ID-146

MANAGING PESTS In HOME FRUIT PLANTINGS

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PURDUE EXTENSION • KNOWLEDGE TO GO

TREE FRUIT DEVELOPMENTAL STAGES

APPLE

Dormant

Silver Tip

Green Tip

Half Inch Green

Tight Cluster

Pink

Bloom

Petal Fall

Fruit Set

PEAR

Dormant

Swollen Bud

Bud Burst

Green Cluster

White Bud

Bloom

Petal Fall

Fruit Set

PEACH

Dormant

Swollen Bud

Half Inch Green

Pink

Bloom

Petal Fall

Fruit Set
Shucks on

Fruit Set
Shucks off

TART CHERRY

Dormant

Bud Burst

Green Tip

Tight Cluster

Swollen Bud

Bloom

Petal Fall

Fruit Set

PLUM/PRUNE

Dormant

Swollen Bud

Bud Burst

Green Cluster

White Bud

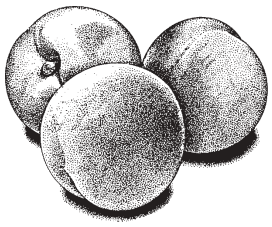
Bloom

Petal Fall

Fruit Set

Contents

Managing Pests in Home Fruit Plantings



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Many homeowners enjoy raising their own fruit crops. As anyone who has attempted to grow various types of fruit knows, most fruit crops are attacked by a wide variety of insect and disease pests. Many fruit crops will be unusable unless the homeowner takes specific actions to reduce or eliminate the damage caused by these pests.

This publication provides homeowners with the information they need to produce an acceptable quantity and quality of fruit. Those homeowners who desire to produce fruit crops similar to those produced by commercial growers will have to look to other publications (ID-168, *Commercial Tree Fruit Spray Guide* <*http://www.agcom.purdue.edu/AgCom/Pubs/ID/ID-168.pdf*>; *Midwest Tree Fruit Pest Management Handbook* <*http://www.ca.uky.edu/agc/pubs/id/id93/id93.htm*> ID-169, *Indiana Commercial Small Fruit and Grape Spray Guide* <*http://www.hort.purdue.edu/hort/ext/sfg*>*; Midwest Small Fruit Pest Management Handbook* <*http://www.ag.ohio-state.edu/~sfgnet/*>) for additional information. Homeowners who desire to produce fruit organically can find specific information elsewhere.

Management

Selecting the right varieties and using proper cultural practices can greatly reduce your insect and disease problems.

The goal of the successful home fruit grower should not be to kill every last insect or eliminate every disease. Rather, the emphasis should be on keeping the various pests at an acceptable level while producing "clean," attractive fruit, but at the same time accepting a small amount of injury. A higher level of pest control may require more effort and inputs.

Many pest problems can be avoided or reduced by various preventive practices. "An ounce of prevention is worth a pound of cure" applies to pest management just as it does to human health. The cultural practices described below can help homeowners significantly reduce pest problems.

Cultural Practices

Resistant Cultivars

For most types of fruit, cultivars are available that are resistant to some diseases. Most nursery catalogs will identify the diseases to which a particular cultivar is resistant, because that can be a major selling point for that cultivar. If you plant a cultivar that is resistant to a major disease, the fruit you produce will not be affected by that disease, you will have less work to do, and you may not have to spray as often. What more could you ask for?

Apples: Apple scab is the most important disease affecting apples in Indiana. Most of the early season fungicide sprays on apples have the sole purpose of controlling scab. There are a number of scab-resistant cultivars available that are suitable for the home fruit grower. See Table 1 for a listing of scab-resistant cultivars recommended for Indiana. If you plant these cultivars, you will generally not need to apply fungicides until petal fall, at which time you can combine fungicides with insecticides for a complete spray program. See Table 6.

Table 1. Apple cultivars with resistance to scab recommended for planting in Indiana. (Listed in order of ripening, beginning with the earliest.)

Pristine
Dayton
Redfree
Prima
Priscilla
Jonafree
Liberty
Enterprise
Goldrush

Conversely, there are some cultivars that are extremely susceptible to certain diseases. See Table 2 for a listing of cultivar disease susceptibility. In the southern region of Indiana, where the disease fireblight is a chronic problem, avoid planting highly susceptible cultivars such as Jonathan, Gala, and Ida Red. If you insist on planting one of these cultivars or if you already have the trees planted, be aware that you will have to continually battle fireblight. See BP-30, *Fire Blight <http://www.agcom.purdue.edu/AgCom/Pubs/BP/BP-30.html>*, for more information.

The key diseases of apple are scab and fireblight. Select varieties accordingly.

Pears: Select cultivars that are resistant to fireblight, such as Magness, Maxine, or Honeysweet. Avoid very susceptible cultivars such as Bartlett. For more information, see HO-122, *Growing Pears <not available on the web>*.

Strawberries: Select cultivars that are resistant to the three major leaf diseases, leaf spot, leaf scorch, and leaf blight, and to Verticillium wilt and red stele. Cultivars that show resistance to most or all of these diseases include Allstar, Delite, Demarvel, Earliglow, Guardian, Lateglow, Lester, Noreaster, Primetime, Redchief, Scott, Tribute, and Tristar. Other varieties have resistance to one or more of the five diseases. Some cultivars that are particularly susceptible to diseases include Annapolis,

Table 2. Resistance of Several Apple Cultivars to Important Apple Diseases

Cultivar	Apple Scab	Cedar-Apple Rust	Fire Blight	Powdery Mildew
Braeburn	-	-	4	-
Cortland	4	3	3	4
Dayton	1	-	-	-
Delicious	3	1	2	2
Early McIntosh	3	2	2	-
Empire	4	2	2	3
Enterprise	1	2	2	2
Freedom	1	3	2	-
Fuji	3	-	4	-
Gala	3	2	4	-
Golden Delicious	3	3	3	3
GoldRush	1	3	2	2
Granny Smith	3	2	4	4
Grimes	3	-	2	-
Honeycrisp	2	2	2	-
Idared	3	3	4	3
Jerseymac	4	1	3	
Jonafree	1	3	2	2
Jonagold	4	3	4	3
Jonamac	3	2	3	3
Jonathon	3	4	4	4
Liberty	1	1	2	2
Lodi	3	3	4	2
Macfree	1	1	3	-

Cultivar	Apple Scab	Cedar-Apple Rust	Fire Blight	Powdery Mildew
Melrose	3	-	2	-
McIntosh	4	1	2	3
Mollies Delicious	3	1	3	-
Mutsu (Crispin)	4	3	4	4
Northern Spy	3	3	2	3
Novamac	1	-	-	-
Paulared	3	2	4	3
Prima	1	4	2	2
Priscilla	1	2	2	3
Pristine	1	-	2	-
Redfree	1	1	3	2
Rome Beauty	4	4	4	4
Sir Prize	1	4	4	2
Smoothee	3	3	2	-
Spartan	3	2	3	2
Stayman	4	3	2	3
Tydeman's Red	3	1	3	2
Turley	4	3	2	3
Wealthy	3	3	3	3
William's Pride	1	1	2	-
Winesap	4	3	2	3
Yellow Transparent	3	3	4	2

*Varieties in italics are highly resistant to apple scab.

Key to resistance rating as originally determined in New York by Cornell University Extension personnel; cultivars have been added and ratings revised using Midwestern observations.

1 = very resistant - no control measures are required. (There are few cultivars in this category of disease.)
2 = resistant - control measures are only required under high disease pressure.
3 = susceptible - control measures are usually required where disease is prevalent.
4 = very susceptible - control measures are always required where disease is prevalent. (These cultivars should receive first priority.)

Pocahontas, Raritan, and Sparkle. For more information, check BP-46, *Strawberry Root Disease* <*www.agcom.purdue.edu/AgCom/Pubs/BP/BP-46.html*>, or reputable nursery catalogs.

Grapes: Select cultivars that are resistant to black rot, downy mildew, and powdery mildew. Some common cultivars used by homeowners that are relatively resistant to all three of these diseases include Mars, Cayuga White, Fredonia, and Steuben. See Table 3 for a listing of cultivar disease resistance.

Table 3. Relative Resistance of Grape Varieties to the Three Most Serious Diseases.

Variety	Black rot	Downy mildew	Powdery mildew
Catawba	+[1]	+	++
Cayuga White	+++	++	+++
Concord	+	+++	++
Delaware	++	+	++
Fredonia	+++	+	++
Niagara	+	+	++
Mars	+++	+++	+++
Reliance	+	++	++
Steuben	++	+++	+++

[1]Disease resistance is rated as follows:
+ = susceptible, ++ = moderately resistant, +++ = resistant.

Sanitation

Sanitation is of major importance in controlling diseases. Prune out dead and diseased twigs and branches as soon as you detect them. Prune when the twigs and foliage are dry, so that you are less likely to spread diseases to other plants or branches. In other cases, where disease is extensive, remove the entire plants to reduce the threat to nearby healthy ones of the same type.

In early spring, remove mummified fruit left on plants after harvest and those on the ground, and either burn or deeply bury them. Immediately remove rotten fruit that appear on plants early in the summer because they are a source of infection for fruit at harvest time.

Table 4. Fruit Diseases in Which Sanitation is Very Important.[1]

Fruit	Disease(s)
Apple, Pear	Fireblight
Peach	Perennial canker
Plum	Black knot
Blueberry	Twig blight
	Cankers
Raspberry, Blackberry	Anthracnose
	Cane cankers
Grape	Black rot

[1]Control of most leaf, fruit, and stem

You can reduce damage from plum curculio by picking up and destroying young fruit that fall from trees. Some of these fruit will contain plum curculio larvae that will pupate and produce the next generation of adults.

On brambles, after harvest, remove and destroy badly infected canes. Because the

fungus that causes anthracnose survives on both living and dead plant tissue, remove old fruiting canes as well as severely affected new canes from your planting after harvest.

Pruning and Training

Train and prune your fruit plants each year to achieve good production and to permit light, air, and spray materials to readily penetrate throughout the canopy. Maintain trees at a height at which they can be well sprayed. See HO-49, *Pruning Fruit Trees <not available on the web>*, HO-45, *Growing Grapes<http://www.hort.purdue.edu/ext/HO-45.pdf>*, and HO-44, *Raspberries <http://www.hort.purdue.edu/ext/HO-44.pdf>* for suggestions on pruning.

Fertilization

Apply a balanced fertilizer according to soil test results and recommendations from local Extension or other horticultural advisors. Healthy plants are generally less seriously damaged by insects and diseases and will produce a more desirable product. Avoid over-fertilization with nitrogen. Rapid growth encourages certain disease and insect pests. You can find specific fertilization recommendations in the HO series publications listed at the end of this publication.

Weed and Rodent Control

Proper weed management will cause plants to grow more vigorously and reduce your pest problems.

Weeds are seldom a problem for the home fruit grower if trees are planted within the lawn area. If your planting is in a garden area or orchard, take care to keep the grass closely mowed or the ground clean around the base of the trees. This will facilitate insect, disease, and rodent control. Plastic tree guards placed around the trunks of the trees can be helpful in rodent control. Eliminating the grass around the trees in a circle 2 feet or more in diameter and applying a layer of pea gravel, crushed stone, or bark mulch will help the appearance of the planting as well as aid in rodent control. Removing the grass around the base of the tree is especially helpful in getting newly planted trees off to a good start. Do not use a string-type weeder around the base of the trees. The only herbicide that should be used around fruit trees is glyphosate (Roundup). Be careful not to get any of the herbicide mixture on the tree.

Weeds can be a real problem in small fruit plantings because most small fruits have a shallow root system, and weeds, especially grasses, can be very competitive. The soil around small fruit plants should be free of all vegetation. You can achieve this by hand pulling weeds, shallow cultivation, or mulching. Mulching with black plastic, woven fabric, or organic materials such as grass clippings, leaves, pine needles, bark chips, etc., is one of the most effective methods of reducing weed problems in small fruit plantings. The only herbicide that should be used in and around small fruit plantings is glyphosate (Roundup). Be careful not to get any of the herbicide mixture on the fruit plants.

Chemical Controls

Equipment

You will get the best insect and disease control if you use the right tools for the job you have to do. You can spray a few dwarf fruit trees or a small strawberry patch effectively with a 2-or 3-gallon pump up sprayer that you can purchase at any garden center. If you have a number of trees and/or bushes or a large strawberry patch, you may want to invest in larger (and more expensive) equipment. Having the right equipment will increase the likelihood that you will spray at the proper time. Larger equipment takes longer to get ready and to clean up, so having a larger sprayer may discourage you from spraying the two apple trees in your backyard. Conversely, if you have to fill your 2-gallon sprayer 10 times to spray your small orchard, you are less likely to spray as often as you should.

Having the right equipment will make spraying less of a chore and improve your pest control.

It is also important that you invest in the right types of safety equipment. Check the labels of the pesticides you use to see what safety equipment is required. Almost all pesticides require that you wear long pants, long sleeves, a hat, and chemically resistant gloves when spraying. If you are going to be spraying above your head, you should probably invest in some protective eyewear or a face shield.

Safety

In addition to having the proper protective equipment, there are several guidelines you should follow when mixing and applying pesticides. Most of these are on the pesticide labels, but it never hurts to repeat them.

- Read the pesticide label before opening the container, mixing, and applying any pesticide. The label contains important instructions.
- Be especially careful when mixing pesticides. This is when the pesticides are in their most concentrated form.
- Only mix the amount of pesticides that you will use in a single day. Estimate how much pesticide you should mix by spraying water on some or all of your plants to determine the total volume needed.
- Do not spray when the wind is blowing hard enough to take any of the pesticide mixture to a location other than where you want it to land. Again, you can test the wind by spraying water before you mix your pesticides.
- Never spray with small children or pets in the vicinity. Keep them away from the sprayed area for at least 24 hours or until the Re-Entry Interval on the pesticide label has expired.
- The harvest restriction is the number of days that must elapse between the last application of a particular pesticide and harvest of the fruit. This period may be different for each crop, so check the label carefully. If you spray more than one pesticide, you must adhere to the longest harvest restriction.
- Do not use herbicide (weed killers) in the same sprayer used for insecticides and fungicides. Small residues of herbicides in the tank may cause damage to the crops you are treating.

Frequency of Sprays

The spray schedules recommended in this publication are designed to provide you with a reasonable amount of fruit that is free of insect and disease damage. Spraying less frequently or at the wrong time will likely result in less than satisfactory results. Many disease and some insect pests can only be controlled by spraying **before** you see the pests. The sprays recommended in this publication will usually prevent serious problems from these pests. Spraying more frequently than recommended probably will not greatly increase the level of control achieved.

Table 5. Approximate spray volume required for thorough coverage of fruit trees to the point of run-off.

Tree height (feet)	Spread of tree (feet)	Gallons of spray mixture per tree per application
5 to 8	3 to 6	1 to 1-1/2
8 to 12	6 to 9	1-1/2 to 3
12 to 18	9 to 15	3 to 5
18	15	4 to 6

Table 6. Approximate Dilutions for Small Volumes of Spray Mixes.*

	Equivalent Rates for Different Quantities of Water			
Formulation	**100 gallons**	**5 gallons**	**3 gallons**	**1 gallon**
Wettable	5 pounds	15 tablespoons	9 tablespoons	3 tablespoons
Powder	4 pounds	13 tablespoons	8 tablespoons	8 teaspoons
(dry)	3 pounds	10 tablespoons	6 tablespoons	2 tablespoons
	2 pounds	8 tablespoons	4 tablespoons	4 teaspoons
	1 pound	3 tablespoons	6 teaspoons	2 teaspoons
	1/2 pound	5 teaspoons	1 tablespoon	1 teaspoon
Emulsifiable	5 gallons	1 quart	1 1/4 pints (10 oz.)	13 tablespoons
Concentrate	4 gallons	1 1/2 pints	1 pint	10 tablespoons
(liquid)	3 gallons	1 1/4 pints	3/4 pint (6 oz.)	1/4 pint (2 oz.)
	2 gallons	3/4 pint (6 oz.)	1/2 pint (4 oz.)	5 tablespoons
	1 gallon	1/2 pint (4 oz.)	8 tablespoons	3 tablespoons
	1 quart	3 tablespoons	2 tablespoons	2 teaspoons
	1 pint	5 teaspoons	1 tablespoon	1 teaspoon

*We wish to thank Michael Ellis and Celeste Welty, Ohio State University, for use of this table.

Measuring Small Amounts of Pesticide

The rate or amount of pesticide to use is listed on the product label. For most products packaged specifically for homeowner use, rates are given in teaspoons or tablespoons per gallon of water. With these products, you will have no problem measuring the exact amount of product you need to use. Many backyard growers choose to purchase larger quantities of pesticide that are packaged primarily for use by commercial growers. This is acceptable and, in some cases, depending on the quantity of plants to be sprayed, may be more convenient and economical.

In some situations, however the preferred pesticide may not be available in homeowner packaging, and commercial packages of 2 to 5 pounds are all that is available. A problem with commercial packages is that rates are often given in the amount of pesticide to use per 100 gallons of water. Commercial rates are also commonly given in the amount of pesticide to use per acre in a given amount of water. Problems arise when the label states, "Use 1 pound of pesticide per 100 gallons of water," and you need only 1 gallon of pesticide mixture. For dry formulations of pesticide (powders), it is difficult to calculate the number of teaspoons or tablespoons required for 1 gallon of water when the rate is 1 pound per 100 gallons. To help you, Table 6 gives approximate dilutions for small volumes of spray mixes. For liquid formulations, it is possible to calculate down to teaspoons and tablespoons.

Multipurpose Fruit Sprays (MPFS)

Multipurpose fruit sprays (MPFS) are convenient mixtures of pesticides for some home fruit growers.

The two most common types of pesticides used on fruit crops are insecticides and fungicides. Insecticides are designed to kill insects, and fungicides control diseases caused by fungi, such as apple scab, powdery mildew, and fruit rots. Most garden centers sell multipurpose fruit sprays (MPFS), sometimes called "orchard sprays" (sold as Fruit Guard, Home Orchard Spray, Fruit Tree Spray, etc.), which contain two insecticides, usually malathion and either carbaryl (Sevin) or methoxychlor, and a fungicide, usually captan. Methoxychlor and carbaryl are most effective against insects with chewing mouthparts, and malathion works best against insects with sucking mouthparts. Captan is a broad-spectrum protectant fungicide that will control several diseases if applied before the disease becomes established.

If you have only a small area to spray, such as one or two trees, a few bushes, or a small patch of strawberries, the multipurpose fruit spray is the most convenient method of controlling your pest problems.

However, if you have more than a few trees or bushes, or a large strawberry patch, it might be preferable to buy the individual pesticides rather than the premixed multipurpose fruit spray. There are several reasons for this. First, there may be times when you want to spray a fungicide and not an insecticide, or vice versa. As an example, you should not apply insecticides during the bloom period because they will kill the bees that are pollinating the flowers. You may need to apply a fungicide during that time. If the only fungicide you have has two insecticides mixed with it, you cannot apply the fungicide and may have disease problems as a result.

Second, the insecticides included in the MPFS are not always the best

insecticides available. Insecticides such as esfenvalerate and spinosad will generally provide superior control than MPFS. For specific problems, carbaryl or malathion may also be used, but methoxychlor would rarely be recommended.

Finally, the premixed fruit sprays are often more expensive than buying the fungicide and insecticide separately and mixing yourself as you need them.

Insecticides

Botanical Insecticides (Extracted from Plants)

Although botanical insecticides are considered "organic," they may be toxic to humans and animals, and should be used with care.

Pyrethrum comes from the flowers of certain chrysanthemum plants. It is usually used against insects with sucking mouthparts. Insects that are paralyzed by pyrethrum may later recover. Pyrethrum does not remain effective on the plant for very long, so the level of control received is often not very good.

Neem is a relatively new product in the United States that is derived from the neem tree. It appears to be effective against insects with both chewing and sucking mouthparts. Neem is probably the most effective of the botanical insecticides in most situations. Neem can act as a repellent against some insects, such as Japanese beetles. Applying neem as soon as Japanese beetles appear can reduce the amount of damage they cause.

Microbial Insecticides

The microbial insecticides available to the home fruit grower contain spores of the bacterium, *Bacillus thuringiensis* (BT), which contains a toxin that causes gut paralysis in the insect after being consumed. There is a BT strain is available that is effective against most caterpillars. The microbial insecticides do not affect bees, beneficial insects, humans, or other vertebrates. BT products work best when applied against caterpillars that are still small.

Inorganic Insecticides

Superior oil (70-second viscosity) sprays effectively smother overwintering European red mite eggs, aphid eggs, and scale insects. Oil sprays can be used early in the spring when apple trees, grapes, and blueberries have undergone little or no growth. Apply superior oil sprays when temperatures are above 45°F - and never within 48 hours of freezing weather.

Highly refined **summer oils** (such as Sunspray UFO) can be sprayed on some fruit crops after the leaves have emerged. These sprays can smother insects on which they land, which means they are more effective against slow moving insects. You should take care, however, because the summer soils sometimes will burn the plants. It is probably a good idea to spray a small area with oil first to make sure that no damage will occur.

Commercially available **insecticidal soaps**, which are made from naturally occurring fatty acids, will control aphids, mites, scales, and whiteflies on which the

spray lands. Like the summer oils, test soaps on a small area before spraying your entire planting. Summer oils tend to be more effective than insecticidal soaps.

Surround is a kaolin clay based insecticide that is registered for use on most fruit crops. It has been widely touted as an organic solution to many pest problems on fruit. Experimental results in the Midwest have shown that Surround provides some control of plum curculio on apples, but little or no control of codling moth. It does appear to prevent damage from potato leafhoppers. Surround must be applied at high rates, 0.25 to 0.5 pounds per gallon of water, which may be difficult to keep in suspension in small hand sprayers.

Chemical Insecticides

Carbaryl (Sevin) is a widely used insecticide sold under many trade names. Sevin is effective against insects with chewing mouthparts, such as caterpillars and beetles, and remains effective for 3-4 days. However, carbaryl is toxic to predatory mites that keep pest mites under control. It will also kill a number of predators that eat aphids. Sometimes the use of Sevin will result in outbreaks of mites or aphids. Sevin is highly toxic to bees and should not be used during bloom. Sevin causes apples to drop if used within 30 days of full bloom.

Malathion is moderately effective against insects with sucking mouthparts. It is primarily used for aphid control. It remains effective for 2-3 days.

Diazinon has activity against a number of insect pests, including both chewing and sucking insects. It has greater residual activity than malathion, lasting 5-7 days in most situations.

Methoxychlor is somewhat effective against insects with chewing mouthparts and lasts for 3-4 days. It is not nearly as effective as other insecticides and is rarely recommended. Methoxychlor is less toxic to bees than some other insecticides.

Permethrin is a very effective insecticide against a wide variety of insects. It can be used on apples before petal fall and on peaches and pears throughout the season. Permethrin will provide 10-14 days of control. It is very toxic to honeybees and fish. Prolonged use may result in outbreaks of mites.

Table 7. General use Insecticides Labeled for use on Fruit Crops.

Sevin	Malathion	Diazinon	Methoxychlor	Permethrin	Esfenvalerate	Spinosad
Apple	Apple	Apple	Apple	Apple	Apple	Apple
Pear	Pear		Pear	Pear	Pear	Pear
Peach	Peach	Peach	Peach	Peach	Peach	Peach
Plum	Plum	Plum	Plum		Plum	Plum
Cherry	Cherry	Cherry	Cherry		Cherry	Cherry
Blackberry	Blackberry		Blackberry		Blackberry	
Raspberry	Raspberry		Raspberry		Raspberry	
Blueberry	Blueberry		Blueberry			Blueberry
Grape	Grape		Grape			
Strawberry	Strawberry		Strawberry			Strawberry

A close relative of permethrin is **esfenvalerate**. This insecticide acts much like permethrin, but is labeled for use on more fruit crops and can be used throughout the season on apples. Esfenvalerate is also toxic to honey bees and fish and can cause outbreaks of mites. A single application on apples at petal fall to control plum curculio usually will not cause a mite outbreak.

Imidacloprid is available for use as a systemic insecticide for control of borers on apple and pear. this insecticide is applied as a drench to the base of the tree. It is then taken up by the tree and kills the borers.

Spinosad is a fermentation product that may be sold as an organically approved insecticide (Entrust) depending on how the pesticide is formulated. Spinosad is also available to homeowners in formulations that are not organically approved. Spinosad works well against codling moth and other caterpillars and provides good control of some sucking insects such as stink bugs and tarnished plant bugs. Only a limited amount of this product can be used each season, so be sure to check the label.

Fungicides

As mentioned previously, fungicides are pesticides that control diseases caused by fungi. Fungal infections occur when the spores of the fungus are present and the environmental conditions are favorable for the particular pathogen. Moisture, whether in the form of rainfall, dew, or humidity, is often one of the necessary ingredients for a fungal infection to occur. Most fungicides act as a protective barrier on the leaf and fruit surfaces and so must often be in place **before** the disease occurs. Where possible, apply fungicides just before a prolonged wet period occurs, not after. Once disease symptoms appear, it is generally too late to "cure" the problem. Be aware that additional fungicide sprays may still be required to prevent further disease increase.

Insecticides work best when the insect is sprayed directly, but fungicides must be present before disease symptoms occur.

Bordeaux mixture is a combination of copper sulfate and hydrated lime. It is most useful as a dormant spray on apples and pears for fire blight and as a dormant spray on peaches for peach leaf curl and bacterial spot. It is not compatible with many other pesticides and can injure plant tissue if applied incorrectly. *Be especially diligent in following ALL label directions.*

Captan is the primary fungicide found in home fruit spray mixtures such as Fruit Guard, Home Orchard Spray, Fruit Tree Spray, etc. It can also be purchased separately as Captan or Orthocide and combined with insecticides. An effective and reliable fungicide, it controls apple scab and most summer leaf and fruit spotting apple diseases. Also good for brown rot control of stone fruits, strawberry leafspots, grape black rot, and grape downy mildew. *Note: Captan is not compatible with oil; do not apply captan within 7 to 10 days of an oil application on apples because of potential leaf injury.*

Chlorothalonil (Daconil 2787) is an excellent multipurpose fungicide that can be used on a wide variety of fruit crops as well as vegetables, lawns, trees, shrubs, and flowers. Chlorothalonil is sold under a variety of brand names, such as Daconil 2787, Ortho multipurpose fungicide, and Fertilome liquid fungicide. It has numerous uses in the home fruit planting; however, it is not labeled for apple disease control (other than flowering crabapples).

Coppers, or copper-based fungicides (with numerous trade names), are labeled for fruit, vegetables, and ornamentals. They are especially good for peach leaf curl and early diseases of apple and grape. Along with sulfur, the copper-based fungicides are generally considered "safe" by organic gardeners. They can injure plant tissue if applied incorrectly. *Be especially diligent in following ALL label directions.*

Ferbam is effective against a wide range of fruit diseases. It is especially effective in control of cedar apple rust, apple summer rots, black rot of grape, and peach leaf curl. A black residue may remain on the fruit if ferbam is used late in the season.

Immunox, a myclobutanil product from Spectracide, has recently been added to the tree fruit and grape recommendations. Immunox will replace benomyl for many uses, such as controlling scab and powdery mildew of apple and brown rot of stone fruits. It will also add effective control of cedar-apple rust and grape black rot. Immunox is sold in 1-pint containers and is readily available at retail outlets. Note that Immunox Plus is a different product that, in addition to myclobutanil, contains an insecticide. Immunox Plus is ***not*** labeled for use on food plants.

Lime-Sulfur (Dormant Disease Control) is generally applied just before new spring growth appears. If applied to green foliage, it may cause severe burn. It is excellent as a dormant spray on peaches for peach leaf curl, on raspberries and blackberries for cane blight, spur blight, and anthracnose, and on grapes for anthracnose.

Thiophanate-methyl (Topsin-M, Cleary's 3336) is a locally systemic fungicide very similar in activity to benomyl. Topsin-M is primarily packaged and labeled for commercial fruit plantings.

Cleary's 3336 is packaged and labeled for backyard home fruit plantings, and it also may be used on ornamental plantings. See label for complete listing of uses.

Sulfur is sold both as a dust and in wettable powder form. Sulfur is especially good in the control of powdery mildew; however, use with care on certain grape varieties (see label). Along with copper, sulfur is generally considered acceptable for organic gardeners.

Bactericides

The above-mentioned fungicides will not control bacterial diseases such as fireblight. The exceptions to this are copper based materials such as Bordeaux mixture. However, copper materials will often cause blemishes on the surface of fruit and/or provide poor control. Specific antibiotics, such as streptomycin sulfate, provide the best control of bacterial diseases. To control fireblight, apply streptomycin alone (not combined with other chemicals) several times during the bloom period. Follow all label directions.

Table 8. Spray guide for APPLES.

Time to spray	Pest(s)	Pesticide	Remarks
Delayed dormant: When leaf tips start to protrude from buds.	Scales Aphids Mites	Superior oil	If these pests were not a problem last year, omit this spray.
Half-inch green: 1/2 inch of green tissue.	Apple scab	Captan *or* Immunox *or* MPFS[1]	Insects are not usually a problem before petal fall.
Tight to open cluster: When fruit buds are visible.	Apple scab	Captan *or* Immunox[2] *or* MPFS	Immunox is best for early season scab control.
Pink: Just before any blooms open.	Apple scab	Captan *or* Immunox *or* MPFS	If *cedar rust* or powdery mildew have been a problem. Immunox is the preferred material.
Bloom: When 50% of blossoms are open.	Apple scab Fireblight	Captan *or* Immunox	Do not use MPFS during bloom. If *fireblight* has been a problem, use streptomycin according to label directions. (See BP-30.)
Petal Fall: When 75% of petals have fallen.	Plum curculio Apple scab Sooty blotch Fly speck	Captan *or* Immunox plus Esfenvalerate *or* MPFS	Very important spray for plum curculio control. To prevent fruit drop, do not use Sevin within 30 days after full bloom
First Cover: 7-10 days after petal fall.	Plum curculio Codling moth Apple scab Sooty blotch Fly speck	Captan plus Spinosad[3] *or* MPFS	Important spray for codling moth control. To prevent fruit drop, do not use Sevin within 30 days after full bloom.
Second Cover: 7-10 days after first cover.	Plum curculio Codling moth Apple maggot Apple scab Sooty blotch Fly speck	Same as first cover spray	Apple maggot flies begin to emerge about mid June. Use red sticky balls to tell when maggot flies are present.
Additional Cover Sprays: Apply at two week intervals until harvest restriction date.	Apple scab Fruit rots Sooty blotch Fly speck Codling moth Apple maggot Japanese beetle	Captan plus Spinosad *or* Sevin *or* MPFS	Read container label for number of days between final spray and harvest.

[1]MPFS = Multi-Purpose Fruit Spray
[2]Immunox = Do not apply more than 10 times per season.
[3]Spinosad = Observe limits on amount that can be applied per season.

Table 9. Spray guide for PEARS.

Time to spray	Pest(s)	Pesticide	Remarks
Late dormant:	Scales Aphids Mites	Superior oil	If these pests were not a problem last year, omit this spray.
Prebloom:	Pear scab	Captan *or* MPFS[1]	Insects are not usually a problem befor petal fall.
Bloom: When 50% of blossoms are open.	Pear scab Fireblight	Captan	Do not use MPFS during bloom. If *fireblight* has been a problem, use streptomycin according to label directions. (See BP-30.)
Petal Fall: When 75% of petals have fallen.	Plum curculio Pear scab Sooty blotch Fly speck Pear psylla	Captan plus Esfenvalerate *or* permethrin *or* MPFS	Very important spray for plum curculio and pear psylla.
First Cover: 7-10 days after petal fall.	Plum curculio Codling moth Pear scab Sooty blotch Fly speck	Captan plus Spinosad[2] or MPFS	
Second Cover: 7-10 days after first cover.	Plum curculio Codling moth Pear scab Sooty blotch Fly speck	Same as petal fall spray	
Additional Cover Sprays: Apply at two week intervals until harvest restriction date.	Pear scab Fruit rots Sooty blotch Fly speck Codling moth Japanese beetle	Captan plus Spinosad *or* Sevin *or* MPFS	Read container label for number of days between final spray and harvest.

[1]MPFS = Multi-Purpose Fruit Spray
[2]Spinosad = Observe limits on amount that can be applied per season

Table 10. Spray guide for STONE FRUITS: PEACH, PLUM, CHERRY.

Time to spray	Pest(s)	Pesticide	Remarks
Dormant: Before buds swell in spring (peaches only).	Peach leaf curl Black knot	Lime sulfur	See description of lime-sulfur in "Fungicides" section.
Prebloom: When blossom buds show pink.	Brown rot (blossom blight)	Captan *or* Immunox[2] *or* MPFS[1]	Insects are not usually a problem before petal fall.
Bloom	Brown rot (blossom blight)	Captan *or* Immunox	To protect bees, do not apply MPFS or insecticides during bloom.
Petal fall: When 75% of petals have fallen.	Brown rot Cherry leaf spot Plum curculio Oriental fruit moth	Captan *or* Immunox plus Esfenvalerate *or* Sevin *or* MPFS	Most important spray for plum curculio, which attacks most tree fruit crops. Cherry leaf spot is only on cherry.
Shuck split: When most shucks have split apart.	Brown rot Cherry leaf spot Plum curculio Oriental fruit moth	Captan plus Esfenvalerate *or* Sevin *or* MPFS	Important spray for plum curculio. Good control of curculio will help improve control of brown rot.
First cover: 10 days after shuck split.	Brown rot Cherry leaf spot Plum curculio Cherry fruit fly Oriental fruit moth	Captan plus Spinosad[3] *or* Sevin *or* MPFS	Cherry fruit fly on cherry only.
Additional cover sprays: Apply at two week intervals.	Brown rot Cherry leaf spot Cherry fruit fly Oriental fruit moth	Same as petal fall spray	
Preharvest sprays: Apply according to label directions beginning 3 to 4 weeks before harvest.	Brown rot	Captan *or* Immunox *or* MPFS	Read container label for number of days between final spray and harvest.

[1]MPFS = Multi-Purpose Fruit Spray
[2]Immunox - Do not apply more than 7 times per season.
[3]Spinosad = Observe limits on amount that can be applied per season.

Table 11. Spray guide for GRAPES.

Time to spray	Pest(s)	Pesticide	Remarks
When buds begin to swell	Flea beetle Climbing cutworm Anthracnose	Sevin *or* methoxychlor *or* MPFS[1] Lime sulfur	For flea beetle control if present. To reduce overwintering inoculum.
When new shoots are 2-4 inches long	Flea beetle Black rot Downy mildew	Captan *or* Immunox[2] plus Sevin *or* MPFS	
When new shoots are 8-10 inches long	Rose chafer Black rot	Captan *or* Immunox plus Sevin *or* MPFS	If rainy conditions prevail, additional sprays for black rot may be required.
Just before blossoms open	Rose chafer Black rot Downy mildew	Captan *or* Immunox plus Sevin *or* MPFS	
Just after blossoms have fallen	Grape berry moth Black rot Downy mildew	Captan *or* Immunox plus Sevin *or* MPFS	If powdery mildew is a problem, use Immunox or add thiophanate-methyl or sulfur in post-bloom sprays.
When grapes are size of small peas	Grape berry moth Black rot Downy mildew	Captan *or* Immunox plus Sevin *or* MPFS	
As needed if problems occur	Grape berry moth Japanese beetle	Sevin *or* MPFS	Read container label for number of days between final spray and harvest.

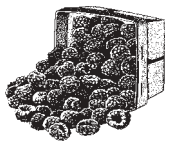
[1]MPFS = Multi-Purpose Fruit Spray
[2]Do not treat within 2 weeks of harvest. Do not apply more than 6 times per season.

Table 12. Spray guide for STRAWBERRIES.

Time to spray	Pest(s)	Pesticide	Remarks
Prebloom: When first blossom buds appear in the spring.	Gray mold Leaf spots Spittlebug Tarnished plant bug	Captan plus Sevin *or* MPFS[1]	To achieve better control of gray mold (Botrytis fruit rot) and other fruit rot diseases, maintain a thick layer of straw mulch between rows, making sure no bare ground is visible.
Early bloom: Every 10 days until first blooms start to open.	Gray mold Leaf spots Spittlebug Tarnished plant bug	Captan plus Sevin *or* MPFS	
Full bloom	Gray mold Other fruit rots Leaf spots	Captan	Important spray for gray mold. *No insecticides during bloom.*
Postbloom: Begin 10 days after full bloom, and continue every 7 days until harvest.	Gray mold Leaf spots Tarnished plant bug Leaf rollers	Captan plus Sevin *or* MPFS	Check label for days between final spray and harvest.
Harvest	Gray mold	Captan *or* MPFS	If wet, cool weather occurs at harvest, repeat Captan sprays as needed, even between pickings. *Check labels for harvest and re-entry restrictions.*
Postharvest	Leaf spots Leaf rollers Leafhoppers	Captan plus Sevin *or* MPFS	

[1]MPFS = Multi-Purpose Fruit Spray

Table 13. Spray guide for RASPBERRIES.

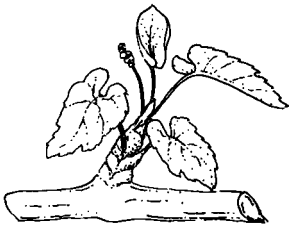


Time to spray	Pest(s)	Pesticide	Remarks
Delayed dormant: When tips of buds show green.	Anthracnose	Lime sulfur	Very important spray for control of Anthracnose. Sprays applied after 1/2 inch green may burn foliage. Remove and destroy infested canes.
Prebloom: Apply one week before bloom.	Raspberry sawfly Raspberry fruitworm Caneborers	Sevin *or* Esfenvalerate	Do not apply any insecticides during bloom.
Postbloom: Apply immediately after bloom.	Red-necked caneborer	Sevin *or* Esfenvalerate	
Preharvest: Begin 10 days after full bloom, and continue every 7 days until harvest.	Sap beetles	Sevin	For sap beetles. Keep berries off the ground and ripe berries picked. Set up bait buckets with over-ripe fruit outside of planting. Destroy contents of buckets regularly.
Postharvest: After harvest is completed and old canes removed.		Sevin	Prompt removal of old canes after harvest is essential to prevent disease spread.

SMALL FRUIT DEVELOPMENTAL STAGES

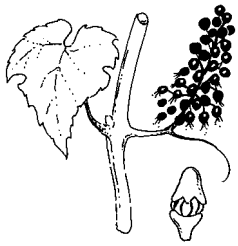
GRAPE

Bud Swell

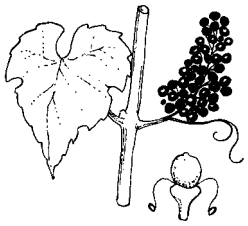


2-4 Inch Shoots

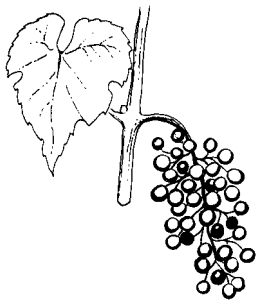
8-10 Inch Shoots



Just Before Bloom



Just After Bloom



Grapes Small Pea Size

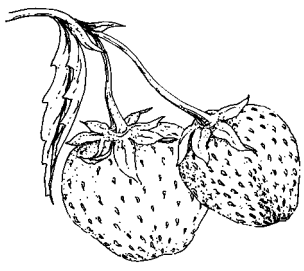
STRAWBERRY

Prebloom

Early Bloom

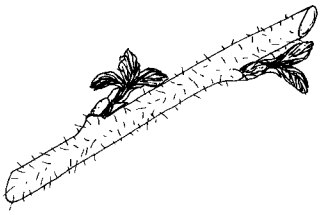
Full Bloom

Post Bloom



Harvest

RASPBERRY



Delayed Dormant

Prebloom

Post Bloom -Petal Fall

Pre-harvest

Drawings by M. L. Hayden

For additional information on fruit crop culture, insects, and diseases, consult the following publications, available from your county Purdue cooperative Extension office, or from the Purdue Media Distribution Center, 1-888-EXT-INFO or <http://www.agcom.purdue.edu/AgCom/Pubs/index.html>.

BP-1, Apple Scab <http://www.agcom.purdue.edu/AgCom/Pubs/BP/BP-1.html>

BP-30, Fire Blight <http://www.agcom.purdue.edu/AgCom/Pubs/BP/BP-30.html>

BP-35, Cedar Apple and Related Rusts <http://www.agcom.purdue.edu/AgCom/Pubs/BP/BP-35.html>

BP-36, Grape Black Rot <http://www.agcom.purdue.edu/AgCom/Pubs/BP/BP-36.html>

BP-45, Brown Rot of Stone Fruits <http://www.agcom.purdue.edu/AgCom/Pubs/BP/BP-45.html>

BP-46, Strawberry Root Diseases <http://www.agcom.purdue.edu/AgCom/Pubs/BP/BP-46.html>

BP-53, Raspberry Anthracnose <http://www.agcom.purdue.edu/AgCom/Pubs/BP/BP-53.html>

BP-54, Peach Leaf Curl <http://www.agcom.purdue.edu/AgCom/Pubs/BP/BP-54.html>

BP-4-3, Strawberry Leaf Spots <http://www.agcom.purdue.edu/AgCom/Pubs/BP/BP-4-3.html>

BP-4-5, Strawberry Grey Mold <http://www.agcom.purdue.edu/AgCom/Pubs/BP/BP-4-5.html>

E-89, Common Fruit Insects <http://www.entm.purdue.edu/Entomology/ext/targets/e-series/EseriesPDF/E-89.pdf>

HO-9, Growing Cherries in Indiana<http://www.agcon.purdue.edu/AgCom/pubs/HO/HO-9.pdf>

HO-17, Currants and Gooseberries<http://www.hort.purdue.edu/ext/HO-17.pdf>

HO-44, Raspberries <http://www.hort.purdue.edu/ext/HO-44.pdf>

HO-45, Growing Grapes <http://www.hort.purdue.edu/ext/HO-45.pdf>

HO-46, Growing Strawberries <http://www.hort.purdue.edu/ext/HO-46.pdf>

HO-49, Pruning Fruit Trees — not available on the web

HO-64, Fertilizers for Strawberries — not available on the web

HO-65, Fertilizing Blueberries <http://www.hort.purdue.edu/ext/HO-65.pdf>

HO-109, Fertilizing Fruit in Small Areas <http://www.hort.purdue.edu/ext/HO-109.pdf>

HO-121, Fertilizing Small Fruit <http://222.hort.purdue.edu/ext/HO-121.pdf>

HO-122, Growing Pears — not available on the web

HO-165, Apple Cultivars for Indiana <http://www.hort.purdue.edu/ext/HO-165.pdf>

HO-221, Grape Varieties for Indiana <http://www.hort.purdue.edu/ext/HO-221.pdf>

ID-168, Commercial Tree Fruit Spray Guide <http://www.agcom.purdue.edu/AgCom/Pubs/ID/ID-168.pdf>

ID-169, Indiana Commercial Small Fruit and Grape Spray Guide <http://www.hort.purdue.edu/hort/ext/sfg/>

Midwest Tree Fruit Pest Management Handbook <http://www.ca.uky.edu/agc/pubs/id/id93/id93.htm>

Midwest Small Fruit Pest Management Handbook <http://www.ag.ohio-state.edu/~sfgnet/>

Consumer Horticulture - Garden Pubs <http://www.hort.purdue.edu/ext/garden_pubs.html>
Entomology Extension Publications <http://www.entm.purdue.edu/entomology/ext/targets/publicat.htm>
Botany & Plant Pathology Extension Page <http://www.btny.purdue.edu/Extension/>

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