Crop Profile for Peaches in West Virginia

Prepared: September, 2000
Revised: January, 2005

General Production Information

Production Statistics

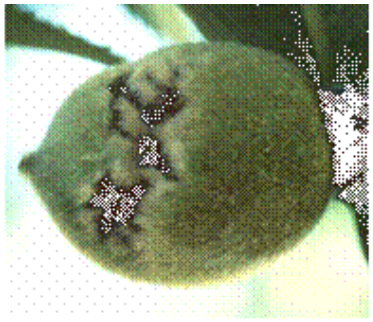
Peach production in West Virginia has averaged over 14 million pounds (296,000 bushels), with an average value of $4.1 million, over the past five years resulting in a state ranking of 14th in U.S. production (1). Acreage has declined from 2,000 in 1995 to 1,300 at present, with production by approximately 62 commercial growers (2). Ninety-nine percent of the peach trees in West Virginia are located in the four eastern counties of Berkeley, Hampshire, Jefferson and Morgan (2). In 1994, the top five varieties were Loring, Redhaven, Blake, Redskin and Cresthaven, representing 67% of the total number of trees (2). These same varieties continue to be planted today, along with newer varieties such as Glohaven, Bellaire, Bounty and Earlibrite. In 1994, 50% of the trees were at least 12 years old (2).

Production Practices

The peach production season begins with bud break in mid-March, bloom in early April, and harvest for most varieties from mid-July through August. Spring frosts are a common occurrence that reduce peach yields, and bud kill and tree damage occasionally occurs from winter freezes. Hail damage and drought conditions can also affect yields in some years. Typical culture consists of Kentucky-31 tall fescue between the tree rows and a weed-free strip within the tree

row maintained with herbicides. Hand thinning of fruit is an annual practice, with a limited amount of thinning done by mechanical and chemical means. Approximately 8-10 applications of crop protection chemicals are made annually for the control of 15-20 arthropod pests and diseases (3). Crop protection chemicals may be applied as complete or alternate-row-middle sprays. Pheromone traps are used for monitoring populations of oriental fruit moth, lesser peachtree borer and peachtree borer, and trees are inspected for insect and disease damage on foliage and fruit. Orchards are pruned annually during the late winter.

Insects and Mites



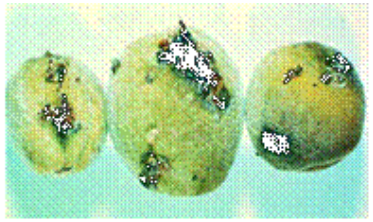
True Bugs: A complex of true bugs, consisting of tarnished plant bug [*Lygus lineolaris* (Palisot de Beauvois)], brown stink bug [*Euschistus servus* (Say)], dusky stink bug [*Euschistus tristigmus* (Say)], and green stink bug [*Acrosternum hilare* (Say)], is responsible for most of the fruit injury in commercial orchards. Types of injury caused by adults of this complex include flower or fruit abscission, catfacing, scarring, dimpling, gummosis and water-soaked. Injury is most severe in weedy orchards and those adjacent to wooded areas.

Chemical control: Most of the injury from this complex can be prevented with 3-4 insecticide applications timed between petal fall and 2-3 weeks after shuck fall. Maintaining coverage during the shuck split and shuck fall stages is especially critical, since the fruit loses chemical protection and is exposed to injury when the shuck splits and falls. Occasionally chemical control is needed close to harvest because stink bug feeding, while not significant in itself, can increase the severity of brown rot by providing an entry for this fungal pathogen.

		Amount used	
Insecticide	% of acres treated	lb a.i./acre/application	lb a.i./acre/year

Azinphosmethyl	5	0.60	0.60 – 1.20
Esfenvalerate	75	0.02 – 0.03	0.04 – 0.06
Permethrin	2	0.125 - 0.19	0.125 - 0.19
Phosmet	3	1.40	1.40 – 2.80

Cultural control: Numerous weed species serve as hosts for this complex of insects and contribute to population levels. Reducing these hosts through ground cover management can significantly lower the incidence and severity of injury from these pests. Mowing the orchard or adjacent fields at the wrong time (when spray residues are old) can contribute to injury by driving pests from ground covers to peach trees.



Oriental fruit moth, *Grapholita molesta* (Busck): Most of the IPM program in peach orchards is directed towards the management of this Lepidopteran pest. This insect overwinters as mature larvae in protected places on the tree and ground, and completes three generations on peach. First and some second generation larvae cause shoot injury, whereas second and third generations injure fruit. Near harvest, larvae often enter fruit through the inside of the stem, leaving no evidence of entry except for a small hole at the stem end of the picked fruit. Population and injury levels have been increasing over the past few years.

Chemical control: Organophosphate insecticides are applied for control in those orchards where the pheromone trap catch reaches an action threshold of 6-8 moths per trap per week. Spray applications are timed to coincide with the beginning and about 50% egg hatch of each generation by using degree day accumulations after biofix (first sustained moth catch in pheromone traps).

		Amount used	
Insecticide	% of acres treated	lb a.i./acre/application	lb a.i./acre/year
Azinphosmethyl	40	0.60	0.60 – 1.20
Carbaryl	60	2.50	2.50

Esfenvalerate	5	0.02 – 0.03	0.02 – 0.03
Phosmet	45	1.40	2.80 – 4.20

Mating disruption: The use of mating disruption technology by West Virginia peach growers has been limited to demonstration trials up to this point. Insecticides are applied for control of the first generation, and hand-applied dispensers or sprayable formulations of pheromones have been used to disrupt mating of subsequent generations. Results have been comparable to chemical control thus far, however, pest pressure in test sites has been low.

Biological control: Eggs and larvae are attacked by various predators and parasites, however, the level of biological control is too low to significantly alter the use of insecticides. Increased use of mating disruption would reduce insecticide applications, which could enhance the effectiveness of biological control.

Peachtree borer, *Synanthedon exitiosa* (Say), and lesser peachtree borer, *Synanthedon pictipes* (Grote & Robinson): These two species of clearwing moths attack the woody parts of trees, feeding on the inner bark and cambium tissue. Peachtree borer has one generation per year and feeds on the lower trunk and large roots near the soil surface. Larvae can girdle and kill a young tree in a single season, and can reduce the vigor and productivity of older trees to the point where they succumb to other causes. Lesser peachtree borer has two generations per year and feeds on previously damaged trees in the trunk, scaffold limbs and small branches. Injury results in a gradual decline in production as girdled limbs break under a fruit load. By enlarging wound areas, feeding can contribute to disease (Leucostoma canker) spread, eventually resulting in limb and tree death.

Chemical control: Insecticide applications are recommended for peachtree borer control if any evidence of infestation is detected on trees up to three years old. In older orchards, an average of more than one cocoon and/or empty pupal case per tree warrants treatment. Lesser peachtree borer control is recommended if there are more than a total of two larvae and/or empty pupal cases per tree. Handgun applications of insecticides directed at the lower trunk and any wound areas are most effective. A pyrethroid insecticide application with airblast sprayer provides some adult control when properly timed using pheromone traps.

		Amount used

Insecticide	% of acres treated	lb a.i./acre/application	lb a.i./acre/year
Chlorpyrifos	85	1.50	1.50
Endosulfan	10	1.50	1.50
Esfenvalerate	15	0.04	0.04

Mating disruption: Mating disruption dispensers are being evaluated for control in demonstration trials in grower orchards. Dispensers for lesser peachtree borer show promise in controlling both species when used at higher densities. Orchard shape and size will be critical factors to success in order to prevent mated females from moving into disrupted blocks.

Cultural control: Minimizing the occurrence of wounds on trees from equipment, pruning practices and weather will reduce the incidence of lesser peachtree borer infestation. Practices that promote rapid wound healing, such as proper pruning cuts made in late winter, will result in fewer attractive sites for borer injury. Painting the trunk and lower portion of scaffold limbs with white latex paint can prevent bark splitting from cold temperatures which provides a wound for borer entry.

Green peach aphid, *Myzus persicae* (Sulzer): This aphid species overwinters in West Virginia as wingless females in protected places on the tree and in ground debris. Two to three generations occur on peach and nectarine trees before winged aphids are produced which migrate to numerous vegetables and ornamental plants. Feeding on the underside of new leaves causes them to curl, become distorted and yellow, and drop prematurely from the tree. Fruit feeding can result in distortion and cracking, especially on nectarine. If abundant, aphid feeding also results in the excretion of large amounts of honeydew which supports the growth of a black sooty fungus that causes spotting of leaves and fruit. Because this aphid may serve as a vector of virus diseases, it has increased in importance in the mid-Atlantic region because of the discovery of plum pox virus in Pennsylvania.

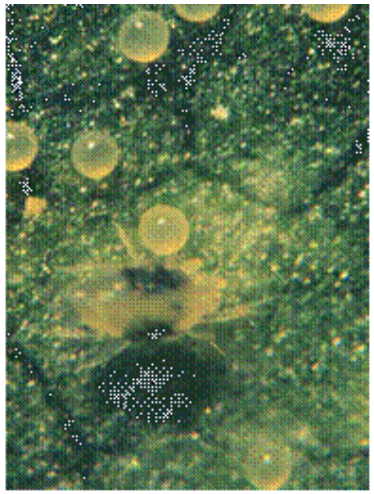
Chemical control: On bearing peach trees, chemical control is recommended if there are more than two colonies per tree by petal fall to shuck split, or more than five colonies per tree after shuck split. Because of the greater potential for fruit damage on nectarine, control is recommended on bearing trees any time there is more than one colony per tree.

Tolerance levels would most likely be lowered to zero if plum pox virus were to be discovered in West Virginia. Because of resistance, none of the currently registered products provide excellent control.

		Amount used	
Insecticide	% of acres treated	lb a.i./acre/application	lb a.i./acre/year
Endosulfan	5	1.50	1.50
Imidacloprid[a]	20	0.06 – 0.08	0.06 – 0.08
Methomyl	50	0.56 – 0.68	0.56 – 0.68

[a] Used in 2000 under a Section 18 Emergency Exemption.

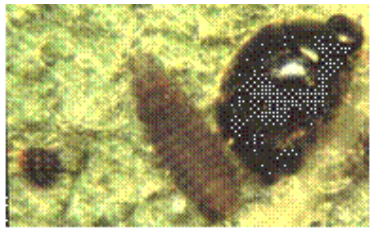
Biological control: Various predators, especially syrphid fly larvae and ladybird beetles are very effective in reducing populations of green peach aphid. Insecticide applications can often be reduced or eliminated if predators are found in at least 20% of the aphid colonies.



European red mite, *Panonychus ulmi* (Koch), and twospotted spider mite, *Tetranychus urticae* Koch: Mites have not been a common problem on peaches and nectarines in West Virginia, usually only occurring near harvest, if at all. This late season injury does not appear to have a detrimental impact on the quality and quantity of fruit production in the same year. Following the cancellation of methyl parathion uses on tree fruits in 1999, pyrethroid use increased in 2000, resulting in higher mite populations that occurred earlier in the season than normal. This can result in premature defoliation which, if early in the season, can reduce fruit size and increase limb and fruit exposure to sunburn. Premature defoliation could also increase tree susceptibility to winter injury. Mites can be troublesome during the harvest period by being a nuisance or irritant to pickers.

Chemical control: In the absence of predators, acaricides are applied for mite control at an action threshold of 10 mites per leaf during the mid-season and 20 mites per leaf late in the season. These thresholds may be adjusted based on the sensitivity of pickers to mites.

		Amount used	
Acaricide	% of acres treated	lb a.i./acre/application	lb a.i./acre/year
Fenbutatin oxide	25	0.38 – 0.50	0.38 – 0.50
Formetanate hydrochloride	5	0.69 – 0.92	0.69 – 0.92
Pyridaben	1	0.17 – 0.25	0.17 – 0.25



Biological control: The primary predator of mites on peach and nectarine trees is the ladybird beetle, *Stethorus punctum* (Leconte) **,** but other predators that aid in biological control include the minute pirate bug, *Orius insidiosus* (Say), and the black hunter, *Leptothrips mali* (Fitch). *Stethorus punctum* is generally resistant to organophosphate insecticides applied for other pests, but growers must limit use of carbaryl and pyrethroids to preserve this predator.

Japanese beetle, *Popillia japonica* Newman, and green June beetle, *Cotinus nitida* (Linnaeus): Adults of both Japanese beetle and green June beetle commonly attack peach and nectarine fruits during the last two weeks of July and first week of August, when fruit is within two weeks of harvest. These beetles usually feed in groups and often remove large chunks from the fruit. Japanese beetles may also skeletonize the leaves. Green June beetles may occasionally injure green fruit.

Chemical control: Because injury to fruit typically occurs close to harvest, carbaryl is the only insecticide that may be applied for control. This treatment is generally applied if the feeding injury exceeds one percent.

		Amount used	
Insecticide	% of acres treated	lb a.i./acre/application	lb a.i./acre/year
Carbaryl	60	2.50	2.50

Cultural control: Planting of later maturing varieties, which are harvested after early August, can eliminate the need to control these insects. Although most growers have some plantings of late maturing varieties, early and mid-season varieties are also planted to satisfy market demand and to spread out harvest labor.

Western flower thrips, *Frankliniella occidentalis* (Pergande): Western flower thrips are most troublesome in peach and nectarine orchards close to harvest, when their feeding on fruit causes injury referred to as silvering, a benign surface blemish which can result in the downgrading of packed fruit. Populations build up in white clover and other weeds in and around orchards, as well as in field crops such as alfalfa. Injury is more severe under drought conditions which make ground cover hosts less attractive. Mowing can also increase thrips movement from groundcovers into trees. Injury usually occurs in protected sites, such as in the stem end, the suture, under leaves and branches that contact the fruit, and between fruit.

Chemical control: The decision to apply insecticides for thrips control is based on observations of the earliest ripening varieties during final swell for silvering injury and the presence of thrips on fruit. Five thrips per 50 fruits may justify control. Control of thrips can be difficult because feeding occurs in protected sites and insecticide options are

limited close to harvest.

		Amount used	
Insecticide	% of acres treated	lb a.i./acre/application	lb a.i./acre/year
Methomyl	12	0.56 – 0.68	0.56 – 0.68
Spinosad	3	0.06 – 0.09	0.06 – 0.09

Cultural control: Groundcover management practices which minimize white clover and other flowering weeds will reduce thrips populations. Avoiding the mowing of orchards and adjacent fields close to fruit harvest can reduce the movement of thrips from groundcovers to trees.

Plum curculio, *Conotrachelus nenuphar* (Herbst): Adults may feed on developing buds, flowers, shucks, and setting fruit. Egg-laying scars are the most common injury, which is most likely to occur soon after bloom in those orchards adjacent to woods. Larvae tunnel into developing fruit and feed near the pit. Injury from first brood larvae causes fruit drop, but fruits injured by second brood larvae will usually remain on the tree.

Chemical control: Insecticides are not normally applied specifically for this insect, but control is achieved with sprays applied for true bugs and oriental fruit moth.

Tufted apple bud moth, *Platynota idaeusalis* (Walker): Injury from this leafroller species is not a common problem in West Virginia peach orchards. Larvae usually feed in protected places between fruit and leaves or between a fruit and the branch from which it hangs. Fruit injury may consist of small holes in the fruit surface, deeper and more extensive surface injury accompanied by fruit gumming, and internal feeding. Most fruit injury is caused by the second generation in August, which makes late maturing varieties most susceptible.

Chemical control: Insecticides are not normally applied specifically for this insect, but control is achieved with sprays applied for oriental fruit moth and western flower thrips.

Table 1. Control periods for arthropod pests of peach.

	Days after full bloom								
Arthropod pest	7-15	15-30	30-45	45-60	60-75	75-90	90-105	105-120	Postharvest
Tarnished plant bug	X	X	X						
Stink bugs			X	X	X	X	X	X	
Oriental fruit moth		X		X	X		X	X	
Peachtree borer							X	X	X
Lesser peachtree borer			X	X					X
Green peach aphid	X	X							
European red mite Twospotted spider mite				Based on action threshold					
Japanese beetle Green June beetle								X	
Western flower thrips								X	
Plum curculio	X	X							
Tufted apple bud moth				X	X			X	

Critical uses and needs

The organophosphate insecticides have been the most widely used class of compounds for insect control on peaches because of their activity against a broad spectrum of pests and tolerance by natural enemies. The loss of methyl parathion (Penncap-

M) in 1999 resulted in increased use of pyrethroids for the control of true bugs, since other OPs are not as effective as methyl parathion. Because of pyrethroid toxicity to predators, this action resulted in an increase in population levels of European red mites and twospotted spider mites in 2000. Only two OPs (azinphosmethyl and phosmet) remain for the control of foliage and fruit pests. Azinphosmethyl use has declined due to an increase in REI for some activities, which has resulted in increased use of phosmet. Dependence upon this very limited selection of OP insecticides is likely to accelerate the development of resistance, especially by oriental fruit moth which has developed OP resistance elsewhere. Non-OP alternatives such as pyrethroids, carbaryl and methomyl are more toxic to mite predators and are likely to result in increased mite levels and acaricide use. Spinosad (SpinTor) is the only new insecticide to be registered on peach, but its use is limited to the control of leafrollers (tufted apple bud moth) and western flower thrips. Pyridaben (Pyramite) is the only new acaricide that was registered in 2000 for mite control. Specific uses for various insecticides and acaricides are listed below.

Organophosphates

Azinphosmethyl: Azinphos-methyl 50W or Guthion 50W is used at 20 oz per acre primarily after shuck fall through mid-season for the control of oriental fruit moth and true bugs. An increase in the REI to 14 days for hand-thinning has virtually eliminated use of this product during a significant portion of the season. Azinphosmethyl has a good fit in an IPM program because of tolerance by natural enemies.

Chlorpyrifos: Lorsban 4E is the most efficacious and widely used product for the control of peachtree borer and lesser peachtree borer. A single handgun application at 3 pts per 100 gallons of water is usually made postharvest to control the first generation of peachtree borer and the second generation of lesser peachtree borer. Thorough coverage of the base of the tree and all wounds on the trunk, scaffolds and branches is necessary for effective control.

Phosmet: Imidan 70 WSB is used at 2 lb per acre after shuck fall through late season for the control of oriental fruit moth and true bugs. It has replaced azinphosmethyl use during the hand-thinning season and late in the season because of its shorter REI and PHI, respectively. It fits well in IPM programs because of low toxicity to natural enemies.

Carbamates

Carbaryl: Sevin XLR Plus (5 pt per acre) or Sevin 50W (5 lb per acre) is typically applied near harvest (3-day PHI) for the control of Japanese beetles and green June beetles. When used at this time, it is also effective in controlling fruit injury caused by oriental fruit moth. Carbaryl is toxic to predators and can result in an increase in mite populations during the harvest season.

Methomyl: Lannate 90SP has been used at 12-16 oz per acre primarily for green peach aphid control shortly after bloom, and also for the control of western flower thrips and occasionally tufted apple bud moth late in the season. Higher rates have been needed for green peach aphid control because of resistance. It has a good fit near harvest because of a 4-day PHI on peach. It has moderate to high toxicity to predators, depending upon application rate, and can lead to increased mite levels during harvest.

Formetanate hydrochloride: A small amount of Carzol 92SP, labeled prior to 2000, was used at 12-16 oz per acre for mite control in 2000. The label change in 2000 prohibiting application after shuck fall will eliminate future use of this product on peaches in West Virginia.

Miscellaneous insecticides and acaricides

Endosulfan: Thiodan 50W has been used at 1.5 lb per 100 gallons primarily for the control of first generation lesser peachtree borer in June and/or control of second generation lesser peachtree borer and peachtree borer after harvest in

August. This chlorinated hydrocarbon is typically not as effective against these pests as chlorpyrifos. There has also been some limited use at 3 lb per acre for the control of green peach aphid shortly after bloom, but effectiveness has been only fair due to resistance.

Esfenvalerate: Asana XL 0.66EC is used at 4-6 oz per acre from petal fall through shuck fall primarily for the control of true bugs. Some application is also made at first cover for controlling adults of lesser peachtree borer. Applications from shuck split through first cover are also effective against first generation of oriental fruit moth. These applications can result in increased mite populations because of toxicity to predators.

Fenbutatin oxide: Vendex 50W was the most widely used acaricide at 12-16 oz per acre in 2000 for control of European red mites and twospotted spider mites. It has a good fit in IPM programs because of its low toxicity to *Stethorus punctum* , the ladybird beetle predator of mites.

Imidacloprid: Provado 1.6F was used at 4-6 oz per acre under a Section 18 Emergency Exemption in 2000 for aphid control on peaches and nectarines. It is the only product rated excellent for green peach aphid control because of this insect's resistance to other materials.

Permethrin: Ambush 25W has been used at 8-12 oz per acre on a limited basis in some local situations for late season control of true bugs (stink bugs), whose feeding has led to significant outbreaks of brown rot near harvest. This use can result in mite outbreaks during harvest or the following season because of toxicity to mite predators.

Pyridaben: Registered in 2000, Pyramite 60WSB was used at 4.4-6.6 oz per acre on a limited basis late in the season for the control of European red mites and twospotted spider mites. It is the most effective acaricide currently registered for use on stone fruits.

Spinosad: SpinTor 2SC has been used at 4-6 oz per acre on a limited basis for late season control of western flower thrips. It is also excellent in the control of tufted apple bud moth, which occasionally causes fruit injury on later maturing varieties.

Weeds

Weeds compete with trees for water and nutrients, provide habitats for voles and insect pests, and serve as hosts for virus diseases that can be transmitted to trees by nematodes. Weeds are managed within the tree row by herbicides in about half of the peach acreage in West Virginia. Applications typically include a combination of preemergence and postemergence herbicides.

Diseases

Fungal Diseases

Brown rot. Brown rot is one of the most important diseases of stone fruits in West Virginia. Field losses of nectarines and sweet cherries can be extensive if conditions favorable for disease development occur during the blossoming or preharvest and harvest periods. Losses of peach vary with susceptibility of the cultivar.

Figure 1. Brown rot,
caused by the fungus *Monilinia fructicola*, on a Redhaven peach.

Chemical Management. Fungicides are recommended generally in a protective program for a complex of diseases, including brown rot, scab, and powdery mildew. Fungicides are to be applied prior to fungal infection periods that occur during rain events, particularly during the bloom and early post-bloom period and during the 2 to 3 weeks preceding harvest. The selection of fungicides depends upon the spectrum of diseases potentially present and fungicide resistance management concerns. Captan combined with a benzimidazole fungicide or sulfur is usually effective during the early part of the season to protect against blossom infections and provide control of scab, mildew, and rusty spot. The SI fungicides are very effective for controlling brown rot infections of ripening fruit. Bravo may be used in the early season up to the shuck split stage of bud development.

Fungicide	% of acres treated	lb a.i./acre/application
Captan	80	1.5 – 2.0
Sulfur	77	14.2
Benomyl	23	0.37 – 0.5
Thiophanate-methyl	62	0.52 – 0.7

Ziram	10	3.0
Sterol inhibitors (SI's) (Indar, Orbit, Elite)	90	0.09
Bravo	20	2.59

Cultural practices. Sanitation is essential if your orchard is to be considered a low risk for a brown rot epidemic. The practices listed below, if followed, should minimize brown rot spore populations and limit the likelihood of an epidemic when conditions are favorable for rapid disease development.

1. Remove all remaining fruit from the tree after the final picking. This practice limits infection of fruit peduncles and twigs thus reducing the number of brown rot cankers. In addition, this practice prevents the situation where overwintered mummies within the tree would be immediately adjacent to susceptible blossoms in the spring. Furthermore, removal of remaining fruit after final picking separates the practice of removing mummies from spring pruning. Where these practices are separated, the grower has more latitude to selectively prune (following a severe winter with high bud mortality, for example) without increased risk of blossom infection.
2. Fruit thinning practices influence the carry over of brown rot during the summer months and into the fruit ripening season. In general, fruit thinned before pit hardening decomposes rapidly; whereas, fruit thinned after pit hardening becomes infected on the orchard floor and serves as a spore source for the disease. Although it would be ideal to thin all cultivars before pit hardening, this is not practical because: (i) early, mid-season and late cultivars reach the pit hardening stage at the same time; and (ii) thinning early season cultivars at pit hardening or before favors formation of split pits. If thinning is done after pit hardening, the thinned fruit should be removed from the orchard (thin with picking baskets or rake and shovel the litter). Alternatively, direct a sprayer nozzle downward so that thinned fruit receive some fungicide.
3. In spring, monitor for blossom infection and prune out any cankers and infected shoots.
4. In spring, just prior to and during the blossom period, examine the orchard floor for apothecia. Their presence requires that blossoms be thoroughly protected with fungicide sprays during wet periods.
5. Prune to avoid excessive overcrowding of branches to increase air circulation, promote rapid drying, and increase light and spray penetration.
6. Fertilize to maintain optimum nitrogen/potassium balance.
7. Avoid dumping rotten fruit in one location, which could become the starting point for disease and insect outbreaks in the following season.

Peach scab. A fungus causes peach scab. The disease can be extremely damaging to trees throughout West Virginia. The disease can be severe under conditions of warm, wet weather during the mid-season period. The disease affects all cultivars of peach and is known to occur on nectarines and apricots as well.

Figure 2. Peach scab,
caused by the fungus *Cladosporium carpophilum*

Chemical and Cultural Management. Proper and regular pruning facilitates air movement, reduces length of wet periods, and improves spray penetration into trees. Fungicide sprays, applied at 10- to 14-day intervals, should be made beginning at petal fall and continuing until 40 days before harvest. Benzimidazole fungicides are highly effective. Captan has good efficacy. Sulfur is widely used and has fair efficacy when used alone. Sulfur is often applied in combination with captan or a benzimidazole fungicide.

Fungicide	% of acres treated	lb a.i./acre/application
Bravo	53	2.59
Captan	62	1.5 – 2.0
Benomyl	8	0.37 – 0.5
Topsin-M	14	0.52 – 0.7
Sulfur	32	14.2
Indar	10	0.09

Leaf curl. Peach leaf curl is a fungus disease that, under the right conditions, can cause severe early defoliation and crop loss on nearly all peach and nectarine cultivars. Because of weather factors and good grower management practices in most years, however, the disease often causes little or no significant damage or loss. For this reason, the destructive potential

of leaf curl is frequently underestimated to the point where important control measures may be forgotten or delayed.

Figure 3. Peach leaf curl,
caused by the fungus *Taphrina deformans*.

Chemical and Cultural Management. In West Virginia, leaf curl can be controlled with one well-timed fungicide application, either in the autumn after 90% of the leaves have fallen, or in the spring before bud swell. All cultivars are susceptible to leaf curl to some degree, although Redhaven and cultivars derived from Redhaven are more resistant to leaf curl than Redskin and cultivars derived from Redskin. If leaf curl is severe, it is important to maintain tree vigor by thinning more fruit than normal, reducing drought stress with irrigation, and applying extra nitrogen fertilizer.

Fungicide	% of acres treated	lb a.i./acre/application
Bravo	69	2.59
Ferbam	14	9.0
Ziram	12	3.0
Copper	10	6.0

Leucostoma canker. Leucostoma canker, also called perennial canker, Cytospora canker, and Valsa canker, is an important disease of peach, nectarines, and sweet cherries in cooler portions of the regions suitable for production of stone fruits. There are two causal organisms of similar host range, and they may be found on species within and outside the family Rosaceae, including apple; apricot; Sitka mountain ash; blackthorn; black, Japanese, flowering, pin, sour, and sweet cherries;

chokecherry; nectarine; Russian olive; peach; pear; common, Damson, and wild plums; prune; serviceberry; and golden willow. Leucostoma canker often kills trees in young orchards, reduces the bearing surface of older, productive trees, and shortens tree life. The disease is sporadic in West Virginia and often occurs where trees have been injured by cold temperatures or pruned improperly.

Figure 4. Leucostoma canker, caused by the fungus *Leucostoma persoonii*.

Chemical and Cultural Management. There are no effective chemical treatments for Leucostoma canker. All attempts to control peach canker must take place within the framework of an integrated crop management strategy. All phases of orchard management from establishment of new plantings to care of bearing orchards are important. Management of cankers is based on preventative measures designed to decrease winter injury and insect damage, promote optimum plant health, and facilitate rapid wound healing. As with any other disease, once established in an orchard, new infections become increasingly difficult to control.

Proper site selection for new peach plantings is essential if young trees are to enter their productive years free of disease. The site should have deep, well-drained soil and good air drainage to minimize the chances for winter injury. Tile drainage systems should be installed where feasible and whenever natural drainage is impeded. New plantings should be reasonably isolated from sources of inoculum. Young trees should not be planted adjacent to older, heavily infected peach blocks and the down-wind side of older blocks should be avoided.

Nursery stock should be disease-free and not excessively large (greater that 11/16 caliper). Trees with small cankers on lateral branches may be planted if they are pruned so that at least 10 cm of healthy tissue below the canker is removed. Examine all trees closely. Plant trees immediately after receiving them from the nursery to avoid any additional stress. Protect trees from peach tree borer by dipping the roots and crown of new trees in an appropriate insecticide. Newly planted trees should be pruned when their buds begin to break and trees should be headed back to about 100-115 cm to promote wide-angled branching. Small trees can be pruned to whips, but four to six side branches on larger trees should be pruned to two or three nodes since trunk buds may not develop. Trees should be inspected after growth begins and any dead branches should be removed.

Control oriental fruit moth and peach tree borer even in the first few non-bearing years. These insects can cause serious damage and their feeding activity creates infection sites for *Leucostoma* spp. It is also important to control brown rot since twig infections by the brown rot fungus are often invaded then enlarged by *Leucostoma* spp. Trees must be trained during the first season so that the tree branches develop the wide crotch angles that are necessary for long orchard life. Where narrow crotch angles form, the tissue in the crotch is susceptible to winter injury and invasion by borers. Also, portions of bark become included in narrow crotches where normally there should be solid wood, thus making the branch more likely to split when bearing a heavy crop. Wire spreaders or wooden spreaders with nails should be avoided because they injure the bark that may then become infected by *Leucostoma* spp.

Rodent damage should be prevented with wire or plastic guards. Plastic wrap-around guards should be removed each summer because they may delay hardening of the wood in late fall, they may harbor boring insects and interfere with trunk sprays for borer control. Latex paint with Thiram also discourages rodent feeding.

Low temperature injury is always a potential problem with stone fruits. This injury occurs to buds, twigs, branches and branch crotches, and trunks. Cold temperatures can injure peach trees early in the winter before the trees are completely acclimated to the cold. Practices to avoid include excessive or late fertilization with nitrogen and late season cultivation. Nitrogen fertilizer should be applied in late winter or early spring to avoid inducing late, cold-susceptible growth in the fall. Foliage should show a healthy green color and terminal growth should be about 30 cm on bearing trees and 45-60 cm for non-bearing trees. Trees with pale, nitrogen deficient leaves are more susceptible to infection by *Leucostoma* spp. Balance nitrogen fertilizer application with an adequate supply of potassium. Use leaf analysis to determine fertilizer requirements. In clean cultivation management systems, cease cultivation and sow a cover crop within 3 weeks of early fruit drop. Sod management, as an alternative to annual clean cultivation, with trickle irrigation, in addition to maintaining tree growth and fruit size, has the added benefit of making trees more resistant to *Leucostoma* spp.

Southwest-injury or sunscald is caused by the warming of the bark by direct sunshine on the south and west exposures of the trunk and scaffold limbs and may occur even during relatively mild winters. This injury may be the most damaging since it occurs on trunks, scaffolds, and crotches. These sites are commonly infected by *Leucostoma* spp. To avoid southwest injury, trunks and scaffolds should be covered with white latex paint that can reduce bark temperatures on sunny winter days. Small mounds of soil or mulch that drain water away from the tree trunk may prevent direct cold temperature injury to the crown. In addition, the mulch prevents formation of ice collars that could cause physical injury. Do not use gravel to fill depressions around tree collars.

Infection at pruning cuts is less frequent when pruning is delayed until late in the spring. The faster a wound heals, the less risk there is for infection. Wound healing is temperature dependent, therefore pruning should be delayed until the first forecasts of warm, dry weather. Approximately 390 accumulated degree-days (base = 0 C) are required for complete wound healing. In general, any practice that promotes tree health encourages more rapid healing. Pruning should be well planned each year so that large cuts, which heal more slowly, will not be needed. When pruning, avoid leaving stubs that may become infected. When pruning side branches from larger limbs, the cut should be made just beyond the ridge of thickened bark where the smaller branch joins the larger limb. The branch bark ridge should not be removed because it is in this region where the most rapid wound healing occurs. On one-year-old wood, the ridge of thickened bark is slightly inset and it is difficult to make the proper cut. In this situation, cut as close as possible to the larger branch without injuring it or leaving a noticeable stub. Prune to open the center of trees to light penetration because shaded branches are weakened and more susceptible to winter injury and *Leucostoma* infection. Remove all dead and weakened wood.

Cankers should be removed from the tree and burned, buried, or moved out of the orchard. Cankers on trunks and large limbs can be removed surgically in mid-summer when trees heal most rapidly. Surgery should be performed in dry weather with a forecast of dry conditions for at least three days. During surgery, remove all diseased bark around the canker and about three and five centimeters of healthy tissue from the sides and ends, respectively. Disinfect cutting tools between cuts with an alcohol or bleach solution. The resulting wound when finished should have a smooth margin and be slightly rounded above and below to favor rapid wound closure.

The practice of covering pruning cuts in spring with a thiram-latex paint mixture provides some protection against fungal infection. Sites of surgery heal best if left uncovered. Leaf scar infections by *L. cincta* take place as the tree defoliates in autumn. Fall or spring sprays applied for leaf curl control have been shown to reduce leaf scar infections. There are no fungicides registered specifically for control of *Leucostoma* spp.

Powdery mildew. Powdery mildew of peach, nectarine, and apricot is a disease that rarely is of major importance in West Virginia. When weather conditions are favorable for infection, however, it can cause some economic loss by

reducing fruit quality. Powdery mildew is sometimes called rose mildew, for it seriously affects roses and other woody ornamentals. The causal fungus, *Sphaerotheca pannosa*, attacks young shoots, leaves, and fruit. Another powdery mildew fungus, *Podosphaera clandestina*,which causes common mildew on cherry, also infects peach. The apple powdery mildew fungus, *Podosphaera leucotricha*, causes rusty spot disease. Rusty spot can cause significant losses to susceptible peach cultivars.

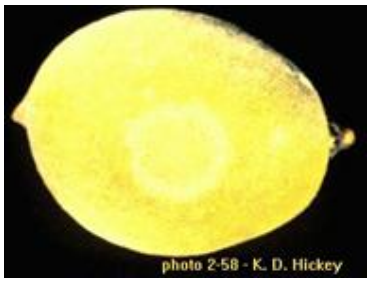


Figure 5. Peach powdery mildew, caused by the fungus *Sphaerotheca pannosa*.

Chemical and Cultural Management. The disease is effectively managed by avoiding peach cultivars susceptible to powdery mildew. With susceptible cultivars, such as Redskin and Rio Oso Gem, spray treatments may be needed. Begin fungicide sprays at petal fall and continue at 10- to 14-day intervals until the pit hardening stage is reached, usually around second cover. Fruit of susceptible cultivars become resistant at this stage. Under severe conditions, additional sprays may be needed to prevent infections of leaves and shoots. The benzimidazole fungicides and sulfur are most effective against the powdery mildew fungi.

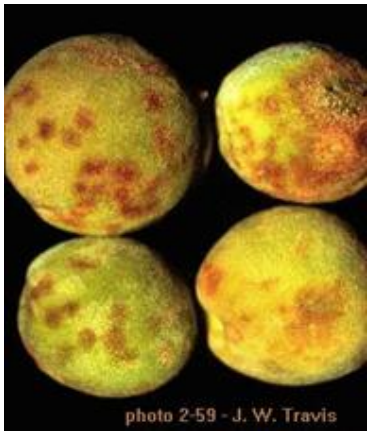


Figure 6. Rusty spot on peach, caused by the apple powdery mildew fungus, *Podosphaera leucotricha*.

Fungicide	% of acres treated	lb a.i./acre/application

Benomyl	8	0.37 – 0.5
Topsin-M	32	0.52 – 0.7
Sulfur	14	14.2
SI's	10	0.09

Phytophthora root and crown rot. In most cases, crown and root rots advance rapidly and trees collapse and die in early spring. Leaves on infected trees wilt, dry, and remain attached to the trees. Phytophthora infections may kill young trees because their root systems are small relative to those of older trees; however, mature trees can also be killed. Periods of 24 hours or longer of water-saturated soil favors infection by *Phytophthora* spp.

Chemical and Cultural Management. Good soil drainage and more frequent but shorter irrigations reduce the risk of root and crown rot caused by *Phytophthora* spp. Planting trees on a berm or raised bed also may reduce the risk of these diseases.

Rhizopus rot. Rhizopus rot is a soft fungal rot of harvested or over-ripe stone fruits. Fungal growth and fruit decay are greatly retarded in cold storage but advance rapidly at warm temperatures, allowing loss of many fruit within the shipping container.

Figure 7. Rhizopus rot of peach, caused by the fungus *Rhizopus nigricans*.

Cultural Management. No postharvest chemical treatments are employed for Rhizopus control, although chlorinated water is used in some packing lines. Allisan, a formulation of botran, is registered for postharvest on stone fruits but is prohibitively expensive. Since the fungus attacks fruit mainly after harvest, storage at 39 F will control the disease because the fungus does no grow at temperatures below 40 F. To minimize the incidence of Rhizopus rot, handle fruit carefully to avoid wounds, keep storage containers and warehouses clean, and keep hydrocooling water clean. Preharvest fungicides, postharvest fungicide dips and/or sprays, or impregnated fruit wrapping papers help prevent the disease, also.

Bacterial diseases

Bacterial spot. Bacterial spot is a serious disease of peach, nectarine, apricot, almond, and plum. It can severely devitalize trees by defoliation and it reduces yield and quality of harvested fruit. Most varieties developed in more humid areas of the country possess fair to good tolerance to the disease. Varieties developed in drier areas of the country are frequently too susceptible to grow successfully in humid areas. Bacterial spot is of most concern in regions with annual rainfall greater than 20 inches (51 cm) per year. The disease occurs sporadically in West Virginia and is not an annual concern.

Figure 8. Bacterial spot of peach, caused by the bacterium Xanthomonas arboricola

Chemical and Cultural Management. Chemical sprays may help to reduce the levels of fruit and leaf infection. To be effective, spray applications must be applied before symptoms occur. The first spray is usually a copper compound applied just before tree growth resumes in the spring. This is followed by weekly applications of an antibiotic (Mycoshield) beginning at petal fall (alternating applications of antibiotic and copper may be effective, also, although many stone fruits are sensitive to copper and injury from copper may be difficult to distinguish from damage caused by the pathogen). The 3-week period following petal fall is critical for early-season fruit infection and establishment of inoculum on new foliage. Rainfall during this period is favorable for infection. Spray programs do not provide complete control of the disease and, in some years, may not provide control that is commercially acceptable. For this reason, the best strategy is the selection of resistant cultivars in areas where the disease is endemic.

Non-chemical Management. The most effective means of disease management is avoiding the selection of highly susceptible cultivars. Locating new plantings of peach and nectarine (apricot and plum, also) near orchards of highly susceptible cultivars ultimately leads to a build up the disease in the more resistant cultivars.

Fungicide	% of acres treated	lb a.i./acre/application
Copper	5	6.0
Mycoshield	5	0.5

Crown gall. Crown gall is caused by the bacterium *Agrobacterium tumefaciens*. The bacterium is soil-borne and infected plants have galls on roots, crowns, or stems. The disease can occur in the nursery or in orchards on trees of any age.

Chemical and Cultural Management. Management techniques are directed at avoiding root wounding, reducing bacterial populations in soil by fumigation, and disinfestations of equipment with sodium hypochlorite.

Postharvest fungal diseases

Brown rot, gray mold, Rhizopus rot. Caused by *Monilinia fructicola, Botrytis cinerea, and Rhizopus* spp., respectively, postharvest diseases are managed with a variety of procedures that are implemented during postharvest handling and storage. Rapid cooling and cold temperature management during packing and shipping of fruit is critical for getting healthy fruit to fresh markets. Sanitation practices should be employed, as well as fruit washes with chlorine solutions (calcium or sodium hypochlorite). Sorting lines that remove rotted fruit help reduce inoculum and prevent re-contamination of fruit.

Critical uses and needs

A broad spectrum of fungicides with differing modes of action is required for effective stone fruit disease management and to prevent the emergence of fungicide-resistant disease organisms. With the diversity of disease-causing organisms that must be effectively managed to produce a profitable crop, and the varying effectiveness of the available fungicides against individual organisms, loss of any class of fungicide materials listed below would seriously threaten the stability of the stone fruit industry.

Strobilurin fungicides

Azoxystrobin (Abound 2.08SC) is now registered for control of scab on peaches with use rates of 6.1 to 9.2 fl oz per acre. Begin application at petal fall and apply at 12-14 day intervals. Do not make more than six applications or use more than 1.73 qt per acre per year. Do not apply within 14 days of harvest. Abound is not registered for nectarines. Because Abound has been shown to be extremely phytotoxic to certain apple varieties, it should not be applied where there is possibility of spray drift reaching apple trees. Also, sprayers used to apply Abound should not be used to spray apple trees.

Benzimidazoles

Benomyl (Benlate 50W) is registered for use in controlling several diseases of stone fruits. It is registered for control of brown rot, scab, and powdery mildew. It is registered in combination with captan for control of other diseases. Benomyl is compatible with oil and may be used at the 2.0 to 3.0 oz rate per 100 gal in combination with superior spray oil at the rate of 2.0 gal per 100 gal. Because captan is not compatible with oil, it must not be added to the Benomyl + oil tank mix. Where resistance is not present, the benomyl-oil combination is effective against brown rot and powdery mildew when applied during bloom at intervals not longer than 7 days and after bloom at intervals between sprays not exceeding 12-14 days.

Strains of benomyl-resistant brown rot are widespread. Brown rot strains are also cross-resistant to thiophanate-methyl (Topsin-M). If resistance is suspected, use of Benlate or Topsin-M should be discontinued, and they should be replaced by full rates of other fungicides. Do not apply to peaches within 14 days of harvest.

Thiophanate-methyl (Topsin-M) is formulated as a 70WP and is available in water-soluble bags. Thiophanate-methyl (Topsin-M) belongs to the same family of chemical compounds as Benlate. Generally, those disease-causing fungi that are resistant to benomyl (Benlate) also are resistant to Topsin-M. Thiophanate-methyl is registered for scab, powdery mildew, and brown rot. Strains of brown rot resistant to thiophanate-methyl and benomyl have been detected in many counties in Virginia and West Virginia. See additional comments on resistance under benomyl. Thiophanate-

methyl appears to have no compatibility problems with those pesticides that commonly are used in stone fruit orchards. However, do not tank-mix with copper-containing chemicals or with highly alkaline pesticides such as Bordeaux mixture or lime sulfur.

Sterol Demethylation Inhibitors (DMI-s or SI's)

Fenbuconazole (Indar 75WSP) is a sterol-inhibiting fungicide registered for use on peaches, nectarines, cherries and apricots, for control of blossom blight and fruit brown rot, peach scab and cherry leaf spot. Use 2 oz per acre. Addition of a wetting agent such as Latron B-1956 is recommended. For blossom blight control begin applications at early bloom and repeat at full bloom and petal fall. For scab control begin applications at shuck split and make 2 to 3 subsequent applications at 10-14 day intervals. For fruit brown rot control begin applications 2 to 3 weeks before harvest using a 7 to 10 day spray interval. INDAR 75WSP may be applied up to the day of harvest. For all crops, do not apply more than 1.0 lb per acre per season. Restricted entry interval is 12 hr.

Propiconazole (Orbit 3.6E) is registered at the rate of 4 fl oz per acre for control of brown rot blossom blight and fruit brown rot on peaches, nectarines, plums, and apricots. Three sprays of Orbit may be applied during the bloom period (pink bud to petal fall on peaches and nectarines). A maximum of two pre-harvest sprays may be applied during the period beginning 3 weeks before harvest through the day of harvest. Do not apply Orbit to cherries or prunes.

Tebuconazole (Elite 45DF), a sterol-inhibiting fungicide is registered for control of brown rot blossom blight and fruit rot on cherry, peach and nectarine and for leaf spot and powdery mildew control on cherry. Rates for these crops are 2 oz and 4 to 8 oz per acre (based on 400 gal dilute/acre). Elite 45DF may be applied up to and including the day of harvest (0 PHI). Do not apply more than 3 lb of Elite 45DF per acre per season.

Myclobutanil (Nova 40W) is a sterol-inhibiting fungicide that is highly effective for control of powdery mildew, and moderately effective for control of brown rot and scab. The dilute rate selection of 1.25 to 2.5 oz per 100 gal, depending upon the target disease and time of treatment, is concentrated per acre according to tree size as indicated on the label. To lengthen the effective life of this class of fungicides, it is recommended that the sterol-inhibiting fungicides be used in alternation with protectant fungicides (captan, ziram, benzimidazoles, and sulfur). Nova is sold in water-soluble PVA bags. Some precautions should be taken to assure that the material is properly suspended in the spray tank. The bag should be dissolved and the fungicide fully-suspended before adding other spray materials to the tank. This is particularly true with spray oils and Solubor (and other materials releasing boron) because these materials cause a reaction that prevents the bag from dissolving. Once in suspension, Nova is compatible with most common spray materials except basic copper-containing fungicides. Nova is not fully compatible with Ambush 2E and requires strong spray tank agitation to keep it in suspension.

Dithiocarbamates

Ferbam (Carbamate) is formulated as a 76WDG powder and used at rates of 0.6 to 2.0 lb per 100 gal. Ferbam is only used during the dormant season for control of peach leaf curl.

Ziram: Ziram is a dithiocarbamate fungicide that is registered for use on peaches, nectarines and cherries. Diseases for which ziram is labeled include leaf curl on peach, brown rot on cherries, peaches and nectarines, scab on peach and nectarine, and cherry leaf spot. Rates of 4.5-8 lb per acre per application and 72 lb per acre per year are permitted on peaches and nectarines. On cherries, the use rate 5-8 lb per acre with a maximum of 40 lb per acre per year. On all Eastern U. S. tree fruit crops, the pre-harvest interval is 14 days. Ziram dust may cause irreversible eye damage and irritation of nasal passages, throat and skin. To avoid exposure, loader/applicators should be properly protected and use low-dust DF, WDG or flowable formulations.

Miscellaneous fungicides

Chlorothalonil (Bravo) is currently formulated as Bravo 720 flowable containing 720 grams per liter or 6 lb a.i. per gallon of flowable formulation and as 90% dry flowable (DF) and dispersible granule (DG) formulation. Bravo 720 is registered on peach, nectarine, apricot, cherry, plum and prune for control of brown rot blossom blight, peach leaf curl, scab, and cherry leaf spot, use rates are 16-22 fl oz per 100 gal dilute or 4.5-5.5 pt/A for trees less than 20 ft tall. For blossom blight control on trees taller than 20 ft the maximum per acre rate is 5.5 pt. Bravo is not to be applied to any stone fruits between shuck split stage and harvest. On cherries, for control of leaf spot, additional applications may be made within 7 days after harvest and again 10-14 days later. Follow label directions for older containers of Bravo 500 or newer containers of Bravo 90DG or Bravo 90DF.

Captan 50W or 80W formulations are used at 6.0-8.0 lb/A of Captan 50W or 3.75-5.0 lb/A of Captan 80W, for control of diseases on stone fruit; other formulations should be used according to label direction. On stone fruit, Captan has proven effective in the control of brown rot and peach scab. Captan should not be used with lime or other alkaline materials. Do not use it with oil or within four days of an oil spray. Although new Captan labels permit application to peaches up to the day of harvest, Captan has a 4-day re-entry interval that makes pre-harvest application more restrictive. A label exception is made for the last 48 hours of the re-entry interval during which workers may enter the treated area to perform hand labor or other tasks involving contact with anything that has been treated, without time limit, if they wear all of the following: coveralls, waterproof gloves, shoes and socks, and protective eye wear.

Copper: Fixed copper is a term that refers to several relatively insoluble forms of copper that are safer and more conveniently prepared than Bordeaux mixture. The addition of spray lime is usually necessary for applications on fruit crops, depending upon timing. Copper fungicides are effective against many diseases, however they must be limited to only certain sprays on specific fruit crops because of the potential for injury to fruit and foliage. Fixed coppers are especially useful on stone fruit as a dormant spray to control, leaf curl, bacterial spot and bacterial canker. Fixed copper compounds are available under many trade names although they can be grouped into several general categories: (Kocide 101, 50% copper, Kocide DF, 40% copper), and tribasic copper sulfate (53% or 26% copper). Dust preparations contain from 5% to 7% metallic copper.

Some pesticide labels warn about incompatibility with copper materials due to their alkalinity. Copper materials also have potential for phytotoxicity to leaves and fruit. Phytotoxic potential is generally increased when copper-containing spray mixtures are acidified.

Bordeaux mixture is a mixture in water of copper sulfate and hydrated spray lime and is usually used as a dormant application on peaches for leaf curl, and on cherries in postharvest sprays for leaf spot. It also has some activity against collar rot. The recommended amount of each ingredient varies according to use and is designated by a three number formula, e.g. Bordeauxx 8-8-100. The numbers represent the amounts of copper sulfate in pounds, spray lime in pounds, and water in gallons, respectively. Bordeaux mixture has some compatibility problems, therefore, when used in combination with other materials, the labels of the pesticides involved should be examined thoroughly.

Fosetyl-Al (Aliette 80WDG) is registered for control of *Phytophthora* crown, collar, and root rots on non-bearing stone fruit trees. Dilute rate per 100 gal is 2.5-5.0 lb. Use 3-4 foliar sprays during the season at 60 day intervals at the 5.0 lb per 100 gal rate or 6-8 applications at 2.5 lb per 100 gal on a 30 day interval. Do not apply more than 5.0 lb of Aliette per acre per application and no more than 20.0 lb per acre per year. Do not apply within 2-3 weeks of leaf senescence.

Aliette is registered in West Virginia as a pre-plant tree root dip for control of Phytophthora crown, collar, and root rots at the rate of 3.0 lb per 100 gal. Mix the appropriate amount in the desired volume of water and dip the entire root system for 30-60 minutes prior to planting in the field.

Metalaxyl (Ridomil 2E) is registered as an aid in control of *Phytophthora* crown, collar, and root rots on bearing and non-bearing stone fruit trees. Applications should be made before symptoms appear, especially in orchards favorable for disease development. Metalaxyl should not be expected to revitalize trees showing moderate to severe crown rot symptoms. To apply, Ridomil 2E is diluted at the rate of 1 qt per 100 gal and poured around the trunk of each tree. The amount of diluted mix applied per tree is based on the trunk diameter as follows: diameter less 1 inch, 1 qt; 1-3 inch diameter, 2 qt; 3-5 inch diameter, 3 qts; greater than 5 inch diameter, 4 qt. Make one application at the time of planting or in the spring before growth starts. Make another application in the fall after harvest. Ridomil is highly specific and will not control other agents causing similar tree decline symptoms such as other root rots, graft union necrosis (Tomato Ring Spot Virus) and vole damage.

Ridomil Gold EC is a more highly refined, more biologically active, 46.6% formulation of metalaxyl isomer. Because of its increased biological activity and higher percent formulation the diluted use rate is lower: 0.5 pt/100 gal. The amount of diluted fungicide to apply as a drench is the same as listed above for Ridomil 2E. The restricted entry interval for the recently registered Ridomil Gold EC is 48 hours. Ridomil 5G is registered for use on non-bearing trees only.

Sulfur: Wettable sulfurs are finely divided, elemental sulfur particles with a wetting agent added so that the sulfur can be mixed with water and remain in suspension while being applied. The most readily available forms of sulfur are dry, wettable powder (95% sulfur) and fused bentonite sulfur (30% to 81% sulfur depending upon the brand). Sulfur dusts are available and generally are more finely divided and therefore more adherent and effective than the coarser wettable powders. Flowable sulfur products are available and their advantage over wettable sulfurs include being effective at lower rates and having better retention properties. Generally, sulfur is used in peach programs for the control of scab and powdery mildew.

Do not use any sulfur products within two weeks before or after an oil spray. Copper, sulfur, and liquid lime-sulfur should be used by growers who intend to produce fruit for the organic market. Growers are cautioned to be aware of the disadvantages and limitations of these materials, compared to synthetic fungicides: sulfur is incompatible with oil, it has poor residual activity, it acidifies soil when used in seasonal programs, and it is phytotoxic to fruit and foliage when used in hot weather; liquid lime-sulfur is extremely caustic and may be dangerous to apply, it may also be phytotoxic to foliage and it may reduce leaf size and yield, several consecutive applications may need to be made to effectively eradicate scab lesions; copper sprays have better residual activity than sulfur sprays and some coppers can be used to tight cluster if surface russetting of the fruit is not a problem. Only a few copper formulations are registered for application after petal fall. Because of these problems, organic growers are best served by planting many of the excellent scab-immune cultivars that are available commercially.

Iprodione (Rovral 50WG or 4F) is registered for control of brown rot blossom blight and fruit brown rot on cherries, peaches, and nectarines. The recommended rate is 2 lb or 2 pt per acre. For blossom blight control, apply at early bloom and repeat at full-bloom and petal fall if conditions are favorable for disease development. For fruit rot control, make an application when disease conditions become favorable in the five weeks prior to harvest. Repeat at no shorter than 7-day intervals in the pre-harvest sprays. Effectiveness may be improved by the addition of a non-ionic spreader such as Latron CS-7. May be applied the day of harvest. Do not apply more than four times per season and no closer than 7 days to harvest.

Oxytetracycline (Terramycin, Mycoshield) is an antibiotic registered under the trade name Mycoshield for the control of bacterial spot on peaches and nectarines. It is the best available material for this use.

Table 2. Seasonal activity of peach diseases in West Virginia.

Growth stage	Brown rot		Scab		Powdery mildew (and rusty spot)	Rhizopus rot	Bacterial spot	Leucostoma canker		Leaf curl
	Blossoms and twigs	Fruit	Fruit	Shoots				new	old	
Dormant					S			+		
Bud swell	+				S			+ S		+
Pink	+							+ S		+
Bloom	+ S $						+	+ S		
Petal fall	S $		+	+	+		+	+ S		S
Shuck split	S $		+	+	+		+	S		S
1st - 3rd covers	S $		+	+	+ S		+ S $	S		S
4th - 6th covers	S $	+ S $	S		S		+ S $	S		
Preharvest	S $	+ S $	S	+ S	S	+ S $	S $			
Harvest	S $	+ S $	S	+ S	S	+ S $	S $			
After harvest	S $	+ S $				+ S $		+		

Fall	S $			S			+	+		

Note: + = initial infections possible; S = observable symptoms; $ = secondary infection. Data for development of diseases may vary more than a month from year to year and by location in West Virginia.

Nematodes

Nematodes are microscopic, non-segmented roundworms that live in diverse habitats. Plant parasitic nematodes live in soil and feed on plants by puncturing and sucking the cell contents with a mouthpart called a stylet. Several genera of plant parasitic nematodes are present in West Virginia soils; however, dagger and root lesion nematodes are considered to be the most important.

Dagger nematode. Dagger nematodes feed externally. They are able to reach the root's vascular tissues with their long stylets. Their feeding reduces the vigor and yield of affected trees. The main damage inflicted by dagger nematode is related to tomato ringspot virus, which is transmitted by the nematode during feeding. The virus causes stem pitting disease. Symptoms of dagger nematode infestation include reduced growth and vigor of trees.

Chemical and Cultural Management. Two chemical fumigants are recommended only for pre-plant applications for peach. The first is metam sodium or Vapam. Vapam can reduce populations of nematodes if applied properly, but it does not penetrate roots very well and is difficult to get into deeper soil layers. The second material is dichloropropene, sold as Telone II or C-17. Two additional chemicals can be used either pre-plant or on established trees. The first is fenamiphos (Nemacur 3). The second is oxamyl (Vydate).

Cultural techniques for nematode management include removing old trunks and large roots, allowing planting sites to lie fallow or planting with green manure cover crops for 1 to 2 years, and use of certified nematode-free rootstocks or seedlings for establishing new orchards. Recently, growers have been increasing the use of rapeseed and other green manure cover crops to replace fumigation. Nematicidal chemicals are released when the crops are incorporated into soils. Two years of rotation or two crops in a year can significantly reduce the populations of nematodes, as well as reduce weed problems, improve soil organic matter content and nutrient availability, and help reduce erosion.

Root lesion nematode. Root lesion nematode is the main nematode associated with replant disease in West Virginia orchards. Trees planted in soils with high populations of root lesion nematode grow poorly and never reach their full productive potential. There are no remedial measures in established orchards. Chemical and cultural management procedures are similar to those for dagger nematode.

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