last for years. Apples, pears, and grapes may be bagged. See the publication, *Bagging Apples: Alternative Pest Management* (ENTFACT-218).
[7] **Diatomaceous earth (d.e.)** is the powdered remains of fossilized diatoms. The powder has extremely small but sharp protrusions that severely injure insects when they crawl over it. Harmless to humans and animals. Reapply after each rain.
[8] Cultural practices is a broad category. Most often, it includes the removal of overwintering plant debris and fruit drops from the field or garden plot. This deprives insects of early emergence and establishment in the spring. Many cultural practices can be done during the growing season. Ideally, the best control for organic growers is prevention. The best prevention comes from the maintenance of a living healthy soil that keeps plants growing at an optimum level. Stressed plants are much more prone to infestation and infection than healthy ones. Proper humus, nutrient, and moisture levels are essential for maintaining a balanced soil environment.
[9] Placing **sticky bands** around the trunk involves wrapping burlap around the trunk, burying it several inches below ground and covering it with tanglefoot.

Wormwood (*Artemisia absinthium*) extracts from the leaves are used as a soil drench or spray for repelling slugs and snails. Steep leaves in boiling water, let cool and use immediately.
Liquid seaweed extract will disrupt the life cycle of many insects when used diluted with water. Mix with insecticidal soap for foliar spray that offers a broad range of pest protection.

to grow organically than tree fruit crops. Most botanical insecticides have a broad spectrum of activity, and users should be aware that many of these materials are toxic to beneficial insects and mites as well as pest insects. Some botanical insecticides are as toxic as some synthetic insecticides and should be handled accordingly.

If fruit is to be sold as organically certified in Kentucky, contact the Kentucky Department of Agriculture, Division of Markets, Frankfort, Kentucky, phone 502-564-4983, for the certification requirements. Only certain pest control materials may be used for insect and disease control; for example, pyrethrin (without piperonyl butoxide). Some of these include the insecticides pyrethrin (without piperonyl butoxide); insecticidal soaps; Bt species; horticultural oils (non-synthetic); herbal extracts and oils, diatomaceous earth, and the fungicides copper and sulfur (only certain preparations of these are acceptable).

Nearly all of these materials can be used up to the day of harvest.

Table 2 contains a list of organic insecticides and practices that people have tried for insect and mite control on various fruit crops. You may want to experiment with some of these and practice on small plantings. **Many of these insecticides and practices are not necessarily as effective as other recommended control measures, and research data to support the use of some of these are lacking.**

One method of dealing with pests sustainably is through the introduction of beneficial insects and predators of the insect pests (Table 3). Beneficial insects do not "cure" the pest problem in a quick fashion as do pesticidal means. They take time and work on reducing the overall population of the pest to economically tolerable levels if the instructions set by the insectiary are followed. The beneficials should be included as part of an integrated pest control system that includes fertilizing, proper cultural practices as outlined within this publication, the use of resistant varieties of fruit when possible, proper irrigation, and timely monitoring of pests.

Using beneficials is most effective when pests are already present in your planting at low or moderate levels. The beneficial insects need an immediate food source to start with. To maintain a constant level of beneficials, there must always be some food source available. So the goal of this type of pest management scheme is not the total eradication of the pests, only the managed balance between beneficial and pest. Be sure to buy your beneficials through a reputable dealer.

Table 3. Beneficial insect control for fruit pests.

Target Insect	Beneficial Organism	Latin Name
All species of soft-bodied insect, mites, eggs	Green lacewing	*Chrysoperla carnea, C. rufilabris*
Eggs of most species of moths and butterflies	Parasitic wasps	*Trichogramma minutum, T. platneri, T. pretiosum*
Two-spotted spider mite	Predatory mites	*Amblyseius cucumeris, A. fallacis*
Various mites		*Neoseiulus californicus, Galendromus occidentalis, Phytoseiulus persimilis, Mesoseiulus longipes*
Strawberry crown borer	Predatory nematodes	*Steinerema carpocapsae*
Strawberry root weevil		
Strawberry rootworm		
Walnut husk fly		
Raspberry cane moth		
Pear psylla	Predatory bug	*Deraeorcoris brevis*
Thrips and mites		*Iphiseius degenerans*
Leaf miners	Parasitic wasp	*Diglyphusisea isea*

Note: Be sure to buy your beneficial organisms through a reputable dealer.

Using Pesticides Safely

Pesticides are used to kill insects and disease pathogens. Handle these chemicals carefully to prevent injury to yourself, other people, or pets. Although pesticides suggested for use in this fact sheet are among the least hazardous available, certain precautions are still necessary.

- Before purchasing, mixing, storing, disposing of, or using any pesticide, carefully read the label. Give special attention to the section on various precautions to be followed. Mix only as much as you need.
- Be sure the crop you intend to treat is listed on the label and follow all label directions.
- Wear long-sleeved shirts, long pants, rubber gloves, and a hat when mixing and applying chemicals. Goggles should be worn, especially if you wear contact lenses. The product label specifies required minimum protective gear.
- Avoid spilling pesticides on yourself or in the immediate area where you are working. If this happens, wash yourself immediately with plenty of water to remove all traces of pesticides. Do not get any pesticide in your eyes, nose, or mouth.
- Do not smoke, eat, or chew tobacco while you are applying pesticides.
- When applying a pesticide, do not permit material to blow back on you or on other people, pets, or pet food or water containers. Adjust your treatment according to wind direction. Avoid tracking pesticides on your shoes to untreated areas. If it is too windy, stop and finish later when the wind dies down. A good time to make pesticide applications is in the evening just before dark when the wind usually dies down. Remember, you are responsible for pesticide spray drift.
- Thoroughly wash yourself and your clothes immediately after applying pesticides.
- Do not permit empty pesticide containers to lie around; triple rinse containers, wrap in paper, and put them in the trash can. Punch holes in empty containers. Do not burn such containers in a backyard trash burner.
- Store pesticides in tightly closed, well-labeled, original containers away from children or pets, never under the sink, in the pantry, or medicine cabinet. Store in a cool, dry place. Placing bags of wettable powders in a sealed clear plastic bag reduces unpleasant fumes. Mark the storage cabinet or storage area "POISON STORAGE." It is best to keep pesticides under lock and key.
- Keep children and pets away from areas where you are mixing or applying pesticides.

- Do not store diluted spray mixtures in jugs or the spray tank from one spray application to the next. It will not be effective and is unsafe.
- Observe all harvest intervals and reentry requirements after using the pesticide.
- Keep a written record of what you apply.

Pesticide Training

Pesticide training is available at your local county Cooperative Extension office. If you feel uncomfortable about handling pesticides and understanding labels, ask about the availability of private applicator pesticide certification training.

Where to Purchase Pesticides

Most garden centers or stores with yard and garden departments where pesticides are sold have commonly recommended pesticides. Many agricultural supply or farmer co-op centers also carry them.

Pesticide Formulations

Even experienced gardeners are sometimes confused by the array of pesticides and special formulations available and the need to select the right materials. Pesticides may be available in one or more formulations.

Wettable powders. Pesticides used on fruit crops are most commonly sold as wettable powders that are meant to be mixed with water, then sprayed on the crop. If the active ingredient makes up 50% of a wettable powder product, it is called a "50W" or "50WP."

Liquid concentrates. Liquid concentrates are also meant to be mixed with water, then sprayed on the crop. The active ingredient usually ranges from 20 to 50% of the product.

Dusts. Dusts are ready to apply as purchased; they are not mixed with water, and they usually contain 1 to 10% active ingredient.

Spray Equipment

Thoroughly cover fruit plants with pesticide sprays according to the "timing" in the spray schedule to adequately control pests. Use a sprayer that is powerful enough to reach all parts of the plant with spray (e.g., tops of trees), easy to clean, and slow to wear out. Suitable sprayers come in various shapes and sizes. Refer to Table 4 in deciding what size sprayer is needed for your fruit planting.

Hand pump sprayers like the one pictured here have metal or plastic tanks which vary in size from one to three gallons. Air is pumped into them by a built-in hand pump. Spray is delivered through an attached hose with a hand shut-off valve and nozzle tip.

Hand pump backpack sprayers are compressed air sprayers that vary in size from three to five gallons and are strapped onto the applicator's back. These sprayers, also equipped with hand shut-off valves, have a hand pump that must be pumped slowly but continuously. Pumping builds up pressure in the tank and forces spray through a hose and nozzle tip at an even, steady rate. Some sprayers allow the addition of a 6-foot extension rod to the spray wand which substantially improves reach and coverage.

Hand-held compressed air and **knapsack sprayers** are satisfactory for a few dwarf fruit trees, vines, bushes, or strawberry plants. They do not have the capacity to spray mature standard-sized trees.

Trombone or **slide-type sprayers** consist basically of two small-diameter tubes. One tube slides within the other, compresses liquids, and forces pesticide solution through a small hole in the end of one tube. These sprayers can deliver spray to tops of most fruit trees and are suitable for plantings of a few trees, as well as small fruit plantings.

Small power sprayers such as backpack mist blowers, gas power sprayers, and electric power sprayers that run off a 12-volt battery are available for larger home orchard plantings.

Accessory Equipment

Two other pieces of equipment are beneficial to the home fruit grower: a one-quart graduated measuring cup and a set of measuring spoons. **Mark the measuring cup and spoons with spray paint or an indelible marker so that they are used for pesticide measurements only. Keep the cup and measuring spoons separate from those used in the home and store them with the pesticides.** These pieces are necessary to accurately measure required amounts of pesticides, thus ensuring the best control and the least possibility of plant injury. A container designated for making a slurry of the pesticides with water will help in getting the pesticide solution into the spray tank.

Table 4. Approximate amount of spray required for fruit trees of different sizes.

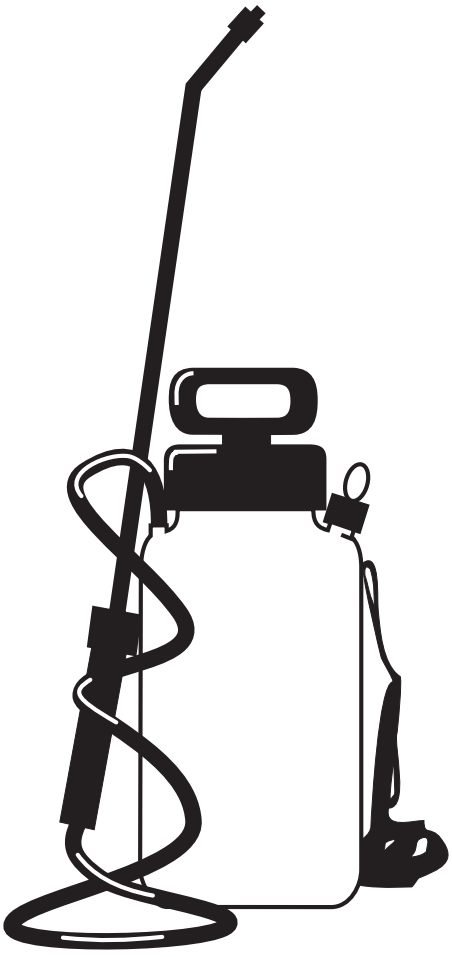
Height (in feet)	Spread (in feet)	Gallon per Tree per Application[1]
4	3	.5
5 to 8	3 to 6	1 to 1.5
8 to 10	4 to 8	2 to 3
10 to 15	8 to 15	3 to 6
15 to 20	15 to 25	5 to 10

[1] Use the greater amounts for trees in full foliage.

How to Spray Correctly

Keys to successful pest control are thorough and proper coverage, correct timing, proper dosage, and the use of correct materials. These points are extremely critical. Lack of attention to them accounts for poor quality fruit production. In addition, keep the following points in mind:

- Thorough coverage of all above-ground plant parts is necessary to control fruit insects and diseases.
- Direct spray onto both top and bottom sides of leaves until spray begins to drip off the leaves.



- The goal of spraying is to place a thin layer of pesticide over all exposed surfaces of each plant so that no matter where an insect may eat or crawl on that plant or where a disease organism may be, each is exposed to a lethal amount of pesticide before damaging the plant.
- Fungicides prevent infection; therefore, new growth must be protected. Fungicides should be applied more frequently in spring when plants are growing rapidly and when pathogens are active.
- Wettable powder sprays tend to settle to the bottom of the tank unless the sprayer has a mechanical or automatic agitator. Stir or shake mixture often during application.
- If pest control results are poor after using the spray schedule, be sure to check these important points:
  - Did plants receive thorough spray coverage at the recommended dosage?
  - Were any recommended sprays omitted?
  - Was the timing according to schedule?
  - Did it rain before the pesticide had time to dry on foliage?
  - Was a fresh spray mixture used each time? Pesticide solutions left in the sprayer soon lose their toxicity and may harm sprayer parts.

Spraying Small Quantities of Pesticides

Table 5 is provided as a guide for home fruit growers to determine how much pesticide is needed to mix up small amounts of spray material because some pesticide containers do not provide this information. **This table should not be used as a recommendation of pesticide rates to apply to fruit crops but as a guide for mixing pesticides based on the pesticide container label.** There are a number of reasons for this.

One of the major limitations in converting from pounds per 100 gallons to a volume measure such as tablespoons is that wettable power pesticides can have different densities. For example, thiophanate-methyl is quite light in comparison to Captan. Thus, there is quite a difference in the volume occupied by a pound of thiophanate-methyl and a pound of Captan.

Be further cautioned that the rate of a pesticide that is applied may vary between different fruit crops. **Thus, ALWAYS USE THE PESTICIDE LABEL AS THE BASIS FOR YOUR CALCULATIONS.**

Cleaning Spray Equipment

Spray any excess spray on the fruit planting rather than dumping it out and contaminating the environment. Next, place a small amount of water in the tank, agitate it and spray this out on the ground beneath the fruit plants. Then, flush the tank several times with clean water and force water through the spray wand and nozzle until clear water is expelled. To prevent corrosion, suspend tank upside down with lid removed to permit drainage and drying.

Table 5. Spray dilution chart for small quantities of pesticides.[1]

	Amount per:	
	100 Gal	**1 Gal**
Insecticides		
Dormant oil (2%)	2 gal	5 tbsp
Dormant oil (3%)	3 gal	7 ½ tbsp
Malathion 25% WP	3 lb	2 tbsp
Sevin 50% WP	2 lb	2 tbsp
Fungicides		
Captan 50% WP	2 lb	2 tbsp
Chlorothalonil	1 lb	1 tbsp
Liquid lime-sulfur (Sulforix)	1 - 3 gal	2.5 - 7.5 tbsp
Mancozeb 80% WP	2 lb	2 tbsp
Maneb 80% WP	2 lb	2 tbsp
Myclobutanil (Immunox)	—	½ - 2 oz
Streptomycin	see label	
Thiophanate-methyl	6 oz	1 tsp
Wettable sulfur 95% WP	6 lb	3 tbsp

[1] This table is only a guide and should be used in accordance with information found on the pesticide label.

Dry Formulations	*Measurement Equivalents*	1 lb = 16 oz = 454 g 1 oz = 28.4 g
	Sample Concentrations	
	English Units	**1 lb pesticide/100 gal water** = 16 oz/100 gal water = 1.6 oz/10 gal water = 0.16 oz/1 gal water
	Metric Units	**1 lb pesticide/100 gal water** = 454 g/100 gal water = 45.4 g/10 gal water = 4.5 g/1 gal water

Liquid Formulations	*Measurement Equivalents*	1 gal = 4 qt = 8 pt = 16 cu = 128 fl oz = 3,785 ml 1 qt = 2 pt = 4 cu = 32 fl oz = 946 ml 1 fl oz = 2 tbsp = 29.6 ml 1 tbsp = 3 tsp = 14.8 ml = ½ fl oz
	Sample Concentrations	
	English Units	**1 qt pesticide/100 gal water** = 32 fl oz/100 gal water = 3.2 fl oz/10 gal water = 0.32 fl oz/1 gal water
	Metric Units	**1 qt pesticide/100 gal water** = 946 ml/100 gal water = 94.6 ml/10 gal water = 9.4 ml/1 gal water

Reentry after Spraying

Home orchards are exempt from worker protection standards, which are mandatory for commercial fruit growers. All pesticides have a minimum 12- to 96-hour reentry interval after spraying, which must be adhered to by commercial growers. **We suggest that you stay out of pesticide-treated areas for at least 12 hours and until the area is dry.**

Harvest Restrictions

(Waiting period from spraying to picking)

Pesticides are poisons, and many backyard fruit growers are concerned about eating fruits that have been sprayed with pesticides.

The U.S. Environmental Protection Agency (EPA) has established set time periods between the last application of a pesticide (which varies for different pesticides and crops) and harvest to avoid unnecessary residues on ripe fruit. When pesticides are used in accordance with label recommendations, fruit residues are well below the established level allowed for sale.

Table 6. Label and harvest restrictions: Days required between final spray and harvest for common fungicides.

Trade Names	Common Names	Harvest Restrictions/Limitations (Days before Harvest)								
		Apple	Pear	Peach	Cherry	Plum	Blackberry/ Raspberry	Strawberry	Grape	Blueberry
Agri-strep	streptomycin	50	30	**	**	**	**	**	**	**
Captan	Captan	0	*	0	0	0	0	0	0	0
Immunox	myclobutanil	90	**	0	0	0	0	0	14	**
Ortho Daconil	chlorothalonil	**	**	0	0	0	**	**	**	**
Dithane M-45	Mancozeb	77	77	**	**	**	**	**	66	**
Kocide 101 C-O-C-S & others	copper hydroxide, copper oxychloride, fixed copper, tribasic copper sulfate, basic copper sulfate	0	0	0	0	0	0	0	0	0
Sulfur	Sulfur	0	0	0	0	0	0	0	0	0
Topsin-M	thiophanate-methyl	1	1	1	1	1	**	1	7	**

* Limited number of applications allowed or other restrictions apply. REFER TO LABEL DIRECTIONS.
** Not registered or recommended.
Note: Check labels for REENTRY TIMES. Restrictions in reentry times may prohibit the use of certain pesticides during harvest.

Table 7. Label and harvest restrictions: Days required between final spray and harvest for insecticides and miticides applied to tree fruit, brambles, strawberries, grapes, and blueberries.

Trade Names	Common Names	Harvest Restrictions/Limitations (Days before Harvest)								
		Apple	Pear	Peach	Cherry	Plum	Blackberry/ Raspberry	Strawberry	Grape	Blueberry
Neem oil	azadirachtin	0	0	0	0	0	0	0	0	0
(numerous)	permethrin	***	***	***	***	—	***	***	—	***
(numerous)	Bacillus thuringiensis (Bt)	0	0	0	0	0	0	0	0	0
Malathion	Malathion	**	**	7	3	**	1	3	3	1
Permethrin	Captain Jack's Deadbug Brew, spinosad	7	7	14	7	7	3	1	7	3
Sevin	carbaryl	3	3	3	3	3	7	7	7	7
Vendex	fenbutatin-oxide	14*	14*	14*	14*	14*	**	1	28	**

* Limited number of applications allowed or other restrictions apply. REFER TO LABEL DIRECTIONS.
** Not registered or recommended.
*** Preharvest intervals vary for different formulations, applications, and uses. See product label for details.
Note: Check labels for REENTRY TIMES. Restrictions in reentry times may prohibit the use of certain pesticides during harvest.

Simply washing fruit before consuming it removes most remaining residue.

There is no problem with excessive pesticide residues on your harvested fruits if:

- Only registered pesticides that list the particular crop to be treated on the label are used.
- Pesticide is used only at the rate recommended on the label.
- Fruit is not picked earlier than the safe preharvest interval given on the label and in Tables 6 and 7.
- Fresh fruit is washed before consumption or processing, even if pesticides are not used.

Every pesticide label provides harvest restrictions. If your pesticide and its label do not give this information, then it probably is not intended for use on fruit and should not be used.

Factors That Can Reduce Pesticide Effectiveness

There are several factors that can reduce the effectiveness of pesticides, making repeat applications necessary.

Weather. Many pesticides volatilize or lose effectiveness in a matter of days or weeks after being applied. Factors such as temperature, humidity, wind, and sunlight affect the life of pesticides. The greater the extremes of these factors, the quicker pesticides lose their toxicity.

Rain, to some degree, physically removes pesticides from plant foliage. In general, a pesticide is less likely to be washed off if it has had an opportunity to dry thoroughly on foliage before rain. Most materials should be reapplied the day after a heavy rain. Strong sunlight and driving winds also shorten the effective life of pesticides.

Plant growth. New plant growth early in the season results in unsprayed and unprotected parts if spray applications are not repeated at regular intervals.

Pest populations. Pest populations are continuously moving and/or multiplying, requiring repeated spray applications.

Pesticide age. Although most pesticides retain their toxicity for several years when properly stored, it is best to buy only enough for one season's use. Most pesticides gradually lose their effectiveness when exposed to moisture, air, light, and high temperatures. Prolonged low or freezing temperatures frequently cause liquid formulations to separate, making them unsafe and noneffective for further use.

Multipurpose or All-Purpose Fruit Sprays

A plant often needs protection from both insects and diseases at the same time. All-purpose sprays are commercially prepared mixtures of insecticides and fungicides that give adequate control for most common problems, are easy to use, and reduce the number of pesticides the homeowner must store safely. However, be aware of the following:

- None of these multipurpose mixtures controls all insects and diseases you are likely to encounter. Not realizing this, many users tend to apply mixtures more frequently and at higher rates trying, in vain, to control some pests.
- Multipurpose mixtures lack flexibility so that when only a fungicide is required (e.g., during bloom), an insecticide also is applied even though it is not needed and could be damaging.
- Most multipurpose mixtures are more expensive than those you prepare yourself.

You can mix all-purpose fruit spray with additional pesticides, but there are some limitations. If you are in doubt about spray combination injury, check the label. If a mixture containing carbaryl is used, do not apply it until 21 days after petal fall on apples and pears. Carbaryl thins or causes fruit to drop if applied before this date. Carbaryl may also cause buildup of pest mites and if applied at bloom will harm bees. Apply the mixture to a small portion of the tree and wait to see what happens. Spray burn should show up in 24 to 48 hours. If burn results, do not apply the combination. If you plan to mix your own combination, use wettable powders to reduce plant injury.

Insect Control

Insect control is best achieved through a variety of measures, including good maintenance of the planting, correctly identifying problems, and safely and effectively applying pesticides at the proper time.

New invasive pests. There are two new invasive pests that attack tree and small fruit crops that have been confirmed in Kentucky. The first is the brown marmorated stink bug that was first identified in 2010 in Kentucky. This highly mobile pest attacks the fruiting structure on many types of ornamental and food crops. With tree fruit, feeding with its piercing-sucking mouthparts causes discolored, corky areas under the skin fruit. These internal blemishes can be ⅓ of an inch or larger. In other states where this pest has colonized, it can build to very high numbers in the home garden. For the home gardener, fruit bagging may be an effective alternative control to insecticides for its management.

The other new invasive pest is the spotted wing drosophila, a new fruit fly (aka vinegar fly) that attacks soft and thin-skinned fruit just prior to harvest. What makes this pest different from other common fruit flies is the pointed ovipositor (egg layer) of the female. Other fruit flies can only lay eggs in damaged or rotting produce, but the spotted wing drosophila female is able to insert her eggs under the skin of undamaged fruit. The eggs hatch and the maggots feed and cause a rapid breakdown of the fruit after harvest. Raspberries, blackberries, blueberries, cherries, strawberries, and grapes are very susceptible to this pest. Attack begins just as the unripe fruit turn color. Sprays containing malathion and spinosad have provided some control. Care must be given to Pre-Harvest Intervals to ensure safety of treated produce.

Traps can be used to determine when certain pests are present and in what numbers. Traps can also be used to control some pests when the number of trees is small. Traps are often used to monitor the adult form of insects that cause damage in the immature or larval form. Pheromone traps are available for codling moth, peachtree borers, various leafrollers, grape berry moth, oriental fruit moth, dogwood borer, San Jose scale, and lesser peachtree borer. These traps use sex-attractant lures to monitor adult males of specific pests.

Pheromone traps can reduce codling moth numbers when many traps (two to four per tree) are used. Pheromone traps need to be set out early in the season, usually before petal fall. Lures in traps should be replaced frequently, as per manufacturer's recommendations. This technique works only when the trees are isolated from other sources of infestation, i.e., other fruit trees. Pheromones are also being sold to prevent mating in some insects such as the codling moth, oriental fruit moth, and grape berry moth. Mating disruption requires that a large amount of pheromone be dispensed over an area and that the orchard be isolated from other sources of these pests. At present, mating disruption is not economically practical for small home plantings. Japanese beetle traps are not a recommended technique for Japanese beetle control. They attract unbelievable numbers of beetles and frequently increase the problem.

Place traps in the southeast corner of the tree canopy, 5 to 7 feet above the ground for tree crops. Traps should be placed on the perimeter of a planting facing the predominant wind direction or bordering wooded areas. In larger plantings, traps could be positioned at two corners and one at the interior.

Traps should be placed into the planting at the pink stage in tree crops. An early start allows the tracking of the first generation from the very beginning. Differentiate between older and younger trees.

Traps should be checked weekly except during peak emergence times when they are checked daily. Record the results. Further information on apple integrated pest management is available in IPM-9, *Kentucky Backyard Integrated Pest Management Manual.*

For more information on pheromone traps, consult the following publications from the University of Kentucky Department of Entomology:

- *Codling Moth* (ENTFACT-203)
- *Oriental Fruit Moth* (ENTFACT-212)
- *Peachtree Borer* (ENTFACT-200)
- *Lesser Peachtree Borer* (ENTFACT-200)
- *Strawberry Crown Borer* (Guidelines not yet established)
- *San Jose Scale* (ENTFACT-204)

Mites. Where mites appear to be a routine problem, the best control strategy is to use several tactics. First, a thorough dormant oil spray at green tip reduces the overwintering population. Second, select insecticides that are least damaging to predatory mites to delay buildup of troublesome populations. Finally, when the number of mites per leaf averages six to 10, apply Vendex or insecticidal soap and repeat in seven to 10 days. Miticide treatments may not be necessary every year, but when they are, be sure to use a two-spray treatment because most miticides do not kill eggs. Avoid unnecessary use of miticides because it quickly leads to resistance development by mites. If uncontrolled, hatching eggs can quickly lead to a buildup of high populations.

Sevin and sulfur are ineffective against pest mites but are highly toxic to predator mites. As a result, mite problems may develop on trees after the use of these materials.

Commonly Used Insecticides

Be sure to read and understand "Using Pesticides Safely" on page 4 before attempting to use any of the following.

Azadirachtin (neem oil, 3% liquid concentrate) is a botanical insecticide derived from the neem tree. Azadirachtin, extracted from the seed, is an insect growth regulator and feeding deterrent for pests. It is effective on fruit tree leafrollers, codling moth, eastern tent caterpillar, peachtree borer, aphids, grape leafhoppers, strawberry rootworm, stink bug, and many other insects. It is most effective on the juvenile or larval stages of insects rather than the adult stage. The growth regulator restricts larvae from molting. Results are evident in three to 15 days as reduced feeding and death. With repeated applications, insect pressure and plant damage are reduced. For organic certified growers, this chemical has been considered as a "Restricted Use Organic," which allows the use of this pesticide as a final choice alternative. Purchase only enough for one year since it loses its effectiveness.

Carbaryl (Sevin 50WP, 27% liquid concentrate, 5% dust, 10% dust) is a carbamate insecticide and is effective against Japanese beetle, codling moth, leafrollers, apple maggot, periodical cicada, grape berry moth, oriental fruit moth, flea beetles, spittlebugs, blueberry maggot, and many other fruit insects. Although toxic to aphids, it can actually worsen aphid and mite problems because it is also toxic to their natural enemies. In addition, carbaryl is very toxic to honeybees, and its use should be avoided during bloom when bees are active in the planting.

Carbaryl causes apple and pear fruit to drop if used within 21 days of bloom. In some cases, it can result in excessive fruit drop, particularly if a number of sprays are applied. It is often found in all-purpose fruit sprays. Its use should be delayed until four to five weeks after petal fall to avoid thinning. If fruits need to be thinned on a few trees, it is best to do it by hand. If there are a number of trees to thin, carbaryl is a readily available thinning agent and works well on a number of cultivars. See ID-92, *Midwest Tree Fruit Spray Guide*, for the specifics on thinning. Too heavy a fruit load can cause tree limbs to break and leads to the production of small fruit and insufficient flower formation for the following year's crop.

Malathion (50% liquid concentrate) is an organophosphate insecticide that is relatively safe for general use. It is effective against aphids, stink bugs, and other pests. Malathion is not effective where mites are resistant to other organophosphate materials. Its residual effectiveness is generally less than three to four days, so it is especially useful near harvest for pests such as sap beetles, yellowjackets, wasps, and bees. Make sure to observe the preharvest interval.

Permethrin (2.5% liquid) is a pyrethroid insecticide, a synthetic analog of pyrethrum. This is a broad-spectrum insecticide that controls a wide range of fruit pests and provides long residual activity. Permethrin is highly toxic to mite predators and can encourage mite outbreaks.

Pyrethrum (liquid or WP or dust) is a botanical insecticide extracted from the flowers of a species related to garden chrysanthemum. This is a natural pyrethrum and should not be confused with the synthetic pyrethroid materials. Pyrethrum gives rapid knockdown of caterpillars, beetles, bugs, leafhoppers and leafminers. Pyrethrum leaves little residue, degrades quickly, and must be sprayed on the insect. Pyrethrum can be harmful to beneficial insects.

Spinosad. This 80% WP or spray concentrate is an insecticide for use on apple, pear, peaches, plums, blueberry, blackberries, strawberries, and raspberries to control codling moth, leafminers, leafrollers, oriental fruit moths , fruit flies, and thrips. It has residual control of 5 to 7 days.

Spray oil ("superior," "horticultural," "dormant") is a superior grade of petroleum oil formulated with an emulsifying agent for easy mixing with water. Oil is generally considered an organic treatment. It is used to control pear psylla, mites (European red mite, pear leaf blister mite), and scale insects on tree fruits and is usually applied during the late-dormant to green-tip stage. To avoid severe injury to trees, do not apply when temperatures are likely to fall below 40°F within 24 hours. Thorough coverage of all bark surfaces is very important for oil sprays to be effective.

Microbial insecticides are derived from beneficial microorganisms such as bacteria, viruses, and fungi. These microorganisms cause lethal sickness in pest insects. The most common microbial insecticide is a bacterium, *Bacillus thuringiensis* (Bt). The active ingredient is not the Bt bacterium itself but a toxin produced by the bacterium that is lethal when ingested by caterpillars, including leafrollers, gypsy moths, and codling moths. Because Bt must be consumed to take effect, it is slower acting than other pesticides. Bt is safe not only to humans but also to beneficial insects such as ladybird beetles, lacewings, predaceous bugs, and parasitic wasps. Avoid spraying Bt near areas of the landscape meant to attract butterflies or provide habitats of butterfly larvae. There is also a virus that is used to control Codling moth. Like Bt it must be consumed and it readily breaks down in sunlight. It is non-toxic to other insects.

Insecticidal soap is a blend of potassium salts of naturally occurring fatty acids that is more effective for pest control and less phytotoxic than ordinary soaps. However, these soaps have no residual activity and are effective only against insects present at the time of application. There are many home recipes made from dish soap, but dish soap has not been cleared for use on food by the EPA.

Disease Control

Disease control is best achieved through a variety of measures, including proper maintenance of plantings, correct pathogen identification, and proper times of fungicide application. Selection of resistant cultivars is also recommended, when possible (see Table 1).

Site management. Most diseases, including apple and pear scab, powdery mildew, and fruit rot diseases are more severe in moist, shaded locations. Thus, disease incidence can be reduced by improving air movement through plantings and increasing sunlight penetration into plant canopies. This can be done by pruning plants, eliminating weeds, and removing overhanging vegetation from nearby landscape trees. Avoid prolonged leaf wetness by irrigating soil around plants rather than using overhead sprinklers.

Drainage. Soilborne diseases may become problematic in poorly drained sites. Thus, proper drainage is critical to reduce risk

for root and crown rot diseases such as Phytophthora root rot. Install new plants in well-drained sunny locations. Raised beds that are high in organic matter are recommended.

Site orientation. When possible, locate orchards on slopes. North- or east-facing slopes make good orchard sites because temperatures remain cooler later in the spring; thus, bloom is delayed, and there is reduced chance of frost or freeze injury during bloom. Slopes also offer good drainage, which helps deter soilborne pathogens. Never locate orchards on poorly drained sites.

Transplants. Soil-borne and root diseases may also be brought into plantings on transplants. Always purchase nursery stock from reputable growers. Inspect all purchases for galls, root decay, stem cankers, or insect pests. Do not plant disease or insect-infested plants.

Commonly Used Fungicides

Read and understand "Using Pesticides Safely" on page 4 before using fungicides. Common fungicides are listed below. For more detailed information on fungicides for home orchards, see Homeowner's Guide to Fungicides http://www.ca.uky.edu/agcollege/plantpathology/ext_files/PPFShtml/PPFS-MISC-7.pdf

Captan (Captan 50WP and other home fruit spray mixes such as Bonide, Fruit Tree Spray) is a broad-spectrum fungicide for use on most fruit crops and many vegetable and ornamental plants. Captan controls scab and is often used in combination with thiophanate-methyl. It also helps control peach leaf curl. Not effective against powdery mildew or rust diseases. Because of incompatibility and injury problems, Captan should not be used in combination with sulfur or spray oil. Captan causes severe leaf injury on Japanese-type and Stanley plums if used before July.

Chlorothalonil (Ortho Max, Daconil or Fungonil) is a broad-spectrum protectant that is effective against peach leaf curl and fruit diseases of peach, plum, and cherry. It can only be used early in the growing season for fruit rot control.

Mancozeb (Dithane M-45, Southern Ag; Bonide Mancozeb) has broad-spectrum protectant activity. It is good for control of scab and rust diseases of apple and for control of grape black rot, leaf spot, and downy mildew.

Myclobutanil (Spectricide, Immunox, Rally) is a locally systemic fungicide effective against apple scab and cedar apple rusts. It can also be used for management of brown rot of peaches and other stone fruits, and for black rot and anthracnose of grape. It is effective against powdery mildew diseases of apples, stone fruits, and grapes. It is best used in combination with Captan or Mancozeb and should not be used on apples past first cover.

Phosphorus acid (Monterey Agri-Fos) is effective against water mold diseases such as Phytophthora root rots of most fruit and downy mildew of grape. Fully systemic.

Thiophanate-methyl (Topsin M) is a systemic fungicide effective against powdery mildew and other diseases of apple and stone fruits. On apples, it controls scab, powdery mildew, and fruit rots but not rust diseases. On stone fruits, it controls brown rot, scab, black knot of plum, and cherry leaf spot. Use in combination with Captan or other labeled fungicide when possible.

Copper Fungicides

Bordeaux mixture is a combination of copper sulfate and hydrated lime in water. It has long residual action and has been used to control many diseases, including peach leaf curl, fire blight and scab of apple, and black rot, downy mildew and powdery mildew of grape. It is available as a pre-mixed dry wettable powder or in liquid form.

Fixed copper fungicides (Ortho Disease-B-Gone Copper dust or liquid copper) are less injurious to plant tissues than Bordeaux mixture, but their use is still limited because of their potential to injure plants and lack of compatibility with other pesticides. Copper is also effective against bacterial pathogens—see "Bactericides" on this page.

Sulfur Fungicides

Sulfur is toxic to foliage of certain grape varieties (especially American grapes) including Concord and the French hybrid grapes Chancellor, DeChaunac, and Foch. Sulfur is relatively safe on most other varieties. Applications after fruit begins to ripen may pose problems during fermentation if grapes are intended for winemaking.

Sulfur is lethal to some beneficial insects, spiders, and mites. These beneficial insects are natural predators of harmful insects and mites that affect fruit crops. Killing beneficial insects may increase certain pest problems, especially mites.

Sulfur provides good control of brown rot and scab of stone fruits. Sulfur is only moderately effective against apple scab. For effective control, sulfur applications must be perfectly timed ahead of scab infection periods.

Liquid lime sulfur fungicide is effective as a dormant spray on peaches for peach leaf curl, on plums for black knot, and on raspberries and blackberries for cane blight, spur blight, and anthracnose. It should be used only when plants are dormant. Severe damage may occur if applied after green foliage appears.

Sulforix is a formulation of liquid lime sulfur with improved surfactants that allows for use at lower rates than liquid lime sulfur.

Dry wettable sulfurs are available under many trade names. Microfine wettable sulfurs are usually much less injurious to foliage and fruit than liquid lime sulfur, but their use during hot weather (above 85°F) may result in leaf burning and fruit russeting. Dry wettable sulfurs are effective for control of powdery mildew on most fruit crops.

Bactericides

Copper materials (Copper dust, liquid copper, or copper soap, Ortho Disease-B-Gone). On apples and pears where fire blight was present the previous season, an application of Bordeaux mixture or fixed copper materials is effective if applied just before bloom to reduce bacterial populations. Where bacterial spot has been a problem on peaches, an application of fixed copper just as leaves begin to fall in autumn helps reduce overwintering bacteria. Copper materials applied during the growing season can damage apple leaves and fruit and cause complete defoliation of peaches and other stone fruits.

Streptomycin (Fertilome fire blight spray) is an antibiotic of limited use but is important for apple and pear varieties with a history of fire blight problems. Although streptomycin is commonly used in commercial apple orchards and is not a restricted-use pesticide, it may be difficult for homeowners to obtain. In addition, timing and number of required sprays are critical to achieve effective control and to avoid problems with resistance. Select varieties with some natural resistance to fire blight and employ cultural practices that reduce risk of infection.

Weed Control

Young trees grow best with clean culture under the tree spread. Older trees can grow and bear well in grass and sod; however, they do best if a bare area is maintained beneath the trees. When present, grass should be mowed, and weeds should not be allowed to grow up through trees. Homeowners should pull and hoe weeds that grow in fruit planting areas. String weed trimmers can seriously damage tree trunks, and care must be taken when these are used.

Mulches, applied 2 to 4 inches thick, control weeds effectively. Before choosing a mulch, consider availability, cost, appearance, and rodent protection. Mice can hide undetected in mulch; therefore, tree guards are a must. Mulches that are applied once during the growing season cut down on weeds significantly and conserve moisture. Weeds that do come through the mulch are easily pulled by hand. While many preemergence herbicides are labeled for use in commercial fruit plantings, they are not recommended for home fruit plantings. Also, lawn herbicides should not be applied near fruit plantings since they may damage trees and small fruits if the application drifts onto these plants.

Glyphosate (Roundup and other brands) is sold in many formulations that are labeled for use on fruit plantings. Glyphosate is a contact herbicide that controls most annual and perennial grasses and broadleaf weeds. For best results, apply when weeds are actively growing. Perennial weeds may require repeat applications, and fall applications that allow the herbicide to be translocated to the root system may be more effective. **Caution:** Do not allow spray to contact any part of the tree including the trunk, or severe damage may result. Glyphosate accumulates in trees from multiple applications and from year to year.

Control Recommendations for Specific Crops

The following discussion, which groups similar fruit crops, is intended as a guide for making decisions in controlling specific pests. Sanitation measures to reduce pests are critically important in managing home plantings.

Spray schedules indicate when specific pesticide applications are required to control various pests on susceptible varieties. Pesticides are used to kill insects and disease pathogens. Handle these chemicals carefully to prevent injury to you, other people, and pets.

If you plan to buy and use chemicals, acquaint yourself with the material to be used, the problems controlled, safety precautions, and specifications of the label. Unless fruit thinning is desired on apples or pears, do not use Sevin in the spray schedule until three to four weeks after flower petals fall. Sevin is especially toxic to honeybees. Repeated use of Sevin increases mite and aphid populations. Always avoid spraying insecticides during bloom in order to preserve honeybees.

The spray schedules are only suggested guidelines because environmental conditions and pest populations vary greatly from year to year. Because of constantly changing pesticide regulations, formulations, and labels, specific application rates are not provided. For more information on common pesticides and the pests they control, refer to the section on "Commonly Used Insecticides." It is the applicator's responsibility to obtain the most current information on use directions and application rates directly from the pesticide label.

Apples and Pears

Diseases

Apple scab, pear scab, and pear leaf spot. Scab and leaf spot diseases overwinter on leaf debris that remains on orchard floors. Destroy all leaves in fall, including those from nearby flowering crabapples and ornamental pears.

Cedar apple rust. This fungus has an unusual life cycle that involves two different hosts, apple and cedar. In spring, infective spores are produced in galls that form on nearby cedar. These spores directly infect apple foliage. If cedar are part of an established landscape, remove visible galls during late fall. Inspect cedars again in early spring during or just after a rain when the orange, gelatinous fungus growth from any remaining galls is highly visible. Protect apple foliage with fungicides when galls begin to appear on cedar. Once rust pustules appear on apple, fungicides are not effective.

Fire blight , powdery mildew, and summer rots. The pathogens that cause these diseases overwinter primarily on dead and diseased wood. Remove all dead or diseased shoots and limbs while trees are still dormant. Early March is usually a good time to prune trees. All pruning cuts should be made at the branch bases, leaving only the branch collar (¼ to ½ inch) so that wounds heal properly. Removal of limbs with cankers and blighted twigs reduces amounts of infective pathogens and increases effectiveness of fungicides. As with other disease management recommendations, all plant debris should be destroyed. Do not use tree wound paints and dressings.

Fire blight is a bacterial disease that requires different management procedures. Pruning fire blight from trees during the growing season creates a risk of increased disease spread. In most cases, pruning should be delayed until winter when bacteria are inactive. However, if the disease is serious in young trees and tree structure is at risk, immediate pruning might be warranted. Break or cut infected parts at least 6 to 8 inches below the lowest point of visible infection or back to the branch collar. If removal is made by pruners, avoid spreading bacteria by sanitizing blades of cutting tools between each cut with: 1) rubbing alcohol (70%); 2) 10% household bleach; 3) 10% Lysol concentrate. Immediately remove diseased material and burn, bury, or otherwise dispose of it.

Rinse bleach or Lysol from tools before storage to prevent rust. Use disease-resistant cultivars when possible. See Table 1 for a listing of disease-resistant apple cultivars.

Table 8. Spray schedules for pest control on apples and pears.

Plant Stage[1]	Insects and Diseases	Examples of [Organic] Pesticides Required[2]		Comments
		Apple	Pear[3]	
Dormant	scale	[dormant oil]		Check label carefully for dormant vs. delayed dormant rates on apple vs. pear. Do not spray dormant oil when temperature is below 40°F (5°C) or likely to drop below 40°F within 24 hours. Do not mix bactericide with oil.
	fire blight	[fixed copper]		Copper sulfate is not the same as fixed copper and should not be mixed with oil.
Green tip to half-inch green	scale	[dormant oil]		See above. Last chance to apply oil on apples, if not applied in dormant spray.
	scab	Captan, Mancozeb, thiophanate-methyl + Captan, myclobutanil + Captan, [fixed copper, sulfur]	No spray needed	Oil, fixed copper, and myclobutanil can be mixed together.
Tight to open cluster	scab	Same as green tip	No spray needed	Using fixed copper past this point is likely to cause fruit russetting.
Pink	aphids, tarnished plant bug, stink bug (if present)	Multipurpose tree fruit spray mixture, [Pyrethrum], malathion		[citrus peel oil, garlic oil]
	scab, rust	Same as green tip but *must* include myclobutanil, Mancozeb, [fixed copper, sulfur]	myclobutanil, Mancozeb [fixed copper, sulfur]	
Bloom	scab, rust, powdery mildew	Same as green tip but *must* include myclobutanil, Mancozeb, [fixed copper]	No spray needed	Do not use insecticide during bloom.
	fire blight	[Streptomycin]—provided sanitation pruning has been done		All dead twigs and branches must have been pruned out while trees were dormant before considering chemical use now.
Petal fall	plum curculio, pear psylla, plant bugs, leafrollers	Multipurpose tree free spray mixture, [Pyrethrum, Surround], malathion		Surround for plum curculio.
	scab, rust, fruit rots, sooty blotch	Same as green tip but *must* include myclobutanil, Mancozeb, [fixed copper, sulfur]	myclobutanil, Mancozeb, [fixed copper, sulfur]	
First cover	codling moth, plum curculio	Malathion, [Pyrethrum, Surround, multipurpose sprays, Spinosad]		Surround for plum curculio. Spinosad for codling moth.
	scab, rust, fruit rot, sooty blotch	Same as green tip but *must* include myclobutanil, Mancozeb, [sulfur]	myclobutanil, Mancozeb, [sulfur]	
Second cover	codling moth, plum curculio, San Jose scale crawlers	Malathion, [Pyrethrum, multipurpose sprays, Spinosad]		
	scab, rust, fruit rots, sooty blotch, leaf spots	Same as green tip, but *must* include myclobutanil, Mancozeb, [sulfur]	myclobutanil, Mancozeb, [sulfur]	
	mites (if present)	Vendex, insecticidal soap		
Third cover	codling moth, pear psylla	Malathion, [Pyrethrum, multipurpose sprays, Spinosad]		
	scab, fruit rots, sooty blotch	Captan, thiophanate-methyl + Captan, [sulfur]		See label for Captan use.
Remaining covers[4]	codling moth, leafhoppers, pear psylla	Malathion, [Pyrethrum, multipurpose sprays, Spinosad]		
	fruit rots, scab, sooty blotch	Captan, thiophanate-methyl + Captan, [sulfur]		See label for Captan use.

[1] See pages 18 and 19 for illustrations of plant floral stages.
Dormant: Early spring before buds swell. **Green tip to half-inch green:** When blossom buds show ½ inch green. **Tight to open cluster:** When fruit buds are visible. **Pink:** Just before blooms open. **Bloom:** When 20 to 60% blossoms are open. **Petal fall:** When last petals are falling. **First cover:** Seven days after petal fall spray. **Second cover:** Two weeks after first cover spray. **Third cover:** Two weeks after second cover. **Remaining covers:** Spray every two weeks.

[2] Growers must read the pesticide label for proper rates of chemical to use. Some materials are effective against some pests and not others. Choose materials needed to control the most important pests in your fruit planting. See Table 5 for information on mixing small quantities of pesticides.

[3] Although cleared for use on apples, Captan is not labeled for pears. Materials in [brackets] are approved for organic production.

[4] Check label for waiting days to harvest. Tables 6 and 7 also give waiting days to harvest.

Note: There are several formulations of multipurpose fruit sprays. Be sure to check the label to determine which are organic formulations.

Avoid apple cultivars that are susceptible to fire blight: Jonathan, Yellow Transparent, Gala, Ben Davis, Granny Smith, Jonagold, Melrose, Mutsu, Paulared, York Imperial, Lodi, Idared, Braeburn, Fuji, and Rome Beauty.

Pear cultivars that are resistant to fire blight include: Blake's Pride, Shenandoah, Maxine, Seckel, Moonglow, Potomac, Harrow Sweet, and HoneySweet. Avoid pear cultivars that are very susceptible to fire blight: Bartlett, Comice, Anjou, Clapps Favorite, and Bosc. Use nitrogen fertilizers sparingly around fire blight-susceptible pear and apple cultivars. Succulent growth that results from excessive nitrogen application encourages development of fire blight.

Insects

Apple maggot, codling moth, and plum curculio. Fruits on the tree showing entrance or exit wounds (holes) of either apple maggot or codling moth should be removed and destroyed immediately. Apple maggot is rarely found in Kentucky but is a serious problem north of the Ohio River. Similarly, all fruits that fall prematurely, especially during May and June, should be promptly collected and destroyed. This is an important step because it prevents developing larvae from reaching maturity and causing more damage to other fruits later in the season. Codling moth larvae are attracted to corrugated cardboard strips as a place to pupate over winter. Attach strips of corrugated cardboard around the trunk of the tree in late summer and remove and destroy them in winter.

Pear psylla on pears. Just before the green tip stage of pear bud development, tiny pear psylla nymphs appear and begin sucking plant juices. They collect beneath leaves, and if left unchecked, their feeding in summer causes leaves to turn brown and drop. Leaves, twigs, and fruits are often covered with sticky honeydew (psylla droppings) on which a black, sooty mold grows.

If pear psylla has been a problem, apply dormant oil spray before buds open, followed by an insecticide at petal fall and in the first cover spray. Wait 30 days and if psyllids are still present, make two more applications of insecticide seven to 10 days apart.

Pesticide Spray Program

A preventative approach emphasizing early-season control of all major diseases and a number of important insect pests is recommended (Table 8). The critical time period is between bud break (green tip) and about one week after petal fall. This is the only time that certain diseases (scab, apple rust, and powdery mildew) and insect pests (plant bugs) can be controlled effectively. In other cases (where pear leaf spot, mites, aphids, plum curculio, pear psylla, and leafrollers are problems), a good early-season program not only provides excellent control but also greatly reduces potential for late-season damage and, therefore, the need for frequent sprays later in the season. Where an early-season control program is followed, timing of mid- to late-season sprays is much less critical and the interval between applications can be safely lengthened to two or three weeks. Learning to identify insect and disease symptoms is the key to reducing sprays at this time.

Bagging Fruit

Paper bags can be placed over individual fruit early in the season to protect them from codling moth, apple maggot, and sooty blotch disease. This substantially reduces the spray program. Special two-layered fruit bags made in Japan or ordinary paper bags with twist ties can be used. Fruit should be bagged when they are ½- to ¾-inch in diameter, about three weeks after petal fall. Bags should be removed two to three weeks before harvest to allow normal color development. For more information, see ENTFACT-218, *Bagging Apples: Alternative Pest Management for Hobbyists.* (See the "Resources" section on the back page.)

Peaches, Nectarines, Apricots, Plums, and Cherries

Diseases

Stone fruit are susceptible to a number of pests and diseases, which require preventative sprays throughout the season. Brown rot is the most important disease of stone fruit (peaches, nectarines, plums, and sweet and tart cherries). However, other diseases such as peach leaf curl, Cytospora canker, black knot of plum, and cherry leaf spot also should be considered.

Brown rot is the most common disease of peach. The fungus overwinters on mummified fruit left hanging on trees or on the ground. After harvest or in spring, before buds open, collect and destroy all mummified fruit beneath trees and any that remain hanging. During the fruiting season, the fungus can infect and sporulate on ripening and over ripe fruit. Throughout the growing season, collect and destroy any fruit that falls prematurely or shows symptoms of brown rot. Never allow rotting fruit to remain on or under trees. Do not allow fruit to overripen or soften before harvest. Peaches, nectarines, and apricots should be harvested when their color (nonblush side) begins to change from green to completely yellow, even though the flesh is still firm. Harvest plums when fruit color is uniform and flesh begins to soften under gentle pressure. Two to three days of further ripening off the tree is necessary to achieve ideal eating quality, although tree-ripened fruit have the best eating quality. Good air circulation through the tree is essential to reduce leaf wetness, which favors brown rot. Proper pruning allows better air and sunlight penetration which reduces disease incidence.

Perennial canker. Be aware of signs of cankers, or dark, sunken areas on limbs and shoots with gum protruding through bark, often with a raised callus margin. Canker pathogens often enter major limbs through wounds, broken limbs, weak shoots, or shoots killed by winter injury.

Delay pruning until late April, when wounds heal more quickly. This helps reduce risk for infection through wounds.

Small cankers on shoots and limb tips should be removed completely during pruning. Prune water sprouts in centers of trees during late summer (early August) to help prevent establishment of cankers within the main tree structure.

Prevention of infection to main scaffold limbs and trunks is critical because once cankers develop, they often cannot be removed. Do not use commercial wound paints on pruning cuts. Make cuts so that

only a small, raised branch collar remains on the supporting branch, and allow them to heal naturally. Limb damage that occurs during the growing season should be removed immediately; do not delay until the dormant season. There is no fungicide cure for perennial canker.

Black knot of plum. Look for symptoms of black knot disease at the time of pruning. These are rough, black tumors or overgrowths that develop on shoots and limbs. Remove and destroy all knots. If possible, also remove nearby wild plums and wild cherries.

Cherry leaf spot fungus overwinters on fallen leaves. Rake and destroy all leaves in the fall as soon as leaves drop and again in early spring before bloom. This procedure can be very effective for small plantings.

Insects

Borers, catfacing insects (plant bugs, stink bugs), and the oriental fruit moth are usually the most destructive among insect pests that attack peaches. Peachtree borer also attacks other stone fruit trees. Plum curculio can destroy an entire plum crop and is harmful to other stone fruits as well (Table 9).

Plum curculio. Promptly collect and destroy any fruit that falls prematurely to reduce future plum curculio populations.

Yellowjackets, bees, and wasps. Plan on harvesting stone fruit over a period of one to two weeks. Regularly pick fully ripened fruits, and remove any that have fallen or any showing decay. This discourages yellowjacket, bee, and wasp populations around and in your trees so that no special insecticide treatments are necessary. It is a good idea to inspect every fruit before grasping it.

Peachtree borers. The peachtree borer works beneath the bark at or near ground level. The lesser peachtree borer may be found as high as 3 feet above the ground. Presence of borers is indicated by masses of gum that contain small brown particles of bark at the base of the tree or occurrence of frass and empty pupal cases protruding from tree wounds. If borers are found, they should be killed using a knife or flexible wire to probe larva from the trunk. This should be done carefully; carelessness may result in more damage to the tree than the damage that would have been caused by the borers! See ENTFACT-200, *Peachtree Borer,* for more information. Adult borers begin emerging in late April to mid-May in

Table 9. Spray schedules for pest control on peaches, nectarines, apricots, cherries, and plums.

Plant Stage[1]	Insects and Diseases	Examples of [Organic] Pesticides Required[2]			Comments
		Peaches, Nectarines, Apricots	Plums	Cherries	
Dormant	peach leaf curl, plum pockets	Fixed copper, [Bordeaux], chlorothalonil (for leaf curl)	Fixed copper, [Bordeaux], chlorothalonil (only if plum pockets are a problem)	No spray needed	This is the only time that a fungicide spray will control peach leaf curl and plum pockets.
Bud swell	scale insects, European red mites, aphids	[oil]			Application is not required if these pests have not been a problem. Do not spray oil when temperature is below 40°F (5°C) or likely to drop below 40°F within 24 hours.
Pink	catfacing insects (plant bugs and stink bugs)	Sevin, [Pyrethrum] Permethrin		No spray needed	Permethrin and Pyrethrum are for use on peaches.
	black knot		[liquid lime sulfur], thiophanate-methyl, chlorothalonil	No spray needed	Fungicide is required on plums only if black knot is a problem. For black knot control, fungicides will not be effective unless all knots are removed from the tree and destroyed. Infections on nearby trees must also be eradicated.
Bloom	Fungicide should not be required during bloom if good sanitation is used to control brown rot. To protect bees, do not use insecticide during bloom.				
Petal fall and first cover	plum curculio, oriental fruit moth, plant bugs, stink bugs	[Pyrethrum, Surround], Permethrin, Malathion			Permethrin and Pyrethrum are for use on peaches.
	scab and brown rot (on all fruits), black knot of plum, cherry leaf spot	[sulfur], Captan, chlorothalonil, myclobutanil, thiophanate-methyl			Do not apply chlorothanlonil after shuck split.
Remaining covers	plum curculio, oriental fruit moth, plant bugs, stink bugs	[Pyrethrum], Permethrin, Malathion			Permethrin and Pyrethrum are for use on peaches. After this spray, no further spray needed.
	scab and brown rot (on all fruits), black knot of plum, cherry leaf spot	[sulfur], Captan, chlorothalonil, myclobutanil, thiophanate-methyl			Use shorter interval if wet, rainy weather persists.
Final spray[3]	brown rot	[sulfur], Captan, thiophanate-methyl, myclobutanil		No spray needed	

[1] See pages 18 and 19 for illustrations of plant floral stages.
First cover: Seven days after petal fall spray. **Remaining covers:** Continue spraying at 10- to 14-day intervals. **Final spray:** Within one week of harvest.
[2] Growers must read the pesticide label for proper rates of chemical to use. Some materials are effective against some pests and not others. Choose materials needed to control the most important pests in your fruit planting. Materials in [brackets] are approved for organic production. See Table 5 for information on mixing small quantities of pesticides.
[3] Check label for waiting days to harvest. Tables 6 and 7 also give waiting days to harvest.

southern areas and late May to early June in more northern areas. The lesser peachtree borer is a similar pest that attacks trees anywhere in the lower few feet of the trunk and scaffold limbs rather than at ground level.

It is important to prevent borer damage by protecting the base or trunk of the tree with an insecticide. Insecticide solutions are also effective when applied with a paintbrush to the affected area on the lower trunk. Apply Permethrin between mid-May and early June and again six to eight weeks later. Do not apply these compounds to the fruit or foliage. Observe the days-to-harvest restrictions for these insecticides. Avoid mechanical injury to the trunk since open wounds attract borers. Pheromone traps can be used to detect when moth flights occur so insecticide applications can be timed to coincide with egg laying on trees.

Pheromone traps are available for both peachtree borer and lesser peachtree borer.

Blackberries and Raspberries

Most pesticide treatments on blackberries and raspberries can be made on an "as needed" basis (Table 10). However, this approach requires regular inspection so that applications can be made before serious damage occurs.

Sanitation Measures

Most fungi that infect raspberry and blackberry canes overwinter on old canes that were infected the previous season. After spring harvest, remove canes that have fruited to reduce the incidence of spur blight, cane blight, and anthracnose, as well as populations of cane and crown borer insects. Mow or cut old fall fruiting raspberry canes in early spring before new shoots begin to develop. Cuts should be made at soil level (no stubs), and all old canes should be removed from the planting. **Note:** Spring mowing (removal of all canes) results in production of a fall crop only. Good weed control improves air circulation and promotes rapid drying within the canopy. It also discourages populations of insects and diseases that can damage canes and fruit.

Diseases

Orange rust and viruses are the most serious diseases of brambles in Kentucky. Neither of these diseases are curable, and infected plants should be destroyed immediately upon detection. Each spring when new shoots reach 12 to 14 inches long, survey black raspberry and blackberry plantings for symptoms of orange rust and viruses. Orange rust is a destructive disease of black raspberry and blackberry that spreads rapidly, so immediate removal of all infected plants (including roots) is critical. Infected plants are identified by their thin, willowy growth, absence of thorns (on normally thorny varieties), and presence of orange spore pustules on undersides of leaves. Failure to remove orange rust-infected plants threatens survival of nearby healthy plants. Viruses may also infect brambles. Virus-infected plants may have leaves with yellow splotches or streaks and crumbly, incomplete fruit. Virus-infected plants must also be removed from planting, as there is no cure.

Insects

Problems with sap beetles, wasps, fruit flies, and fruit rots are less severe if berries are harvested regularly throughout the ripening period so that overripe fruits do not accumulate. Damaged or fermenting fruit attracts these pests.

Japanese beetles feed on ripe raspberry and blackberry fruit and leaves as well as on fall raspberry flowers. They can be a serious problem in areas with recently established Japanese beetle populations.

Table 10. Spray schedules for pest control on brambles (blackberries and raspberries).

Plant Stage[1]	Insects and Diseases	Examples of [Organic] Pesticides Required[2]	Comments
Bud break	rose scale, anthracnose, cane blight, spur blight	[Liquid lime-sulfur], Sulfurix, [Bordeaux mixture]	This spray is essential for good disease control. If applied to green tissue, damage may occur.
During bloom	Botrytis fruit rot	[sulfur]	In dry growing seasons, fungicide is generally not required.
	No insecticide used during bloom to protect bees.		
Pre-harvest[3]	Cane borer, Japanese beetle, green June beetle	Sevin, Malathion, Permethrin (raspberries only)	As needed.
Pre-harvest through Harvest	spotted wing drosophila	Spinosad, Malathion	Watch pre-harvest intervals carefully. Use to prevent infestation.
Post-harvest	Japanese beetle, cane borer	Sevin, Malathion, Permethrin (raspberries only)	As needed.

[1] See pages 18 and 19 for illustrations of plant floral stages.
Bud break: When buds begin to break and show silver. **Pre-harvest:** As fruit begin to color.
[2] Growers must read the pesticide label for proper rates of chemical to use. Some materials are effective against some pests and not others. Choose materials needed to control the most important pests in your fruit planting. Materials in [brackets] are approved for organic production. See Table 5 for information on mixing small quantities of pesticides.
[3] Check label for waiting days to harvest. Tables 6 and 7 also give waiting days to harvest. Materials in [brackets] are approved for organic production.

Strawberries

Sanitation Measures

Proper weed control is the most important sanitation measure for strawberry production. Weeds compete strongly with shallow-rooted strawberry plants and interfere with runner-plant production. Weeds also harbor many insect and mite pests and prevent rapid drying after rains, promoting increased fruit rot. Straw or plastic mulch should be maintained, especially before fruit begins to ripen. This reduces fruit contact with disease-infested soil.

To reduce populations of pathogens and sap beetles, remove overripe, diseased, and damaged fruit at regular intervals. Renovate beds immediately after harvest to reduce pest problems. Renovation involves removal of older nonproductive plants, weeds, and leaf debris. Rake and destroy old leaves and stems after renovation. Select varieties with resistance to leaf diseases, verticillium wilt, and red stele(Table 11). Rotate planting beds during renovations to prevent buildup of soil-borne diseases, insects, and weeds. Fertilize according to soil test results to promote development of new daughter plants that will produce next year's crop.

Diseases

Fruit rots. Several fruit rotting fungi affect ripening berries. Maintain a layer of straw or plastic mulch to prevent berries from touching infested soil and to prevent pathogens from splashing onto fruit. Remove diseased or damaged fruit immediately to reduce numbers of fungal spores.

Insects

Mites. Mite damage appears as distorted and discolored leaves and stunted fruits. Silken webs may also be found on the lower surface of the leaves. Two species of mites found on strawberries are the two-spotted spider mite, which varies in color from pale greenish yellow to dark crimson with two dark spots on its back, and the cyclamen mite, which is so tiny that it is scarcely visible to the naked eye. Both mites suck sap from foliage, and heavy populations can cause serious damage to strawberry plantings. Life cycles of both species are quite short during summer, and under ideal weather conditions they can build up rapidly if left uncontrolled. Poor weed control can lead to early mite buildup.

When mites are a problem, growers should use a miticide. For best mite control, apply two sprays of insecticidal soap spaced three to five days apart. Hot, dry weather favors rapid development of the two-spotted spider mite, particularly in July and August. Control measures should be applied if mite populations reach five per leaflet. Populations of cyclamen mite usually begin to increase in early May when blossoming starts and peak in early June during fruiting. A sharp decline in cyclamen mite populations generally occurs during July and August. Observations for cyclamen mite probably are best made before blossoms appear. Control measures should be applied at the first sign of an infestation.

Table 11. Spray schedules for pest control on strawberries.

Plant Stage[1]	Insects and Diseases	Examples of [Organic] Pesticides Required[2]	Comments
Pre-bloom	aphids, weevil, spittlebug, plant bugs, bud clipper, crown borer	Sevin, [Pyrethrum] Permethrin	Early-season applications are required only if these pests are a problem.
	spider mites	[insecticidal soap]	
During bloom	fruit rots and leaf spots	Captan, thiophanate-methyl[3]	In dry growing seasons, fungicide is generally not required.
	No insecticide during bloom to protect bees.		
Post-bloom	spittle bug, bud clipper, tarnished plant bug	Endosulfan, Sevin, Permethrin	Follow label instructions and observe all pre-harvest intervals.
Harvest	slugs	[diatomaceous earth]	
	spotted wing drosophila	Malathion, Spinosad	Watch pre-harvest intervals carefully. Use to prevent infestation.
Post-harvest	leaf spot	Captan, thiophanate-methyl[3], thiram	Use if leaf spot has been serious in past years and during rainy seasons.

[1] See pages 18 and 19 for illustrations of plant floral stages.
Pre-bloom: When blossom stems have pushed out of the crown. **Post-bloom:** Begin 10 days after full bloom spray (if needed), and continue spray every seven days as needed. **Post-harvest:** Apply one or more times after renovation if needed) to protect the new foliage for next year's crop.

[2] Growers must read the pesticide label for proper rates of chemical to use. Some materials are effective against some pests and not others. Choose materials needed to control the most important pests in your fruit planting. Materials in [brackets] are approved for organic production. See Table 5 for information on mixing small quantities of pesticides. Check label for waiting days to harvest. Tables 6 and 7 also give waiting days to harvest.

[3] T-methyl is only available in large quantifies and may not be suitable for homeowner use.

Grapes

Sanitation Measures

Diseases

Black rot is the most common disease home gardeners encounter in grapes. The disease can infect leaves and fruit. If leaf lesions develop before fruit set, remove of infected leaves to reduce the level of infection. Promote rapid drying conditions within canopies to reduce disease development; keep vines properly pruned (during the late dormant season), trellised, and weed-free.

If foliar symptoms are not managed early in the season, berries may become infected. Berries infected by black rot fungus become dry, shriveled, raisin-like "mummies." The black rot fungus overwinters primarily on these mummies, but also overwinters on infected canes. Therefore, it is essential to remove all clusters of mummified fruit, as well as those that have fallen to the ground as soon as possible after harvest. Destroy or remove infected canes during the dormant season and remove cuttings from vineyards.

Insects

Several pickings are necessary during harvest because not all grape bunches ripen at the same time. Harvesting in this manner reduces incidence of yellow jackets, bees, and wasps feeding on overripe fruits and discourages rot organisms from becoming established. Remove all old, dried, or rotted unharvested grapes (including cluster stems) from the vine and destroy them. Collecting and destroying leaf debris under vines in the fall reduces overwintering pupae of the grape berry moth. A spray schedule for grapes is shown in Table 12.

Grape clusters can be individually protected from disease and insects by sealing them in one-pound paper bags after pollination has taken place when grapes are BB size. Tear the bag about 1 inch down on both sides of the opening, slide it over a cluster, wrap the bag around the cane, and staple it on. Cut a small corner from the bottom of the bag to allow condensation to drain out. The bags can be left until harvest, and all but the Reliance variety will color inside the bags.

Table 12. Spray schedule for pest control on grapes.

Plant Stage[1]	Insects and Diseases	Examples of [Organic] Pesticides Required[2]	Comments
Dormant	anthracnose, dead arm, black rot	[fixed copper, lime sulfur]	
Bud swell	flea beetles, climbing cutworms	Sevin, [Pyrethrum]	Insecticide may be needed if these pests are a problem (e.g., swollen buds have holes or are eaten). If neither pest is known to occur regularly, no spray is needed.
New growth (4 to 6 inches long)	black rot, Phomopsis cane, leaf spot	Mancozeb, Captan, [fixed copper]	
New growth (10 to 15 inches long or 7 to 10 days after first spray)	black rot, Phomopsis cane, leaf spot	Mancozeb, Captan, myclobutanil, [fixed copper]	
Pre-bloom	black rot, powdery mildew, downy mildew	Mancozeb, Captan, [sulfur], myclobutanil, [fixed copper]	
Bloom	grape phylloxera	Endosulfan	See label; several varieties are very sensitive to Endosulfan injury.
	black rot, powdery mildew, downy mildew	Mancozeb, Captan, [sulfur], myclobutanil, [fixed copper]	
Post-bloom	grape berry moth, leafhoppers	Sevin, Malathion, [Bt, Spinosad]	Spinosad for grape berry moth.
	black rot, downy mildew, powdery mildew	Mancozeb, Captan, [sulfur], myclobutanil, [fixed copper]	In wet weather, do not wait until all blossoms have fallen, especially if black rot is a problem. Spray fungicide every 7 to 14 days.
	mites, if present	[insecticidal soap]	
First, second, third, and fourth covers[3]	grape berry moth, leafhoppers, Japanese beetles	Sevin, Malathion, [Bt, Spinosad]	Spray for leafhoppers and Japanese beetles only when they are present.
	black rot, powdery mildew, downy mildew	Captan, [sulfur], myclobutanil, [fixed copper]	
	mites (if present)	[insecticidal soap]	

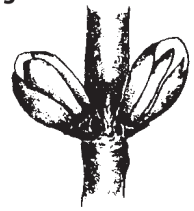
Special Notes: Berries are no longer susceptible to black rot when they reach about 6 to 8% sugar content (usually when they start to change color).

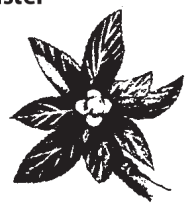
[1] See pages 18 and 19 for illustrations of plant floral stages.
Bud swell: Before buds show green. **New growth:** 4 to 6 inches long; **New growth**: 10 to 15 inches long or 7 to 10 days after first spray. **Pre-bloom:** First blossoms open. **Post-bloom:** Blossoms have fallen. **First cover:** 7 to 10 days after post-bloom. **Second cover:** 10 to 14 days after first cover. **Third cover:** 10 to 14 days after second cover. **Fourth cover:** 10 to 14 days after third cover.

[2] Growers must read the pesticide label for proper rates of chemical to use. Some materials are effective against some pests and not others. Choose materials needed to control the most important pests in your fruit planting. Materials in [brackets] are approved for organic production. See Table 5 for information on mixing small quantities of pesticides.

[3] Check label for waiting days to harvest. Tables 6 and 7 also give waiting days to harvest. Always observe pre-harvest intervals.

Floral Development Stages for Fruit Crops and Critical Temperatures for Flower Bud Kill

	Apple	Pear	Peach	Tart Cherry	Plum and Prune
Stage **1**	**Dormant** 	**Dormant** 	**Dormant** 	**Dormant** 	**Dormant** 
Stage **2**	**Silver tip** 10% kill 15° F 90% kill 2° F 	**Swollen bud** 10% kill 15° F 90% kill 1° F 	**Swollen bud** 10% kill 18° F 90% kill 2° F 	**Bud burst** 10% kill 17° F 90% kill 5° F 	**Swollen bud** 10% kill 14° F 90% kill 1° F 
Stage **3**	**Green tip** 10% kill 18° F 90% kill 10° F 	**Bud burst** 10% kill 20° F 90% kill 7° F 	**Half-inch green** 10% kill 23° F 90% kill 5° F 	**Green tip** 10% kill 25° F 90% kill 14° F 	**Bud burst** 10% kill 18° F 90% kill 3° F 
Stage **4**	**Half-inch green** 10% kill 23° F 90% kill 15° F 	**Green cluster** 10% kill 26° F 90% kill 15° F 	**Pink** 10% kill 25° F 90% kill 18° F 	**Tight cluster** 10% kill 26° F 90% kill 17° F 	**Green cluster** 10% kill 26° F 90% kill 16° F 

	Apple	Pear	Peach	Tart Cherry	Plum and Prune
Stage **5**	**Tight cluster** 10% kill 27° F 90% kill 21° F 	**White bud** 10% kill 26° F 90% kill 22° F 	**Bloom** 10% kill 27° F 90% kill 24° F 	**Swollen bud** 10% kill 27° F 90% kill 24° F 	**White bud** 10% kill 26° F 90% kill 21° F 
Stage **6**	**Pink** 10% kill 28° F 90% kill 25° F 	**Bloom** 10% kill 28° F 90% kill 23° F 	**Petal fall** 10% kill 28° F 90% kill 25° F 	**Bloom** 10% kill 28° F 90% kill 25° F 	**Bloom** 10% kill 27° F 90% kill 23° F 
Stage **7**	**Bloom** 10% kill 28° F 90% kill 25° F 	**Petal fall** 10% kill 28° F 90% kill 24° F 	**Fruit set: shucks on** 10% kill 28° F 90% kill 25° F 	**Petal fall** 10% kill 28° F 90% kill 25° F 	**Petal fall** 10% kill 28° F 90% kill 23° F 
Stage **8**	**Petal fall** 10% kill 28° F 90% kill 25° F 	**Fruit set** 10% kill 28° F 90% kill 24° F 	**Fruit set: shucks off** 	**Fruit set** 10% kill 28° F 90% kill 25° F 	**Fruit set** 
Stage **9**	**Fruit set** 10% kill 28° F 90% kill 25° F 				

Blueberries

The most common problems associated with blueberries are birds, nutrient deficiencies related to soil pH requirements, and water imbalance from lack of proper mulching and irrigation.

As a rule, blueberries do not harbor many diseases, so they do not require large amounts of fungicides. (Table 13). Fungicides are not recommended unless disease problems develop. Monitor plants for symptoms of disease, and apply fungicides if necessary.

Diseases

Phytophthora root rot is the most common disease of blueberry in Kentucky. This water mold pathogen requires free water in order to infect and establish, so proper drainage is critical. Resulting root loss results in stunting, yellowing, and eventual plant death. Plant blueberries on raised beds with high levels of organic materials. Maintain proper pH to promote plant vigor.

Resources

Bagging Apples: Alternative Pest Management for Hobbyists (ENTFACT-218) http://www.ca.uky.edu/entomology/entfacts/ef218.asp

Homeowner's Guide to Fungicides http://www.ca.uky.edu/agcollege/plantpathology/ext_files/PPFShtml/PPFS-MISC-7.pdf

Table 13. Spray schedules for pest control on blueberries.

Plant Stage[1]	Insects and Diseases	Examples of [Organic] Pesticides Required[2]	Comments
Dormant	scale insects	[dormant oil]	Apply only if scale insects are a problem.
Petal fall	leafroller, plum curculio (if present)	Malathion, [Bt], Permethrin	Bt will not control plum curculio.
After bloom	Same as above, plus blueberry maggot and Japanese beetle (if a problem)	Malathion, [Bt], Permethrin	Use only if needed. Observe all pre-harvest intervals.[3]

[1] See pages 18 and 19 for illustrations of plant floral stages. **Dormant:** Before bud break. **Petal fall:** 75% petals have dropped. **After bloom:** 7 to 10 days after petal fall.

[2] Growers must read the pesticide label for proper rates of chemical to use. Some materials are effective against some pests and not others. Choose materials needed to control the most important pests in your fruit planting.

[3] Materials in [brackets] are approved for organic production. See Table 5 for information on mixing small quantities of pesticides. Check label for waiting days to harvest. Tables 6 and 7 also give waiting days to harvest.

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