Crop Profile for Peaches and Nectarines in Virginia

Prepared February, 2000

General Production Information

**Peaches and nectarines are essentially the same, differing only in genes for surface fuzz.*
For the remainder of this publication, peaches and nectarines will be described interchangeably unless otherwise stated.

- Virginia ranks 17th in the nation for peach production, accounting for 0.60% of the U.S. total (1).
- Bearing peach acreage in Virginia in 1997 totaled approximately 1,560 acres with an additional 220 acres of non-bearing trees (1).
- In 1997, the crop totaled 9 million pounds (48 pound equivalent), down 36% from the previous year. The 1997 crop was valued at $2,240,000 (1).
- 89% of the total peach crop was delivered to the fresh market with most of the remaining fruit being used for processing (1). Detailed processing information was not published in order to avoid disclosure of individual operations.
- The total cost to produce an acre of fresh peaches amounts to approximately $4,110/acre (2).

Total Cost Breakdown:

- Preharvest costs (pruning, thinning, pest control, mowing, and fertilizer)--$1,000/acre
- Harvest costs (assuming 450 boxes per acre)—$585/acre
- Storage, hydrocooling and packing costs--$2,025/acre
- Overhead costs (varies depending on year)--$500/acre

Production Regions

The peach growing regions were recently consolidated from six districts. This was due to a continual decline in the number of growers as well as the acres of trees grown. Currently, there are three general fruit producing areas in Virginia, the Northern, Central and Southern regions. The greatest number of peaches is produced within the northern region, followed by the central and then southern sections. Compared to the 1992 Virginia Apple and Peach Survey, tree numbers were up 9% in 1997 in the area previously designated as District VI (Northern Piedmont) while declining in all other regions (1). The

state now has 1,781 total acres of peaches, down 1,563 acres from 1992.

Cultural Practices

Loring, *Redhaven* and *Redskin* are the three leading peach varieties of the approximately 25 currently being grown in Virginia. The majority of varieties produced in the Commonwealth are harvested in the mid-summer, with the other 30% maturing either in early or late summer. Prior to planting, peach varieties are grafted onto rootstocks that have been selected for characteristics such as tree size, fruitfulness, and disease resistance. Standard sized rootstocks, Lovell and Halford, perform well in the Mid-Atlantic region and are therefore most common in Virginia. Dwarf rootstocks are often avoided due to incompatibility with the scion variety.

Peaches grow well in a wide variety of Virginia soils assuming an adequate amount of drainage is available. Soil fertility is not typically of concern except in cases of very fertile soils, which may result in vigorous vegetative growth, low yields and poor fruit quality. In addition to tests for adequate drainage and fertility, probable orchard sites should also be evaluated for nematode presence. Often it is better to choose a site not previously used for peach production in order to avoid disease transmission and possible tree death as a result of nematode infestation. Also of importance when selecting a piece of land for planting peach trees is air drainage for frost control. Peach blossoms are susceptible to temperatures of 25-28° F and often a few feet in elevation can mean the difference between flower survival and death.

Peach trees complete several physiological stages within a growing season. These stages are used as references from which growers are able to monitor fruit development and time spray applications. The order of stage progression is always the same, however, the time of year varies depending on weather conditions and also on the cultivar being grown. The first stage following winter dormancy is known as silver-tip. During this period, buds begin to swell and the scales separate. When green tissue begins appearing in the bud tips, the green-tip stage has been reached. There are also several phases of blossom development, beginning with tight cluster and continuing to open cluster, pink (pink tissue showing in the flower buds) and finally full bloom. Full bloom occurs when 70% of all flowers are open, at which point, flower petals begin falling. Following petal fall, the dried flower parts also fall from young fruit. This particular stage is known as shuck split/fall. The first cover spray for pest control is typically applied two weeks after petal fall with approximately five additional cover sprays occurring in two week cycles throughout the growing season. Postharvest intervals should be considered when choosing chemicals for late season sprays. Both the number of cover sprays and the time of harvest depend on the particular variety of peach grown. Early season varieties usually mature in late July, while later season

cultivars could last through August.

Orchard production systems vary depending on the needs of the grower. Typically, trees are planted within weed-free zones maintained via herbicides, alternating with permanent grass sod alleyways. In addition to herbicides, an average of 7-10 insecticides and fungicides are applied during the growing season (3,4). Within the first 4-5 years after planting, tree canopies are manipulated either by pruning or bending. These processes usually occur during late winter or early spring depending on grower preferences. Thinning is practiced annually to improve fruit quality and prevent limb breakage. Bloom thinning with fingers or stiff brushes will remove about 60% of the flowers, although growers do not preferred this method in the event of subsequent frost damage. The majority of thinning occurs at approximately 45 days after bloom and is typically done by hand. Recently a chemical thinning agent was introduced for use on peaches however; hand thinning is still required. Although rainfall is rarely limiting during the spring, additional water is usually applied six to seven weeks prior to peach harvest. Overhead irrigation is most commonly used followed by trickle systems within Virginia.

Insect Pests

Insect descriptions found below were modified from information presented in the Mid-Atlantic Orchard Monitoring Guide(5) and control recommendations were taken from the *1999 Spray Bulletin for Commercial Tree Fruit Growers (VA, WV and MD Cooperative Extension)* (6).

Insecticides: A table of relative insecticide effectiveness on certain problem pests in Virginia has been included at the end of this section. This table was compiled from data collected in VA, WV and other states and is intended to serve only as a guide. Application methods, weather conditions and insect resistance in certain orchards may yield results that are different than those found in this table. In terms of resistance, it should also be mentioned that a given grower does not apply all chemicals each year. Strategies have been designed to forestall insect resistance by allowing the grower to alternate between organophosphate chemistries and other types of materials, such as pyrethroids or pyrethrins. Removal of a certain class of pesticides may complicate efforts to delay insect resistance by decreasing the number of tools to use in a rotation.

Direct Insects

Ranked in order of importance to the production of peaches in Virginia (1 = most important)

Oriental Fruit Moth, *Grapholita molesta* (Busck)--1

The oriental fruit moth (OFM) is the most important pest of peach in Mid-Atlantic region. OFMs cause damage by burrowing inside terminal shoots resulting in flagging or by direct feeding on the fruit. Such damage renders fruit completely unmarketable. Various stages of OFMs are present within Virginia orchards throughout the duration of the growing season.

Monitoring: Pheromone traps should be placed in the orchard prior to first adult emergence (2 traps/ orchard). Once the first adult is captured, degree day (DD) accumulation should begin to aid in the accurate prediction of insecticide timing and hence the elimination of non-essential applications. Weekly trap examinations during mid- and late season will support the prediction process.

Chemical Control: The first OFM spray should be applied after an accumulation of 200 DD and the second at 400 DD. These two applications should provide complete control of the first generation. Following control of the first OFM generation, a treatment threshold of 6 to 8 moths per trap per week is maintained for the second through fifth generations. Additional sprays should be applied if any flagging or fruit damage is seen.

- **azinphos-methyl (**Guthion 50W**)**-PHI-21 days. Non-systemic organophosphate insecticide providing broadspectrum control of non-resistant insects. Applied at a rate of 20.0 oz./acre for the control of OFMs; allow 14 days between sprays. The amount of material applied should be monitored to aid in the avoidance of resistance. Fits well into IPM programs given its low rate of predator toxicity. REI-48 hours.
- **esfenvalerate (**Asana**)**-PHI-14 days. Pyrethroid insecticide formulated as an emulsifiable concentrate, which provides broadspectrum insect control at low application rates (8.0 oz./acre). Treatments made prior to bloom may reduce beneficial mite and other predator populations useful in IPM programs. REI-12 hours.
- **isomate-M** - Applied twice per season to disrupt OFM mating. The initial treatment should be placed in the orchard prior to the first male flight and the second at 90 days following the first. This type of chemistry works best with low-moderate populations. Treated blocks should not be smaller than two acres, in order to minimize the effect of immigrating gravid females. The greatest economic benefit may be derived in non-bearing blocks where OFM is the main insect pest.
- **methomyl (**Lannate 90SP**)**-PHI-4 days. Systemic carbamate insecticide used at a rate of 10.0 oz./ acre for control of OFM. Given the short residual life of this chemical, it may also be combined with azinphos-methyl, phosmet, or methyl parathion and applied at a half rate. Do not apply more than 5 applications per crop. REI-(72-96) hours. Not labeled for use on nectarines.
- **methyl parathion (**Penncap-M**)**-PHI-21 (less than 3.0 pt./acre)-28 (greater than 3.0 pt./acre) days. Organophosphate insecticide formulated as microcapsules. Applied at a rate of 2.5 pt./acre to control OFMs. Fits well into IPM programs given its low rate of beneficial predator toxicity. Should not exceed 4 applications from petal fall to harvest. REI-48 hours.
- **permethrin (**Ambush**) (**Pounce**)**-PHI-7 days. Non-systemic pyrethroid insecticide formulated primarily as an emulsifiable concentrate. Provides excellent control of most organophosphate-

resistant insects. Permethrin should be applied at a rate of 0.2 lb. a.i./acre. Generally not recommended for use after bloom in order to prevent damage as a result of harmful mite outbreaks. Permethrin reduces the number of mite predators allowing for increased population size of European red mites. Wettable powder formulations are also available. REI-24 hours. Not labeled for use on nectarines.

- **phosmet (**Imidan**)**-PHI-14 days. Broad-spectrum organophosphate formulated as a 70W powder and applied at a rate of 2.0 lb./acre to control OFMs. Fits well into IPM programs given its low rate of beneficial predator toxicity. REI-24 hours.

Biological Control: None that are commercially effective.

Cultural Control: OFMs utilize orchard trash, mummified fruits and weed hosts for cocoon sites. Removal of these sites may help to control subsequent generations.

Tarnished Plant Bug, *Lygus lineolaris* (Palisot de Beauvois)--2

The tarnished plant bug (TPB) attacks the buds, flowers and fruit of peach trees in Virginia. TPB feeds by piercing the plant and sucking out sap. Damage is easily detected, ranging in severity depending on the stage of development when infestation occurs. Early season damage typically results in the characteristic "catfacing" injury. In addition to peach, the TPB also utilizes a variety of herbaceous hosts (especially legumes); therefore tree populations may be influenced by orchard ground cover.

Monitoring: The most critical time to monitor for TPB is between the petal fall and shuck fall stages. Direct tree examinations, jarring or beating tray counts, sticky traps, orchard floor sweep sampling, and fruit damage counts will aid the grower in population assessment.

Chemical Control: Weekly applications of the following chemicals from petal- to shuck-fall will provide excellent control of TPB when used in conjunction with a rigorous weed management strategy. Following shuck-fall, bi-weekly applications of an insecticide will be needed until 3-4 weeks prior to peach harvest. Weed control should be maintained throughout the season.

- **esfenvalerate (**Asana**)**-PHI-14 days. Pyrethroid insecticide formulated as an emulsifiable concentrate, which provides broad-spectrum insect control at low application rates (6.0-8.0 oz./ acre). Treatments made prior to bloom may reduce beneficial mite and other predator populations useful in IPM programs. REI-12 hours.
- **formetanate hydrochloride (**Carzol**)**-PHI-21 (peaches), 14 (nectarines) days. Non-systemic carbamate miticide/insecticide recommended for use at a rate of 1.0 lb./acre for controlling TPB. This product is highly toxic to predatory mites and, therefore, care should be taken to time applications properly. Effective against most organophosphate-resistant insects. Not stable in alkaline spray mixtures. REI-48 hours.

- **permethrin (**Ambush**) (**Pounce**)**-PHI-7 days. Non-systemic pyrethroid insecticide formulated primarily as an emulsifiable concentrate. Provides excellent control of most organophosphate-resistant insects. Permethrin should be applied at a rate of 0.63 lb. a.i./acre. Generally not recommended for use after bloom in order to prevent damage as a result of harmful mite outbreaks. Permethrin reduces the number of mite predators allowing for increased population size of European red mites. Wettable powder formulations are also available. REI-24 hours. Not labeled for use on nectarines.

Biological Control: Although predators have been noted for the TPB, damage caused by this pest occurs rather quickly and therefore, control by natural enemies is ineffectual.

Cultural Control: Given the intimate connection with alternate hosts found beneath the tree, fruit injury and populations within the tree are often influenced by good ground cover maintenance (i.e. weed control, aisle mowing and cultivation).

Plum Curculio, *Conotrachelus nenuphar* (Herbst)--3

Plum curculio (PC) adults feed on developing buds, flowers, shucks, and setting fruit prior to laying their eggs within the peaches. As the fruit matures, larvae hatch and tunnel toward the center to feed near the pit. Most fruit injury occurs in those orchards adjacent to hedgerows and woodlots or close to other overwintering sites of PC. Two generations of PC occur in the eastern and central portions of Virginia while only one generation per year is seen in the western portion. Primarily this is due to the biological variations between the southern and northern strains, respectively.

Monitoring: Adults are difficult to monitor given the lack of effective traps, however beating trays may be used from bloom through two weeks after shuck-fall. Fruit can also be checked for feeding or egg-laying scars.

Chemical Control: Since this insect has the potential to injure 100% of the fruit in an untreated orchard, an insecticide should be applied immediately if evidence of insect presence is detected. In the case of the northern strain, one application at either petal fall or shuck split/shuck fall should provide sufficient control. However, where the southern strain is present a second application will be needed during the fourth or fifth cover spray. Currently, growers alternate different chemistries to guard against resistance. Elimination of organophosphate insecticides may lead to increased damage resulting from this pest.

- **azinphos-methyl (**Guthion 50W**)**-PHI-21 days. Non-systemic organophosphate insecticide providing broadspectrum control of non-resistant insects. Applied at a rate of 20.0 oz./acre for the control of PC; allow 14 days between sprays. The amount of material applied should be monitored to aid in the avoidance of resistance. Fits well into IPM programs given its low rate of predator toxicity. REI-48 hours.

- **esfenvalerate (**Asana**)**-PHI-14 days. Pyrethroid insecticide formulated as an emulsifiable concentrate, which provides broad-spectrum insect control at low application rates (6.0-8.0 oz./ acre). Treatments made prior to bloom may reduce beneficial mite and other predator populations useful in IPM programs. REI-12 hours.
- **formetanate hydrochloride (**Carzol**)**-PHI-21 (peaches), 14 (nectarines) days. Non-systemic carbamate miticide/insecticide recommended for use at a rate of 1.0 lb./acre for controlling PC. This product is highly toxic to predatory mites and, therefore, care should be taken to time applications properly, so as to reduce the likelihood of harmful mite outbreaks. Not stable in alkaline spray mixtures. REI–48 hours.
- **methyl parathion (**Penncap-M**)**-PHI-21 (less than 3.0 pt./acre)-28 (greater than 3.0 pt./acre) days. Organophosphate insecticide formulated as microcapsules. Applied at a rate of 2.5 pt. per acre to control PC. Fits well into IPM programs given its low rate of predator toxicity. Should not exceed 4 applications from petal fall to harvest. REI-48 hours.
- **permethrin (**Ambush**) (**Pounce**)**-PHI-7 days. Non-systemic pyrethroid insecticide formulated primarily as an emulsifiable concentrate. Provides excellent control of most organophosphate-resistant insects. Permethrin should be applied at a rate of 0.63 lb. a.i./acre. Generally not recommended for use after bloom in order to prevent damage as a result of harmful mite outbreaks. Permethrin reduces the number of mite predators allowing for increased population size of European red mites. Wettable powder formulations are also available. REI-24 hours. Not labeled for use on nectarines.
- **phosmet (**Imidan**)**-PHI-14 days. Broad-spectrum organophosphate formulated as a 70W powder and applied at a rate of 2.0 lb./acre to control PC. Although it may also be used to manage a wide range of other insects, phosmet is particularly effective against PC. Fits well into IPM programs given its low rate of predator toxicity. REI-24 hours.

Biological Control: Natural enemies of PC have been discovered, however previous research has found them to be economically ineffective in commercial orchards.

Cultural Control: None that are commercially effective.

Stink Bugs--4

Brown Stink Bug, *Euschistus servus* (Say)
Dusky Stink Bug, *Euschistus tristigmus* (Say)
Green Stink Bug, *Acrosternum hilare* (Say)

Three species of stink bugs (SB) are important pests of peaches in Virginia, as well as other Mid-Atlantic States. Injury by SB results primarily from feeding, with the stage of fruit growth determining the severity of the damage. The most common form of injury is the characteristic "catfacing" also seen as a result of TPB feeding.

Monitoring: The most critical time to monitor for SB is between the petal fall and shuck fall stages. Direct tree examinations, jarring or beating tray counts, sticky traps, orchard floor sweep sampling, and fruit damage counts will aid the grower in population assessment.

Chemical Control: Weekly applications of the following chemicals from petal- to shuck-fall will provide excellent control of SB when used in conjunction with a rigorous weed management strategy. Following shuck-fall, bi-weekly applications of the insecticides will be needed until 3-4 weeks prior to peach harvest. Weed control should be maintained throughout the season.

- **esfenvalerate (**Asana**)**-PHI-14 days. Pyrethroid insecticide formulated as an emulsifiable concentrate, which provides broad-spectrum insect control at low application rates (6.0-8.0 oz./ acre). Treatments made prior to bloom may reduce beneficial mite and other predator populations useful in IPM programs. REI-12 hours.
- **formetanate hydrochloride (**Carzol**)**-PHI-21 (peaches), 14 (nectarines) days. Nonsystemic carbamate miticide/insecticide recommended for use at a rate of 1.0 lb./acre for controlling SB. This product is highly toxic to predatory mites and, therefore, applications should be timed properly, so as to not induce population increases of harmful mites. Not stable in alkaline spray mixtures. REI-48 hours.
- **permethrin (**Ambush**) (**Pounce**)**-PHI-7 days. Non-systemic pyrethroid insecticide formulated primarily as an emulsifiable concentrate. Provides excellent control of most organophosphate-resistant insects. Permethrin should be applied at a rate of 0.2 lb. a.i./acre. Generally not recommended for use after bloom in order to prevent damage as a result of harmful mite outbreaks. Permethrin reduces the number of mite predators allowing for increased population size of European red mites. Wettable powder formulations are also available. REI-24 hours. Not labeled for use on nectarines.

Biological Control: None that are commercially effective.

Cultural Control: SB overwinter in protected areas such as fence rows, dead weeds, and other ground cover, therefore, limiting the proximity of peach trees to these areas may provide some form of control for the growing season. Also ground cover practices that eliminate seed heads and broadleaf weeds help minimize SB populations.

Beetles--5

Green June Beetle, *Cotinus nitida* (Linnaeus)
Japanese Beetle, *Popillia japonica* Newman

Adult beetles are the principal injurious stage to peaches, often feeding in groups and chewing large chunks from the fruit. Adult beetles also commonly attack leaves and petioles, but fruit feeding is the most damaging to the commercial industry. In the Mid-Atlantic area most injury occurs during the end

of July into the beginning of August and, in the case of the Japanese beetle (JB), affects mainly ripening varieties. Green June beetles (GJB) can cause damage to either green or ripening fruit.

Monitoring: Adult presence is best monitored by quietly moving into the tree, jarring several branches, and observing how many beetles fly off. Fruit examination is most effective way of assessing damage. If fruit feeding exceeds 0.5-1.0 %, then treatment is justified.

Chemical Control:

- **carbaryl** -PHI-3 (nectarines), 1 (peaches) days. Carbamate insecticide available in two formulations, **(**Sevin 50W**)** and/or **(**Sevin XLR Plus**)**.. Both should be applied at a rate of 2.5 lb. a. i./acre for adequate control of the JB and GJB. Sevin is highly toxic to bees and mite predators and therefore should not be used near bloom or in long-season control programs. Sevin XLR Plus is less hazardous to bees and other beneficial insects and also provides a longer period of residual activity. REI-12 hours.
- **methyl parathion (**Penncap-M**)**-PHI-21 (less than 3.0 pt./acre)-28 (greater than 3.0 pt./acre) days. Organophosphate insecticide formulated as microcapsules. Applied at a rate of 2.5 pt. per acre to control both JB and GJB. Fits well into IPM programs given its low rate of predator toxicity. Should not exceed 4 applications from petal fall to harvest. REI-48 hours.

Biological Control: None that are commercially effective.

Cultural Control: None that are commercially effective.

Leafrollers--6

Redbanded Leafroller, *Argyrotaenia velutinana* Walker
Tufted Apple Bud Moth, *Platynota idaeusalis* (Walker)
Variegated Leafroller, *Playtnota flavedana* Clemens

The leafrollers listed above are among the most damaging insects of apple in the Mid-Atlantic region, however, this status has not carried over into the peach industry. Leafrollers are considered sporadic pests of peach, especially when both apple and peach orchards are in close proximity.

Monitoring: Individual pheromone traps can be used to monitor adult male leafroller flight. This information can in turn be plugged into a degree-day (DD) model to coordinate insecticide applications.

Chemical Control: Given the organophosphate resistance of many of these pests in relation to control on apple crops, resistance management strategies should be employed.

- **methomyl (**Lannate 90SP**)**-PHI-4 days. Systemic carbamate insecticide used at a rate of 10.0 oz./

acre for control of leafrollers. Given the short residual life of this chemical, it may also be combined with azinphos-methyl, phosmet, or methyl parathion and applied at a half rate. Do not apply more than 5 applications per crop. REI-(72-96) hours. Not labeled for use on nectarines.

- **methyl parathion (**Penncap-M**)**-PHI-21 (less than 3.0 pt./acre)-28 (greater than 3.0 pt./acre) days. Organophosphate insecticide formulated as microcapsules. Applied at a rate of 2.5 pt. per acre to control leafrollers. Fits well into IPM programs given its low rate of predator toxicity. Should not exceed 4 applications from petal fall to harvest. REI-48 hours.

Biological Control: Leafroller larvae are parasitized by a variety of fly and wasp species, and are subject to infection by a virus within commercial orchards. However, additional chemical controls will still be needed to maintain damage within an economically acceptable range.

Cultural Control: Limiting the amount of food available at spring emergence may reduce overwintering populations. Once emerged, larval populations can also be limited by maintenance of a weed-free zone beneath the tree canopy.

INDIRECT INSECTS—ATTACKING TREE COMPONENTS

Ranked in order of importance to the production of peaches in Virginia (1 = most important)

Borers--1

Peachtree Borer, *Synanthedon exitiosa* (Say)

Lesser Peachtree Borer, *Synanthedon pictipes* (Grote & Robinson)

Both the peach tree borer (PTB) and lesser peach tree borer (LPTB) larvae have the potential to kill or seriously weaken peach trees. Although PTBs attack healthy trees, LPTB infestation is almost always associated with previously damaged trees. LPTB damage is typically more severe in older orchards with greater incidence of bacterial canker, winter injury, and pruning and other mechanical wounds.

Monitoring: Pheromone traps are available for monitoring PTB and LPTB male emergence and flight. Examination of the base of the tree and surrounding soil for evidence of PTB presence is also a common practice to determine the necessity of treatment. In the case of LPTB, wounded areas on the upper trunk scaffold limbs and branches should also be inspected when moth flight is increasing to determine the necessity of treatment.

Chemical Control: The chemicals listed below provide excellent control of the PTB and LPTB. A number of other formulations are available to provide good to fair control of these insects.

- **chlorpyrifos (**Lorsban 4E**)**-PHI-14 days. Registered for mid-season control of PTB and LPTB, however the best results have been obtained when the material was applied immediately following harvest to the trunks of trees at a rate of 3.0 pt./100 gal. of water. REI-24 hours.
- **Isomate PTB**-Applied once per season to disrupt PTB mating. This type of chemistry has been very effective against PTB, replacing the special borer spray.

Biological Control: None that are commercially effective.

Cultural Control: None that are commercially effective.

Aphid--2

Green Peach Aphid, *Myzus persicae* (Sulzer)
Black Peach Aphid, *Brachycaudus persicae* (Passerini)

Green peach aphids (GPA) typically feed on the underside of leaves causing severe curling and reduced photosynthate potential. Feeding of large GPA populations' results in excretion of large amounts of honeydew that supports the growth of a black sooty fungus that causes spotting of leaves and fruit. GPA may also function as vectors of certain virus diseases of peach. Resurgence in GPA populations may be due to destruction of natural predators and resistance to chlorinated hydrocarbon and organophosphate insecticides.

Black peach aphids (BPA) are rare in mature commercial orchards, however they are particularly damaging to young trees and also nursery plantings. These aphids feed mainly on the roots rather than above ground portions of peach trees. If BPA are discovered in the tree canopy, below ground portions should be inspected for high populations' densities.

Monitoring: Early detection is critical for effective management, therefore, inspection of leaves, flowers and developing fruit should begin around petal fall. Treatment should begin if more than 2 colonies/peach tree or 1colony/nectarine tree are/is discovered between the petal fall and shuck split/fall stage. Continued treatment will be necessary if more than 5 colonies/tree are present by mid-May.

Chemical Control: The chemicals listed below provide good control of GPA if sprayed at either the pink, petal fall, or shuck split/shuck fall stages. Insecticide applications should be based on monitoring results.

- **esfenvalerate (**Asana**)**-PHI-14 days. Pyrethroid insecticide formulated as an emulsifiable concentrate, which provides broad-spectrum insect control at low application rates (6.0-8.0 oz./ acre). Treatments made prior to bloom may reduce beneficial mite and other predator populations useful in IPM programs. REI-12 hours.

- **methomyl (**Lannate 90SP**)**-PHI-4 days. Systemic carbamate insecticide used at a rate of 10.0 oz./ acre for control of aphids. Given the short residual life of this chemical, it may also be combined with azinphos-methyl, phosmet, or methyl parathion and applied at a half rate. Do not apply more than 5 applications per crop. REI-(72-96) hours. Not labeled for use on nectarines.

Biological Control: Several natural aphid predators include lady bird beetle larva and adults, aphid midges, green lacewings and syrphid fly larvae. However, control by natural predators themselves, is insufficient to prevent fruit injury within commercial orchards in Virginia. Control is likely to occur if greater than 20% of the aphid colonies have predators.

Cultural Control: None that are commercially effective.

Mites--3

European Red Mite, *Panonychus ulmi* (Koch)
Twospotted Spider Mite, *Tetranychus urticae* Koch
Peach Silver Mite, *Aculus cornutus* (Banks)

European red mites (ERM), although a major pest of apples within Virginia, seldom reach economic levels on peaches until late summer. Peach silver mites (PSM) and twospotted spider mites (TSM) may damage foliage by feeding, which destroys chlorophyll, reduces respiration, and decreases the ability of the leaf to produce photosynthate.

Monitoring: Mite densities should be monitored during the growing season by counting mites per leaf with a hand lens or with a leaf-brushing machine. Action thresholds are only provisional on peach however, recent research has shown that peach trees are only about half as sensitive to mite feeding as apple trees.

Chemical Control: The chemical listed below is the only registered insecticide that provides excellent control of mite populations on peach trees. Additional products, such as Carzol 92 SP (formetanate hydrochloride), Vendex 50 WP (fenbutatin oxide) and Pyrellin offer good control of these insect pests.

- **clofentezine (**Apollo**)**-Should be applied at a rate of 4.0-8.0 oz./acre when mites are first discovered. Provides control primarily by preventing egg hatch—not an adulticide. Only one application is permitted per season. Not for use if hexythiazox (Savey) has previously been applied to a given block within the growing season.

Alternate Control: Oil treatments are typically sprayed during dormant periods at a rate of 2.0 gal./100 gal. of water to prevent the hatching of overwintering mite eggs.

- **Superior Oil**-Should not be applied at a temperature higher than 85° F or lower than 35° F.

Biological Control: Natural predators of the foliage feeding mites include *Stethorus punctum* (Leconte) larva and adults. The population size of this predator is important for adequate control. Control will occur if the number of *S. punctum* larva and adults is at least 2.5 times as abundant as the number of mites per leaf during a 3-minute scouting period. Low to moderate populations of PSM are considered advantageous when providing an alternative food source for mite predators if primary prey species are scarce.

Cultural Control: Elimination of groundcover, which fosters detrimental mites during the winter, may reduce population size for the following spring. Groundcover control should also be a priority within the growing season given that mite populations tend to build up on herbaceous hosts and move to the peach trees as these hosts senesce.

Scale Insects--4

European Fruit Lecanium, *Parthenolecanium corni* (Bouche)
San Jose Scale, *Quadraspidiotus perniciosus* (Comstock)
Terrapin Scale, *Mesolecanium nigrofasciatum* (Pergande)
White Peach Scale, *Pseudaulacaspis pentagona* (Targioni-Tozzetti)

European fruit lecanium, San Jose scale and white peach scale were introduced into the U.S., while the terrapin scale is a native species. All of these insects are widely distributed and feed primarily on tree sap, greatly reducing vigor and productivity. Typically, the European fruit lecanium and the terrapin scale tend to be less injurious than the other two species. Scale insects are also capable of feeding on the leaves and some fruit often resulting in discoloration resulting from black sooty mold produced on the honeydew of feeding scale insects. At present, control of these pests is achieved through the use of currently available chemicals; except in cases where sprays are unable to penetrate the tree canopy.

Monitoring: Placement of black electrician's tape around infested branches--sticky surface outward--aids in the evaluation of crawler emergence and hence timing of chemical control applications. The effectiveness of the tape may be enhanced by the addition of petroleum jelly.

Chemical Control: Recommended spray schedules for OFMs, TPB, PC and SB usually control the buildup of scales on late maturing varieties. Early season varieties may need an additional treatment as found below. Based upon current data, chlorpyrifos is the only registered chemical that provides effective control against scale insects.

- **chlorpyrifos (**Lorsban 4E**)**-PHI-14 days. Non-systemic organophosphate insecticide formulated as an emulsifiable concentrate. Applied at a rate of 1.0 pt./100 gal. water, either separately or with oil, to control scale insects. REI-24 hours.

Alternate Control:

- **Superior Oil**- Used in combination with Lorsban 4E to control overwintering populations of scale insects when applied at a rate of 2.0 gal./100 gal. dilute during periods of dormancy.

Biological Control: None that are commercially effective.

Cultural Control: Annual dormant pruning to improve spray coverage may reduce the severity of this pest.

Periodical Cicada, *Magicada* spp.--5

Damage by the periodical cicada results from egg deposition, which causes wounding and possibly death of the affected branch. Feeding by nymphs among the roots may also lead to damage, but usually to a much lesser degree. Injury due to the cicada does not happen every year, however it may be extremely severe in instances where periodical emergence is scheduled. This may be every seventeen or thirteen years, although overlapping broods could increase occurrence.

Monitoring: Evidence of the cicada or cicada presence should be monitored during years when adult emergence is expected. Maps are available which predict current outbreaks based on previous emergence data.

Chemical Control: In years during which cicada emergence is expected, frequent insecticide applications may be necessitated by immigration of cicadas from unsprayed areas.

- **azinphos-methyl (**Guthion 50W**)**-PHI-21 days. Non-systemic organophosphate insecticide providing broad-spectrum control of non-resistant insects. Applied at a rate of 20.0 oz./acre for the control of periodical cicada, allow 14 days between sprays. Fits well into IPM programs given its low rate of predator toxicity. REI-48 hours.
- **carbaryl**-PHI-3 (nectarines), 1 (peaches) days. Carbamate insecticide available in two formulations, **(**Sevin 50W**)** and/or **(**Sevin XLR Plus**)**. Both should be applied at a rate of 2.5 lb. a. i./acre for adequate control of the periodical cicada. Sevin is highly toxic to bees and mite predators and therefore should not be used near bloom or in long-season control programs. Sevin XLR Plus is less hazardous to bees and other beneficial insects and also provides a longer period of residual activity. REI-12 hours.
- **esfenvalerate (**Asana**)**-PHI-14 days. Pyrethroid insecticide formulated as an emulsifiable concentrate, which provides broad-spectrum insect control at low application rates (8.0 oz./acre). Treatments made prior to bloom may reduce beneficial mite and other predator populations useful in IPM programs. REI-12 hours.
- **methomyl (**Lannate 90SP**)**-PHI-4 days. Systemic carbamate insecticide used at a rate of 10.0 oz./

acre for control of periodical cicada. Given the short residual life of this chemical, it may also be combined with azinphos-methyl, phosmet, or methyl parathion and applied at a half rate. Do not apply more than 5 applications per crop. REI-(72-96) hours. Not labeled for use on nectarines.

- **methyl parathion (**Penncap-M**)**-PHI-21 (less than 3.0 pt./acre)-28 (greater than 3.0 pt./acre) days. Organophosphate insecticide formulated as microcapsules. Applied at a rate of 2.5 pt./acre to control periodical cicadas. Fits well into IPM programs given its low rate of beneficial predator toxicity. Should not exceed 4 applications from petal fall to harvest. REI-48 hours.
- **permethrin (**Ambush**) (**Pounce**)**-PHI-7 days. Non-systemic pyrethroid insecticide formulated primarily as an emulsifiable concentrate. Provides excellent control of most organophosphate-resistant insects. Permethrin should be applied at a rate of 0..2 lb. a.i./acre. Generally not recommended for use after bloom in order to prevent damage as a result of harmful mite outbreaks. Permethrin reduces the number of mite predators allowing for increased population size of European red mites. Wettable powder formulations are also available. REI-24 hours. Not labeled for use on nectarines.
- **phosmet (**Imidan**)**-PHI-14 days. Broad-spectrum organophosphate formulated as a 70W powder and applied at a rate of 2.0 lb./acre to control periodical cicadas. Fits well into IPM programs given its low rate of beneficial predator toxicity. REI-24 hours.

Biological Control: Parasitic wasps and flies and predatory mites are the most significant natural enemies of periodical cicada eggs. Birds or killer wasps may attack adults, however the wasps are usually timed for annual cicadas that emerge later in the season. *Massospora cicadina*, a fungal pathogen also infects the adults. Naturally occurring enemies provide insufficient commercial control of the periodical cicada during years of severe outbreak.

Cultural Control: Delaying planting in years of expected emergence may prove beneficial, especially since periodical cicada damage is most detrimental among young trees.

Relative Effectiveness of Chemicals for Peach Insect Control[1]

(E = excellent; G =good; F = fair; P =poor)

Chemicals	GPA	TPB	PC	S	OFM	LR	PTB	LPTB	JB	C	M
azinphos-methyl	-	G	E	-	E	G	-	-	-	-	-
carbaryl	-	-	F	-	G	F	-	-	E	E	-
chlorpyrifos	-	-	-	E	-	-	E	E	-	-	-
clofentezine	-	-	-	-	-	-	-	-	-	-	E
endosulfan	F-G	G	-	-	-	-	G	G	-	-	-

esfenervalerate	**P-F**	**E**	**G**	**-**	**E**	**E**	**-**	**G[4]**	**-**	**E**	**-**
formetanate hydrochloride	**-**	**E**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**G**
isomate-M	**P**	**P**	**P**	**P**	**E**	**P**	**P**	**P**	**P**	**P**	**P**
isomate-PTB	**P**	**P**	**P**	**P**	**P**	**P**	**E**	**-**	**P**	**P**	**P**
methomyl	**G-E**	**G**	**F**	**-**	**E**	**E**	**-**	**-**	**G**	**E**	**-**
oil	**-**	**-**	**-**	**E**	**-**	**-**	**-**	**-**	**-**	**-**	**E[2]**
oxamyl	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**G**
methyl parathion	**-**	**G**	**E**	**E[3]**	**E**	**E**	**-**	**F**	**E**	**-**	**-**
permethrin	**P-F**	**E**	**G**	**-**	**E**	**E**	**-**	**G[4]**	**-**	**E**	**-**
phosmet	**-**	**F**	**E**	**-**	**E**	**G**	**-**	**-**	**-**	**-**	**-**
pyrethrin	**-**	**-**	**-**	**-**	**-**	**G**	**-**	**-**	**-**	**-**	**G**

[1]Compiled from data collected in Virginia, West Virginia and other states. Intended only as a guide. Different results may be obtained in individual orchards as a result of resistance (or lack of it), application methods, and weather conditions. GPA = Green peach aphid; RPB = Tarnished plant bug and Stinkbugs; PC = Plum curculio; S = scale; OFM = Oriental fruit moth; LR = Leafroller; PTB = Peachtree borer; LPTB = Lesser peachtree borer; JB = Japanese beetle; C = Cicada; M = Mites.
[2]Overwintering eggs.
[3]Crawler stage.
[4]Adult stage. Use pheromone trap for proper timing.

Diseases

Ranked in order of importance to the production of peaches in Virginia (1 = most important)

The major peach and nectarine diseases in Virginia are brown rot, scab, leaf curl, powdery mildew, rusty spot and Rhizopus rot. These diseases are managed by reduction of inoculum where feasible and timely applications of fungicides effective against the diseases active at the time of application. Resistance to fungicides and the need for programs to manage this spectrum of diseases present some challenges. Because there are now strains of both the scab and brown rot fungi that are resistant to benomyl and thiophanate-methyl in Virginia, it is not advisable to use these broad-spectrum fungicides throughout the entire season. Three newer sterol-inhibiting fungicides (SIF), fenbuconazole (Indar), propiconazole (Orbit), and tebuconazole (Elite) are highly effective for brown rot management and have gained

registration in the past several years while registration of the dicarboximides, iprodione (Rovral), and vinclozolin (Ronilan) has become more restricted. All of these fungicides are at risk for development of resistance in the brown rot fungus. Chlorothalonil (Bravo) is registered for early season disease control on peaches and nectarines, is effective for scab control but is not registered for use during the most critical time of the season. Myclobutanil, another SIF, controls powdery mildew (*Sphaerotheca pannosa*) and rusty spot (*Podoshaera leucotricha*), which are active during the early cover sprays, but it is not effective on scab, which also infects during that period.

Disease Pests

Disease descriptions and control recommendations found below were modified from information presented in the 1999 Spray Bulletin for Commercial Tree Fruit Growers (VA, WV and MD Cooperative Extension) (6) and in the *WVU Index of Fruit Disease Photographs, Biology, Monitoring and Management Information* (7).

Fungicides and Bactericides: A table of effectiveness of peach fungicides on diseases in Virginia has been included at the end of this section. Effectiveness ratings are based on research conducted at Blacksburg and Winchester, VA, and also on research from surrounding states. The results listed in this table may vary depending on weather conditions, how well the trees were sprayed the previous year, concentration of inoculum present, tree size and age, formulation of a given fungicide and how the fungicide was applied.

Brown Rot, *Monilinia fructicola*--1

In addition to causing fruit rot, the fungus, *Monilinia fructicola* can also cause blossom blight, shoot dieback and twig dieback on stone fruit trees. Losses as a result of this fungus can be economically devastating depending on the weather and also the amount of control employed by the grower. Fungal development is also stimulated by damage resulting from insects, birds or hail. Nectarine varieties are more susceptible to brown rot than peach varieties and should, therefore, receive even closer attention during periods of warm, wet, humid weather.

Monitoring: Orchards should be closely monitored for evidence of the brown rot fungus in order to determine the necessity of preventative fungicide applications. During or after pruning, trees should be examined for mummified fruit and cankers. Chance of blossom infection is high if greater than 10 of these are discovered. Also during this period, the orchard floor can be inspected for the presence of apothecia indicating a high risk of subsequent infection. Examination of shoots for blossom infection will indicate the danger of infection during the pre-harvest and harvest periods. If more than 10 shoots are infected, the likelihood of disease is high. During the pre-harvest period, fruit should be monitored

every 3-5 days given that fruit susceptibility increases as ripening progresses.

Chemical Control: Fungicides are recommended as a means of disease protection when applied either during bloom (2-3 times) or at the onset of fruit ripening (1-2 times). One fungicide application can be used to protect against several types of fungal infection at a time (e.g. brown rot, powdery mildew and peach scab), although various treatments corresponding to particular stages of growth will still be necessary. Few available chemicals control postinfection fungal activity and effectiveness depends on a relatively small time frame of application. Resistance management strategies are necessary to prevent reduced efficacy of the chemicals currently on the market.

- **benomyl (**Benlate 50W**)**-PHI-3 days. Formulated as a wettable powder and applied at a rate of 12.0-16.0 oz./acre when combined in tank mixes with captan or sulfur. Benomyl is individually compatible with oil, but the benomyl/captan mix is not. Benomyl resistant brown rot strains are known to exist in some areas of Albemarle, Frederick, Montgomery, and Patrick Counties of Virginia. REI-24 hours.
- **captan (**Captan 50W**)**-PHI-0 days. Formulated as a wettable powder and applied in combination with benomyl or thiophanate-methyl at a rate of 3.0-4.0 lb./acre. Should not be used with lime or other alkaline materials or within 4 days of an oil treatment. REI-96 hours.
- **fenbuconazole (**Indar 75WSB**)**-PHI-0 days. Systemic sterol-inhibiting fungicide (SIF) used to protect, cure and eradicate brown rot when applied at a rate of 2.0 oz./acre. REI-12 hours.
- **iprodione (**Rovral 50W**)**-PHI-7 days (nectarines only; Rovral is not registered for use on peaches after petal fall). Formulated as a wettable powder and a flowable. For blossom blight control, applied at a rate of 2.0 lb./acre at early bloom and also full-bloom as needed. Repeated at no less than 7 day intervals to nectarines during the pre-harvest period. No more than 4 applications can be made to nectarines or 3 to peaches within a growing season. REI-12 hours.
- **myclobutanil (**Nova 40W**)**-PHI-7 days. Systemic SIF formulated as a wettable powder and applied at a rate of 2.5-6.0 oz./acre for control of brown rot. May not be applied within 7 days of harvest. REI-24 hours.
- **propiconazole (**Orbit 3.6E**)**-PHI-0 days. Systemic foliar SIF formulated as an emulsifiable concentrate and applied at a rate of 4.0 fl. oz./acre. A maximum of two preharvest sprays may be applied during the period beginning 3 weeks before harvest through the day of harvest. REI-24 hours.
- **sulfur (**95% sulfur**)**- PHI-0 days. Formulated as a dry wettable powder and applied in conjunction with benomyl at a recommended rate of 6.0-9.0 lb./acre or with thiophanate-methyl at a rate of 12.0-15.0 lb./acre. Should not be used within two weeks before or after an oil spray. REI-24 hours.
- **tebuconazole (**Elite 45DF**)**-PHI-0 days. SIF formulated as a dry flowable and applied at a rate of 5.0 oz/acre to aid in the control of brown rot. Do not apply more than 3.0 lb. of tebuconazole per acre per season. REI-0 hours.
- **thiophanate-methyl (**Topsin-M 70W**)**-PHI-1 days. Formulated as a wettable powder and applied at a rate of 12.0-16.0 lb./acre when combined in tank mixes with captan or sulfur. Given the chemical similarity to benomyl, chances for development of brown rot resistance to thiophanate-methyl are high. REI-12 hours.

- **vinclozolin (**Ronilan 50W**)**-PHI-14 days. Formulated as a 50W powder or 4F for control of the brown rot fungus when applied at a rate of 1.5-2.0 lb. 50W/acre. No more than 8.0 lb. of vinclozolin should be applied per acre per year. REI-12 hours.

Biological Control: None that are commercially effective.

Cultural Control: Several cultural activities will reduce the likelihood of an outbreak of brown rot under favorable conditions. These include good orchard sanitation practices, fertilization favoring an optimum nitrogen/potassium balance and careful fruit handling during the harvest and postharvest stages. In the case of peaches, fruit thinning prior to the pit hardening stage will allow the thinned fruit to decompose completely without becoming infected.

Peach Scab, *Cladosporium carpophilum*--2

The severity of peach scab, like brown rot, is dependent upon weather conditions and the fungicidal control applied by the grower. Primary infection occurs approximately within the month following bloom, although symptoms do not usually become visible until 5 to 7 weeks after infection. Fungicide application during the postbloom period is critical to prevent peach scab. Lack of fungicide treatment will result in severe cracking of the fruit skin, which also can allow for infection by secondary fungi.

Monitoring: Examination of sample trees aids the grower in identifying areas of future disease concern, and also allows for assessment of the effectiveness of the current spray program.

Chemical Control: Fungicide sprays, applied at 10 to 14 day intervals, should be made beginning at petal fall and continuing until 40 days before harvest. Resistance management strategies should be considered when planning season-long spray schedules to control peach scab.

- **benomyl (**Benlate 50W**)**-PHI-3 days. Formulated as a wettable powder and applied at a rate of 12.0-16.0 oz./acre when combined in tank mixes with captan or sulfur. Benomyl is individually compatible with oil, but the benomyl/captan mix is not. Peach scab resistance to benomyl and thiophanate-methyl has been found in some orchards in Virginia. REI-24 hours.
- **captan (**Captan 50W**)**-PHI-0 days. Formulated as a wettable powder and applied in combination with benomyl at a rate of 3.0-4.0 lb./acre. Should not be used with lime or other alkaline materials or within 4 days of an oil treatment. REI-96 hours.
- **chlorothalonil (**Bravo 720**)**-Do not apply to any stone fruits between shuck split stage and harvest. Non-systemic foliar fungicide formulated as a flowable that can be applied at a rate of 3.1-4.1 pt./acre for control of peach scab during the petal fall stage.
- **sulfur (**95% sulfur**)**- PHI-0 days. Formulated as a dry wettable powder and applied in conjunction with benomyl at a recommended rate of 6.0-9.0 lb./acre. Should not be used within two weeks before or after an oil spray. REI-24 hours.

Biological Control: None that are commercially effective.

Cultural Control: Proper and regular tree pruning facilitates air movement, reduces length of wet periods, and improves spray penetration into trees. At present, no peach scab resistant cultivars are available.

Peach Leaf Curl, *Taphrina deformans*--3

Leaves infected with the airborne fungus known as *Taphrina deformans* are severely deformed often displaying a variety of colors ranging from light green and yellow to shades of red and purple. As the fungus completes its life cycle, the curled leaves turn brown, shrivel, and drop from the tree. Fruit can also be infected resulting in premature drop or deformation. Peach leaf curl is most severe in years with cool, wet conditions during bud swell. In cases of infection, grower management practices can bolster tree health by through increased thinning, fertilizer and irrigation.

Monitoring: Given that treatment is not effective once an infection has occurred, monitoring consists mainly of assessment of the efficacy of the current spray program and planning for the next season based on the condition of the orchard.

Chemical Control: This disease can be adequately controlled with application of a single fungicide either in the late-fall or early spring, prior to bud swell. Possible choices are listed below:

- **chlorothalonil (**Bravo 720**)**-Do not apply to any stone fruits between shuck split stage and harvest. Non-systemic broad-spectrum foliar fungicide that should be applied at a rate of 3.1-4.1 pt./acre for control of leaf curl in peaches.
- **copper (50%)**-Recommended at an application rate of 4.0 lb./100 gal. dilute; particularly beneficial where bacterial spot has been a problem.
- **ferbam (**Ferbam 76WDG**)**-PHI-21 days. Foliar broad-spectrum fungicide, which provides excellent control against peach leaf curl when, applied at a rate of 2.0-3.0 lb./100 gal. dilute. Not labeled for use on nectarines. REI-24 hours.
- **ziram (**Ziram 76DF**)**-PHI-14 days. Typically applied as a contact foliar fungicide at a rate of 2.0 lb./100 gal. dilute REI-48 hours. Ziram has broad-spectrum activity.

Rhizopus Rot-4

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. A distinguishing characteristic is that Rhizopus rot causes the skin to slip readily from the decaying flesh underneath, while brown rot does not. The early appearance of the fungal mycelium is as a fluffy white mass. This later turns dark gray to black as the fungus begins to sporulate. Rotted fruit on the orchard floor allow for inoculum build up as the harvest season progresses. After harvest, Rhizopus rot can spread from fruit to fruit without injury at the point of contact. Rot progression is temperature related, with rapid fungal growth at the optimum temperature of 81ºF (27ºC), but no spore germination or growth at 40ºF (4ºC).

Monitoring: Be aware of conditions (insects, hail, birds) that injure fruit in the pre-harvest period and during the harvest operation. Check for Rhizopus rot buildup while monitoring for brown rot throughout the preharvest period. Rhizopus rot is more likely to be a problem where fruits are allowed to fully ripen on the tree. Monitor sanitary conditions of field bins or crates, the hydrocooler, and the packinghouse to reduce the incidence of this disease.

Chemical Control: Pre-harvest fungicide options are not particularly effective against Rhizopus rot.

Biological Control: None that are commercially effective.

Cultural Control: Since the fungus attacks fruit mainly after harvest, storage at 39ºF will almost completely stop its growth. To minimize the incidence of Rhizopus rot, handle fruit carefully to avoid wounds, keep storage containers and warehouses clean, and keep hydrocooling water clean.

Mildews—5

Powdery Mildew, *Sphaerotheca pannosa*

Powdery mildew of peach, nectarine, and apricot is a disease that is of sporadic importance. It is favored by dry, warm weather and it may build up over several years of favorable conditions following bloom. During these conditions, new lesions will develop within ten days, and can cause some economic loss by reducing fruit quality. The causal fungus, *Sphaerotheca pannosa*, attacks young shoots, leaves, and fruit. Damage is by downgrading of fruit quality and distortion and stunting of growth.

Monitoring: Monitor blocks from year to year to assess disease potential on individual cultivars in a planting.

Chemical Control: Begin fungicide sprays at petal fall and continue at 10-14 day intervals until the pit hardening stage is reached. Fruit of susceptible cultivars usually become resistant at this stage. The SIFs listed below generally provide good control of powdery mildew. Under moderate disease pressure, wettable sulfur applied at 8-10 day intervals will suppress disease build-up. Under severe conditions, additional sprays and more effective compounds may be needed.

- **fenbuconazole (**Indar 75WSB**)**-PHI-0 days. Systemic SIF formulated in water-soluble bags and applied during the 8 week period following petal fall at a rate of 2.0 oz./acre. REI-12 hours.
- **myclobutanil (**Nova 40W**)**-PHI-7 days. Systemic SIF formulated as a wettable powder and applied at a rate of 2.5-6.0 oz./acre for control of powdery mildew. May not be applied within 7 days of harvest. REI-24 hours.

Biological Control: None that are commercially effective.

Cultural Control: The disease can be effectively managed by avoiding peach cultivars susceptible to powdery mildew, such as Redskin and Rio Oso Gem. Removal of alternate hosts adjacent to peach orchards may help to reduce the amount of inoculum present. Practices such as heavy pruning and/or the use of nitrogen fertilizers during the growing season result in increased succulent growth and therefore provide ideal habits for mildew outbreaks.

Rusty Spot (Podoshaera leucotricha)

Rusty spot of peach, characterized by the presence of rust-colored spots that can cover the entire surface of the fruit, is believed to be caused by the apple powdery mildew fungus, *Podosphaera leucotricha*.. Many observations have shown that peach orchards with rusty spot are usually next to apple orchards that are infected with powdery mildew. Rusty spot symptoms appear first as small, orange-tan spots three to four weeks after shuck fall. The discolored area enlarges slowly, and the older discolored hairs begin to shed, leaving a fuzzless, smooth, bald center surrounded by a band of orange to tan hairs. By harvest, the spots are quite spread out leaving brownish or reddish centers of hard, smooth skin that appear somewhat like a bruise from a limb rub. Losses result in the downgrading of fresh market fruit quality.

Monitoring: Peach blocks may be monitored from year to year to assess disease potential on individual cultivars within a planting. It is too late to prevent fruit damage after symptoms have appeared.

Chemical control: Because there is evidence that implicates the apple powdery mildew fungus as the rusty spot pathogen, controlling mildew in adjacent apple orchards reduces rusty spot in peach orchards. Although most infection seems to occur from petal fall to one month after shuck fall, some new spots on the fruit may continue to appear up to the time of harvest. The incidence of rusty spot is reduced by SIFs as listed below. Under moderate disease pressure, wettable sulfur is effective when applied beginning at petal fall and continuing at 8 to 10 day intervals for eight weeks.

- **fenbuconazole (**Indar 75WSB**)**-PHI-0 days. Systemic SIF formulated in water-soluble bags and applied during the 8 week period following petal fall at a rate of 2.0 oz./acre. REI-12 hours.
- **myclobutanil (**Nova 40W**)**-PHI-7 days. Systemic SIF formulated as a wettable powder and applied at a rate of 2.5-6.0 oz./acre for control of powdery mildew. May not be applied within 7

days of harvest. REI-24 hours.

Biological Control: None that are commercially effective.

Cultural Control: None that are commercially effective.

Bacterial Spot, *Xanthomonas pruni*--6

Bacterial spot causes severe defoliation and fruit spotting on susceptible peach varieties resulting in reduced yield and also quality of fruit.

Monitoring: Beginning at shuck split, weekly examinations should be made to determine the onset of infection. Once infection has occurred weekly leaf inspections should continue to estimate disease spread.

Chemical Control: Where bacterial spot is a problem, copper materials should be applied at a rate of 4.0 lb./100 gal. dilute during the dormant period. Following the initial copper treatment, weekly applications of an antibiotic compound will help to suppress development of the disease, but will not eliminate it.

Biological Control: None that are commercially effective.

Cultural Control: Depending on weather and disease pressure in a given area, spray programs may not provide commercially acceptable control and may also be costly for the grower. Selection of resistant cultivars, especially those developed in humid areas, offers the best protection against bacterial spot.

Effectiveness of Peach Fungicides1

Fungicide	Rate per 100 gal dilute	Leaf Curl	Scab	Brown Rot Blossom	Brown Rot Fruit	Rhizopus Rot	Rusty Spot/ Powdery Mildew
Benlate 50W + Captan 50W	4-6 oz + 1-2 lb	-	E	E	E	S	F
Benlate 50W + Sulfur 95W	4-6 oz + 3-6 lb	-	E	E	E	S	G
Coppers	-	E	-	-	-	-	-

Botrn 75W + Captan 50W	1 lb 1 lb	-	-	G	G	G	-
Bravo 720	16-22 fl oz	E	E	G	-	-	-
Captan 50W	2 lb	-	G	G	G	S	-
Elite 45DF	2.0 oz	-	-	E	E	S	-
Ferbam 76W	2-3 lb	E	-	-	-	-	-
Indar	(2oz/A)	-	G	E	E	-	E
Liquid lime sulfur	4 gal	E	-	-	-	-	-
Nova 40W	1.25-2.0 oz	-	-	E	-	-	E
Orbit 3.6E	(4 fl oz/A)	-	-	E	E	S	-
Rovral 50W	(2 lb/A)	-	N	E	E	F	-
Sulfir 95W	6 lb	-	G	G	G	S	F
Topsin-M 70W + Captan 50W	4-6 oz + 1-2 lb	-	G	E	E	S	F
Topsin-M 70W + Sulfur 95W	4-10 oz + 4-6 lb	-	G	E	E	S	G
Ziram 76DF	2.0 lb	E	G	G	-	-	-

Rating Scale: E=excellent; generally good disease control under heavy disease pressure; G=good; good control under moderate pressure; F=fair; fair control under moderate disease pressure; S=slight; some control under light disease pressure; N=none; little or no effect on indicated disease;-=information lacking or not applicable.

[1]CAUTION: Combinations involving Benlate or Topsin-M, the benzimidazole fungicides, may become ineffective for scab or brown rot if resistance to these fungicides develops.

Nematodes

Nematode problems are not frequently encountered within Virginia, however if present, poor orchard vigor as well as a decline in productivity and life span of the tree may result (6). The majority of these problems arise from root stunting/death or secondary infections such as the peach tree short life (PTSL) complex, caused by nematode feeding. Nematode pests of peach include species of *Criconemell*a (ring), *Meloidogyne* (root-knot), *Pratylenchus* (root-lesion), and *Xiphinema* (dagger) (8). No single practice

will eliminate nematode problems from a site however; chances for control are greater prior to planting. Once trees are established, there are no effective methods for nematode control. Non-fumigant nematicides may be used, but usually result in limited success.

Monitoring: Properly collected soil samples will allow for accurate estimations of the number of nematodes present within a given area. Population size is usually indicative of the severity of damage that might be caused by nematodes. Techniques for subsampling can be found in the 'Nematode Management' section of the *1999 Spray Bulletin for Commercial Tree Fruit Growers (VA, WV and MD Cooperative Extension)* (6).

Chemical Control: Preplant soil fumigation and post-plant non-fumigant nematicides can provide effective control against all species which attack peach trees, although chemicals available for these treatments are limited. The following recommendations were taken from the *1999 Spray Bulletin for Commercial Tree Fruit Growers (VA, WV and MD Cooperative Extension)* (6).

- **1,3-dichloropropene (**Telone II**)**-Nemacidal fumigant applied at a rate of 27.0-54.0 gal./acre for preplant control of nematodes. REI-days.
- **1,3-dichloropropene + chloropicrin (**Telone C-17**)**-Broad-spectrum fumigant applied at a rate of 30.0-60.0 gal./acre for preplant control of nematodes, other soil-borne diseases and weeds. REI-5 days.
- **fenamiphos (**Nemacur 3**)**-PHI-72 days. Only chemical control agent labeled for use in established peach orchards. Should be applied in a band beneath the drip line of the tree at a rate of 1.5-3.0 gal./acre. May also be applied via low-pressure irrigation systems, not exceeding six treatments per year. REI-48 hours.
- **metam-sodium (**Vapam**)**-Broad-spectrum fumigant applied at a rate of 40.0-80.0 gal./acre for preplant control of nematodes, other soil-borne diseases and weeds.
- **oxamyl (**Vydate L**)**-PHI–14 days. Carbamate insecticide-acaricide-nematicide, applied at a rate of 2.0-4.0 pt./100 gal. water directly to the foliage when non-bearing trees reach full leaf and then at subsequent intervals, not exceeding 4 treatments/ season. Spray is absorbed and moves systemically through the plant to the roots. Also has growth regulator properties. REI-48 hours.

Biological Control: None that are commercially effective.

Cultural Control: Planting peaches in sites previously unoccupied by fruit trees or with no prior history of nematode presence will reduce the chances for nematode damage. However, if this is not an option, removal of old peach roots prior to replanting an orchard site may provide some control. Pre-planting the new site with select herbaceous species that serve as poor nematode hosts may also reduce the effects of nematodes in newly established orchards. Nematode-free rootstocks along with ground covers that suppress root-knot nematodes provide additional defense against this species. Damage resulting from ring and dagger nematode infestation can be limited by planting either tolerant or virus-free rootstocks, respectively. No such rootstocks are currently available for the root-lesion nematode. In general, techniques such as cover cropping to improve soil structure, sound orchard management practices

(fertilization, soil pH, etc.) and control of broadleaf weeds may also reduce the effects of nematode feeding.

Weeds

Portions of this section were adapted from the herbicide recommendations as listed in the 1999 Spray Bulletin for Commercial Tree Fruit Growers (VA, WV and MD Cooperative Extension) (6).

Overall tree growth, survival and productivity may be greatly reduced by the presence of weeds within the planted row. This is especially true of young trees as a result of competition for water, nutrients and space. In addition, both grasses and broadleaf weeds harbor harmful pests, enhance the likelihood of disease and increase tree injury due to mechanized procedures, such as mowing and cultivation. Individual weed species may create other management problems given their specific nature and effects within the orchard. The best method of controlling weeds involves the establishment and maintenance of continuous weed-free zones beneath the tree canopy alternating with permanent grass sod in the alleyways. Pre-emergence, post-emergence and/or a combination of pre- and post-emergence herbicides can be used to develop the weed-free zone. Herbicide selection is primarily based on the type of problem weeds present and the stage of tree growth. Factors such as soil characteristics may also be important in determining pre-emergence herbicide rates based on movement of a particular chemical through the soil profile. Initial rainfall is necessary for activation; however, frequent rainfall may cause the herbicide to leach away from the zone of seed germination, rendering it ineffective. Post-emergence herbicide treatments may occasionally be needed to control broadleaf weeds in the grass sod or non-planted strips within the orchard.

The following list contains the most troublesome weeds found in Virginia orchards:

- Annual Morningglory
- Bindweed species
- Dandelion
- Horsenettle
- Japanese Honeysuckle
- Johnsongrass
- Plantain species
- Poison Ivy
- Pokeweed
- Tall Fescue
- Virginia Creeper
- Wild Blackberries, Dewberries and other Bramble species (Rubus)

Monitoring: -No monitoring techniques in use at present.

Chemical Control:

PREEMERGENCE HERBICIDES:

- **diuron (**Karmex DF**)**-PHI-0 days. Formulated as a dry flowable. Applied once per season to the orchard floor prior to fruit set (early spring) at a rate of 3.2 lb. a.i./acre for good to excellent control of most annual weed species. Diuron combined with a contact herbicide provides consistent control of emerged weeds as well. Partial control of many non-woody perennials around trees established, at least two years, may be achieved by mixing diuron (0.8-1.6 lb. a.i./ acre) and terbacil (0.8-1.6 lb. a.i./acre). Treated areas should not be re-cropped within two years following the last application. Not labeled for use on nectarines. REI-12 hours.
- **napropamide (**Devrinol 50DF**)**-PHI-0 days. Formulated as a dry flowable and applied once per season at a rate of 4.0 lb. a.i./acre. Application to the soil surface occurs in the fall through early spring prior to weed emergence. Spring treatment requires rainfall or irrigation within 24 hours. Safe for use on newly planted and l established trees. Additional herbicides may be paired with napropamide for improved control of annual broadleaf weeds. REI-12 hours.
- **norflurazon (**Solicam DF**)**-PHI-0 days. Formulated as a dry flowable for pre-emergence control of annual grasses and certain broadleaf weeds. Recommended for use on newly transplanted and established trees. Applied by ground at a rate of 2.0-4.0 lb. a.i./acre once time during the growing season. Combinations with other pre-and post-emergence herbicides results in improved control of annual broadleaf weeds and emerged perennials, respectively. REI-12 hours.
- **oryzalin (**Surflan A.S.**)**-PHI-0 days. Formulated as an aqueous solution for long-term (6-8 months) control of annual grass and broadleaf weed emergence when applied at a rate of 2.0-6.0 lb. a.i./acre. Lower rates are used for short-term control (4 months). In each case, one application occurs by ground during the growing season on both newly transplanted and well established trees. For control of many more broadleaf weeds, oryzalin may be mixed with diuron, simazine or terbacil. REI-12 hours.
- **oxyfluorfen (**Goal 2XL**)**-Formulated as an emulsifiable concentrate and registered for dormant or delayed-dormant application of bearing or non-bearing trees at a rate of 0.5-2.0 lb. a.i./acre. Controls small seedlings of annual weeds but can be improved when combined with other preemergence herbicides. Although oxyfluorfen controls small seedlings of annual weeds, it should be combined with an additional postemergence herbicide (i.e. glyphosate, glufosinate, etc.) to increase efficacy on emerged species. REI-24 days.
- **pronamide (**Kerb 50W**)**-PHI-0 days. Formulated as a wettable powder for use on annual (1.0-2.0 lb. a.i./acre) and perennial (2.0-4.0 lb. a.i./acre) grasses. Recommended for fall applications in orchards to control cool-season perennial grasses and certain other weeds. However, pronamide does not provide full-season coverage and will, therefore, need to be used in conjunction with other herbicides. REI-12 hours.
- **simazine (**Princep**) (**Caliber 90 or 4L**)**-PHI-0 days. Formulated as a water dispersible granule and as a liquid. Recommended for use around young trees that have been established one full year.

Found to be effective on annual broadleaf weeds (before emergence) when applied at a rate of 2.0-4.0 lb. a.i./acre. Application can occur anytime by ground, one time per growing season. Should not be used on sandy or gravelly soils. Although simazine alone does not kill emerged weeds, it is effective when paired with glyphosate or paraquat. However, a reduced rate of simazine may be necessary when paired with other pre-emergent herbicides. Not labeled for use on nectarines. REI-12 hours.

- **terbacil (**Sinbar**)**-PHI-0 days. Formulated as a wettable powder. Recommended for use in trees that have been established at least 3 years for good control of annual and some perennial weeds. Applied once either in the spring or after the harvest in the fall (before weeds emerge or during early seedling stage) at a rate of 1.6-3.2 lb. a.i./acre. Terbacil can also be used to control most annual and some perennial weeds in trees established two full years when applied one time during the year in combination with diuron at a rate of 0.8-1.6 lb. a.i./acre. Should not be used on sandy or gravelly soils or on soils low in organic matter (less than 1%). Treated areas should not be re-cropped within two years following application. Not labeled for use on nectarines. REI-12 hours.

POSTEMERGENCE HERBICIDES:

- **2,4-D amine (**Weedar 64**) (**Hi-Dep**)**-PHI-0 days. Formulated as a liquid for effective control of dandelion. May be applied in combination with other postemergence herbicides (glyphosate, sethoxydim) for improved control of troublesome weeds. Sprayed directly, one or two times per season, on young actively growing weeds at a rate of 1.5 lb. a.i./acre. Commonly used in the permanent sod strips to eliminate or suppress blooming weeds. Control of blooming weeds, especially dandelions is imperative given their competition with blossoms for pollinators, particularly bees. Research suggests that other insecticide residues found on the grass may inadvertently kill the bees interested in the blooming weeds. No other herbicides currently registered can function in the same capacity as 2,4-D in relation to the control of blooming weeds. REI-48 hours.
- **fluazifop-P-butyl (**Fusilade DX**)**-PHI-365 days. Formulated as an emulsifiable concentrate for control of emerged annual and perennial grasses in nonbearing trees. Applied directly on actively growing annual grasses at a rate of 0.25-0.37 lb. a.i./acre. May not be harvested for one full year after application. Fluazifop-P-butyl is a systemic herbicide that affects only grasses and leaves no soil residue. REI-12 hours.
- **glyphosate (**RoundUp Ultra**)**-PHI-14 days. The most broad-spectrum herbicide available to growers. Formulated as a liquid and recommended for excellent control of emerged annual and perennial weeds. Should be used with wick applicator only at a rate of 1.5-5.0 lb. a.i./acre for general control. Higher rates, not exceeding 5.0 lb. a.i./acre, will be needed for troublesome perennials and hard to kill problem weeds. Treatments for perennial weeds should be made to the ground after the weed species flowers, sets fruit, or has mature foliage. REI-12 hours.
- **paraquat (**Gramoxone Extra**)**-PHI-0 days. Formulated as a liquid and used as a contact herbicide for most weed species, particularly annual broadleaf and grass weeds. Repeated applications of 0.6-0.9 lb. a.i./acre will be necessary to give sustained control. Most effective if sprayed directly on the weeds and grasses when they are succulent and the new growth is from 1-6 inches high.

Safe for use on young trees and also for mature trees in the late summer. REI 12-48 hours.

- **sethoxydim (**Poast**)**-PHI-14 days. Formulated as a liquid to control emerged annual and perennial grasses in bearing and non-bearing orchards within one growing season. Applied by ground at a rate of 0.5 lb. a.i./acre, for control of grasses but does not affect broadleaf weeds or crops. Sethoxydim is a systemic herbicide that leaves no soil residue. REI-12 hours.

Cultural Control: In some orchards, both the grass alleyways (Kentucky-31 tall fescue) and the vegetation beneath the tree canopy are maintained solely by mowing (9). However, mowing of row middles often occurs in addition to an effective herbicide program. Cultivation may also serve as a form of weed control, sometimes in conjunction with herbicide application.

Plant Growth Regulators

Recommendations were taken from the 'Programs for Peaches' section found in the 1999 Spray Bulletin for Commercial Tree Fruit Growers (VA, WV, and MD Cooperative Extension) (6).

Plant growth regulators modify the growth and development of fruit trees either by separately influencing vegetative growth or fruiting parts, or by effecting a combination of both. Although a number of plant growth regulators have worked effectively on apple trees to promote such things as flower initiation, improve fruit shape, finish and color and thin crop size, very few of these have produced similar results in peach. The explanations for this are varied given that a number of factors such as species, stage of development and weather can effect the performance of regulators within an orchard. Recently, a chemical known as *Wilthin* was introduced and has allowed for somewhat consistent thinning of peaches (see additional description below), however subsequent hand thinning or mechanical rope thinning may still be necessary.

Chemical practices:

- **(**Wilthin**)**-Registered in Virginia for application at a rate of 3.0-6.0 qt./acre; however data indicate that higher rates of 5.0-6.0 qt. will be needed for adequate thinning. Should not be applied if foliage is wet or if rain is expected within two hours following treatment. Also, Wilthin may not be sprayed with any material other than the spreader/sticker, Regulaid (1.0 pt./100 gal.) or within 14 days of spray oils, other nutrient, sulfur or fungicide sprays in the prebloom period. Application should occur when 90% of the flowers have opened with approximately 10% of the buds in the pink stage of development. This chemical is safe for bees.

Vertebrate Pests

The various species of wildlife described below may cause damage within commercial orchards in Virginia. Portions of this section were adapted from the recommendations for wildlife control found in the *1999 Spray Bulletin for Commercial Tree Fruit Growers (VA, WV and MD Cooperative Extension)* (6).

Voles

Meadow Vole, *Microtus pennsylvanicus*
Pine Vole, *Microtus pinetorum*

Both the meadow vole and the pine vole may cause damage within orchards in Virginia. Damage results primarily from vole feeding at the base of a tree causing girdling of the cambium or within the root system, which weakens the tree. Trunk damage above the soil line is most often associated with the meadow vole, while weakened or girdled roots result from pine vole feeding. The largest amount of injury usually takes place in the winter when other food sources are in limited supply. The economic threshold for damage happens at very low population levels.

Monitoring: The presence of the meadow vole is easily evidenced by a system of surface runways, while pine vole activity is more difficult to detect given their underground habitat. Vole presence may also be evidenced and monitored by feeding on fruit that has dropped from the tree.

Chemical Control: There are several rodenticides labeled for control of voles in Virginia. The method (hand-placed baiting or broadcasting) depends on the label, grower and also on the type of groundcover present. The chemicals listed below are registered only for use following harvest and during the dormant season. Although there have been no reported cases of resistance to these chemicals, care should be taken to avoid the continuous supply of any one formulation.

- **chlorophacinone**-Hand placed baits of this compound should be applied at a rate of 10.0 lb./acre for both types of voles and it should be broadcast at a rate of 20.0 lb./acre for pine voles and 15.0 lb./acre for meadow voles. Rates lower than this may not allow for the lethal dose required for killing these pests. Chlorophacinone, which acts as an anticoagulant, is more effective against pine voles than meadow voles.
- **Diphacinone** - Available in pelleted form, diphacinone also acts as an anticoagulant. It should be hand-placed or broadcast at a rate of 10.0+10.0 lb./acre at 20-40 day intervals for both meadow and pine voles.
- **zinc-phosphide** - Zinc phosphide hand-placed grain baits should be applied at a rate of 2.0 lb./ acre and broadcast at a rate of 10.0 lb./acre for control of both meadow and pine voles. Broadcast applications require at least 3 good days of weather following treatment. Apple baits coated with 1.0 tsp./qt. of zinc phosphide and placed under covers and in holes are more effective than grain

baits for vole control. However, if populations remain high, this chemical should not be used as a repeat bait due to bait shyness as a result of taste.

Biological Control: Natural predators of voles include foxes hawks, house cats, opossums, owls, raccoons, shrikes, snakes, weasels. Although biological control is rarely considered to be of importance within commercial orchards, vole predators can help to manage populations. Care should be taken to encourage their presence in areas of vole activity.

Cultural Control: Several practical approaches are available for controlling voles within orchards. These include habitat modification, exclusion, and trapping. Habitat modification is one of the best long-term methods for maintaining vole populations. Eliminating grasses and other groundcover beneath tree canopies discourages voles from living near the bases of trees. Repeated mowing of the vegetative strips/ orchard rows limits food sources and also helps to expose the voles to potential predators. Exclusion refers to the use of hardware cloth barriers or tree guards to deter vole feeding around tree trunks. The exclusion method is effective for meadow vole management, but does not work particularly well to control pine voles. Of the possible cultural controls, trapping is the least efficient, however, it is an effective and safe way of maintaining voles in specified areas or small orchards.

White-tailed Deer, *Odocoileus virginianus*

One of the most well known mammals in North America, the white-tailed deer is commonly found in commercial apple orchards in Virginia. Deer can cause damage either by browsing on the dormant or terminal buds in the winter months, "rubbing" tree trunks and limbs during the spring and summer, and feeding on mature fruit in the fall.

Monitoring: No monitoring techniques in use at present.

Chemical Control: Taste and odor repellents are available to deter deer presence within an orchard; with effectiveness depending on population size, other deer food sources and weather. These chemicals may become expensive if repeated applications are necessary, (i.e. following every rain event). Repellents are generally applied during the dormant season either as aerial, ground or spot treatment application. In addition to the products listed below, both deodorant soap and human hair have been used to ward off deer, especially within young trees.

- **capsaicin (**Hot Sauce Animal Repellant**)**-Applied as an aerial spray during the dormant period. Must be used in combination with Vapoguard (2.0 qt./gal. of water) at a rate of 6.0-8.0 oz./gal. of water. Both mixtures should be added to water to obtain a total volume of 100 gal.
- **denatonium saccharide (**Ro-pel**)**-Should be applied only during periods of tree dormancy. Do not dilute; apply directly from bottle with a paintbrush or course sprayer to areas commonly fed upon by deer (i.e. twigs and trunks).

- **hinder (**Hinder**)**-Active ingredients (13.8%) include ammonium salts of C8-18 and C18' fatty acids, ammonium soaps of fatty acids, and phenol, 2,4-dichloro-benzenesulfonate. May be applied during the growing season or dormant period at a rate of 3.0-5.0 gal./100 gal. of water (ground) or 3.0-5.0 gal/5-10 gal. of water/acre (aerial) to deter deer feeding.
- **putrescent whole egg solids (**Deer Away Big Game Repellent**)**-Should be applied directly with a coarse sprayer to areas targeted for deer feeding.. Two part product that when mixed results in a 20 gal. treatment. Apply only during the dormant period.
- **thiram (**Thiram 42-S**)**-Can be applied either during the growing season or dormant periods, however, treatment should not occur within one year of expected harvest. If applied as a foliar spray, 1.0 qt. Thiram 42-S should be combined with 1.0 pt. latex sticker in 7.0 qt. of water. Dormant apple twigs and tree trunks should receive 2.0 gal. combined with 1.0 gal. sticker in 100 gal. of water. Fruit can not be harvested for a full year following repellent treatment. Chew-not contains 20% of the active ingredient, thiram and is formulated as a ready to use product.

Biological Control: None that are commercially effective.

Cultural Control: Hunting licenses or special permits may be obtained to decrease population size. Trained dogs confined by invisible fencing may also be used to reduce the presence of deer within an orchard. Various forms of electric and non-electric fencing are available for prohibiting deer entry into orchards. Combinations of these control techniques are usually more effective than any form used alone.

Rabbit, ***Sylvilagus floridanus***

Rabbits may create serious problems for orchardists during the late fall and winter as a result of bark chewing and feeding on scaffold limbs of young trees (< 5 years old). The worst type of damage results from feeding at the base of the tree resulting in girdling of the cambium and possible cambium death. If caught in a timely manner, injury to the girdled area may be repaired by bee's wax or a water-based dressing.

Monitoring: No monitoring techniques in use at present.

Chemical Control: Protection against damage caused by rabbits may be conferred through the use of chemical repellents applied to tree trunks and other areas where feeding occurs. As with deer repellant, effectiveness depends on population size/pressure, timing and also weather, particularly rainfall. Products used as rabbit repellents are similar to those applied for deer (see above), however, rates may be slightly less in some cases.

Biological Control: Some natural predators of rabbits include barn owls, coyotes, foxes, hawks, opossums, and weasels. However, within orchards where rabbit populations have reached damaging levels, predators have not solely maintained effective control.

Cultural Control: Tree guards are both economical and effective in preventing rabbit access to commercial orchards, especially when used in conjunction with repellents. Additional control may be facilitated through hunting and/or the removal of potential habitats such as brush piles and heavy weeds.

Woodchuck/Groundhog, *Marmota monax*

The burrowing nature and vegetative feeding habits of the woodchuck may result in tree damage within the orchard setting. Direct injury to the roots, trunks and scaffold limbs is common, especially among young or newly planted trees. Indirectly, open woodchuck burrows may be hazardous to humans working within the orchard as well as damaging to farming equipment.

Monitoring: No monitoring techniques in use at present.

Chemical Control: Chemical fumigation of the animals within the burrows is the most practical control method available. Currently, phostoxin™ is recommended in the early spring for woodchuck control within orchards in Virginia, although it is classified as restricted. Aluminum phosphide is the active ingredient of phostoxin™.. Phosphine gas is evolved once this material comes in contact with moisture. Care should be taken when storing this compound.

- **aluminum phosphide** - Formulated in combination with various waxes, 2-4 pellets should be placed in an active burrow and all burrow openings sealed. Lower rates may be used in small burrow systems or when moist conditions prevail. Conversely, higher rates may be needed for larger burrows or when soil moisture is low. Additional treatments should be applied 1-2 days after initial treatment if burrows are reopened.

Biological Control: None that are commercially effective.

Cultural Control: Hunting and/or trapping are both effective means of controlling woodchuck populations, however, they may not be practical within large-scale orchard operations.

Beaver, *Castor canadensis*

Orchards that are planted near waterways may be at risk for severe damage as a result of beaver inhabitancy. Once beavers move into this type of environment, complete devastation of whole trees can occur in a very short period of time.

Monitoring: No monitoring techniques in use at present.

Chemical Control: No specific chemical controls are available to reduce beaver damage within Virginia orchards.

Biological Control: None that are commercially effective.

Cultural Control: Currently trapping is the most effective way of avoiding damage due to beaver populations. Fencing may also be an option, although not a very cost efficient alternative.

On-Line Resources

C&P Press Online Crop Protection Reference

http://www.greenbook.net/free.asp

Mid-Atlantic Regional Fruit Loop

http://www.caf.wvu.edu/kearneysville/fruitloop.html

Office of Pest Management Programs/Pesticide Impact Assessment Program Site

http://ipmwww.ncsu.edu/opmppiap

Virginia Tech Pesticide Programs

http://www.vtpp.ext.vt.edu

Virginia Pesticide Impact Assessment Program http://www.vtpp.ext.vt.edu/htmldocs/vanapiap.html

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