Crop Profile for Cherries in Virginia

Prepared April, 2000

General Production Information

Few commercial (maintaining 100 or more trees) cherry growers operate within Virginia and as a result detailed production facts will not be presented in order to avoid disclosure of individual operations.

Production Regions

Given that commercial cherry production is rare within Virginia, defined regions have not been established. The bulk of the acreage, however, is located in the southwestern portion of the state, mostly in Carroll and Patrick counties.

Cultural Practices

The majority of cherries grown within the Commonwealth are sweet rather than tart varieties, and are marketed primarily as fresh fruit. In general, there are four kinds of sweet cherries: light- and dark-colored hearts and light- and dark-colored Bigarreus (1). The hearts are best suited for eating fresh and are therefore more common within Virginia, while the Bigarreus types produce firmer fruit for commercial production. Prior to planting, cherry varieties are grafted onto rootstocks selected for characteristics such as tree size, fruitfulness, and disease resistance. At present, Mazzard, Mahaleb, Colt, and MxM rootstocks are available, although certain of these work better with tart rather than sweet cherries.

Cherries grow well in a wide variety of Virginia soil types assuming an adequate amount of drainage is

available. Soil fertility is not typically of concern except in cases of very fertile soils, which could produce vigorous tree 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 fruit 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 cherries is air movement for frost control. Cherries bloom early and as a result, are susceptible to spring frosts.

Cherry trees complete several physiological stages within the 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. 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 applied approximately two weeks after petal fall with an additional cover spray being applied two weeks later. Cherries are typically harvested from late June into early July. Postharvest intervals should be considered when choosing chemicals for late season sprays.

As with other tree fruit crops, orchard production systems vary depending on the needs of the grower. Cherry production systems should take into consideration that tart varieties generally set fruit with pollen from the same variety while sweet varieties require pollen from other varieties. Once the orchard has been laid out, trees are typically planted within weed-free zones maintained with the application of herbicides, alternating with permanent grass sod alleyways. 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. Sweet cherries are hand-harvested in early summer followed by the mechanical harvesting or "shaking" of tart cherries in mid-summer. Cherries typically receive an average of 4-6 crop protection chemicals/herbicides during the growing season (2, 3).

Insect Pests

DIRECT PESTS—ATTACKING THE FRUIT

Insect descriptions found below were modified from information presented in the Mid-Atlantic Orchard

Monitoring Guide (4) *and control recommendations were obtained from the 1999 Spray Bulletin for Commercial Tree Fruit Growers (VA, WV and MD Cooperative Extension)* (5).
Ranked in order of importance to the production of cherries in Virginia (1 = most important)

Plum Curculio, *Conotracelus nenuphar* (Herbst)--1

Plum curculio (PC) adults feed on developing buds, flowers, shucks, and setting fruit prior to laying their eggs within the fruit. As the fruit matures, larvae hatch and tunnel toward the center to feed near the pit. Most injury occurs in those orchards adjacent to hedgerows and woodlots or close to other overwintering sites of the 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. Beating trays have been used, with limited success, 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 chemicals to guard against resistance. Elimination of organophosphate insecticides may lead to increased damage resulting from this pest.

- **azinphos-methyl (**Azinphos-50**) (**Guthion 50W**)**-PHI-15 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 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.
- **methyl parathion (**Penncap-M**)**-PHI-14 days. Organophosphate insecticide formulated as microcapsules. Applied at a rate of 2.5 pt./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.
- **phosmet (**Imidan**)**-PHI-7 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. Should not be used on sweet cherries. 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.

Cherry Fruit Flies--2

Cherry Fruit Fly, *Rhagoletis cingulata* (Loew)
Black Cherry Fruit Fly, *R. fausta* (Osten Sacken)

Cherry fruit flies (CFF) lay eggs directly into the cherries, giving rise to maggots when they hatch. The maggots or larvae tunnel throughout the fruit to feed. Infested cherries become shrunken, misshapen and undersized and may also turn reddish and ripen earlier than uninfested fruit.

Monitoring: Cherry fruit flies (CFF) can be monitored from mid-season through harvest by placing one yellow sticky trap per 10 acres. Traps should be baited with ammonium acetate. An action threshold of three flies per trap per week should be used to determine application of treatment. For easier larval detection, infested fruit can be boiled in water for one minute. Larvae tend to sink to the bottom of the container and can then be counted.

Chemical Control: Treatment for CFF usually occurs during the second cover spray.

- **azinphos-methyl (**Azinphos-50**) (**Guthion 50W**)**-PHI-15 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 CFF; 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.
- **methyl parathion (**Penncap-M**)**-PHI-14 days. Organophosphate insecticide formulated as microcapsules to improve applicator safety. Applied at a rate of 2.5 pt./acre to control CFF. 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.
- **phosmet (**Imidan**)**-PHI-7 days. Broad-spectrum organophosphate formulated as a 70W powder and applied at a rate of 2.0 lb./acre to control CFF. Although it may also be used to manage a wide range of other insects, phosmet is particularly effective against CFF. Fits well into IPM programs given its low rate of predator toxicity. Should not be used on sweet cherries. REI-24 hours.

Biological Control: None that are commercially effective.

Cultural Control: None that are commercially effective.

INDIRECT PESTS—attacking tree canopy

Insect descriptions found below were modified from information presented in the Mid-Atlantic Orchard Monitoring Guide (6) *and control recommendations were obtained from1999 Spray Bulletin for Commercial Tree Fruit Growers (VA, WV and MD Cooperative Extension)* (5).
Ranked in order of importance to the production of cherries in Virginia (1 = most important)

Black Cherry Aphid, *Myzus cerasi* (Fabricius)--1

The black cherry aphid (BCA) is found on most cherry trees within Virginia, although it much prefers and is more damaging to sweet varieties. Colonies are typically found feeding on sap on the underside of leaves of growing shoots. High populations can reduce the quantity and quality of the crop on mature trees by stunting tree growth and vigor. These conditions may prove fatal to young trees.

Monitoring: Population size can be monitored by noting the location of the aphids on the developing shoots (small populations = top few leaves). No economic thresholds for BCA have been developed, but young trees can withstand very little injury.

Chemical Control: Chemical control agents should be directed against the stem mothers early in the spring (prebloom) by using contact or systemic aphicides. Based upon current data, endosulfan is the only registered chemical that provides effective control against the BCA.

- **endosulfan (**Thiodan 50W**)**-PHI-21 days. Non-systemic organochlorine insecticide used to control BCA when applied as a foliar spray at a rate of 3.0 lb./acre concentrate. Should not be applied more than twice within a season. Endosulfan is highly poisonous and should be used with caution. REI-24 hours.

Biological Control: Several natural predators of the RAA include ladybird 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 cherry orchards.

Cultural Control: Removal of water sprouts or tender shoots from the center of trees may reduce population levels.

Japanese Beetle, *Popillia japonica* Newman--2

Adult beetles are the principal injurious stage to cherries, 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 within the commercial industry.

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 the most effective way of assessing damage. If fruit feeding exceeds 0.5-1.0 %, then treatment is justified.

Chemical Control:

- **carbaryl** -PHI-1 days. Carbaryl is a 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. 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-14 days. Organophosphate insecticide formulated as microcapsules to improve applicator safety. Applied at a rate of 2.5 pt./acre to control Japanese beetles. 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.

Periodical Cicada, *Magicada* spp.--3

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, but may be extremely severe in instances where periodical emergence is scheduled. This may be every thirteen or seventeen years, although overlapping broods could increased 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 cicada from unsprayed areas.

- **carbaryl** -PHI-1 day. Carbaryl is a 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.

Biological Control: Parasitic wasps and flies and predatory mites are the most significant natural enemies of periodical cicada eggs. Adults may be attacked by birds or killer wasps, however the wasps are usually timed for later emerging annual cicadas. *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.

Diseases

Ranked in order of importance to the production of cherries in Virginia (1 = most important) Disease descriptions and recommendations found below were modified from information presented in the 1999 Spray Bulletin for Commercial Tree Fruit Growers (VA, WV and MD Cooperative Extension) (5) and in the *WVU Index of Fruit Disease Photographs, Biology, Monitoring and Management Information* (7).

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 fruits. Field losses of sweet and sour cherries can be extensive if conditions favorable for disease development occur during the blossom period, following shuck fall, or during the pre-harvest and harvest period. Fungal development is also stimulated by damage resulting from insects, birds or hail.

Monitoring: Orchards should be closely examined at various stages throughout the growing season for evidence of the brown rot fungus. Careful monitoring will enable the grower to determine the necessity of preventative fungicide applications and to target areas of concern for the following season.

Chemical Control: Fungicides are recommended as a means of brown rot 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 diseases at a time (e.g. brown rot, powdery mildew, and leaf spot), although various treatments corresponding to particular stages of growth will still be necessary. Few available chemicals control post-infection fungal activity and effectiveness depends on a relatively small time frame of application. Resistance management strategies are necessary to prevent reduced efficiency of the chemicals currently on the market.

- **benomyl (**Benlate 50W**)**-PHI-3 days. Formulated as a wettable powder and applied at a rate of 18.0-24.0 oz./acre when combined in tank mixes with captan. Benomyl, by itself, is compatible with oil, but benomyl mixed with captan 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 3.0-6.0 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 fungicide used to protect, cure and eradicate brown rot in cherries when applied at a rate of 2.0 oz./acre. REI-12 hours.
- **iprodione (**Rovral 50W**)**-PHI-7 days. Formulated as a wettable powder. For blossom blight control, applied during the pre-harvest period at a rate of 2.0 lb./acre. Should be repeated at no less than 7-day intervals at this time. No more than 4 applications can be made within a growing season. REI-12 hours.
- **myclobutanil (**Nova 40W**)**-PHI-7 days. Systemic sterol inhibiting fungicides (SIF) formulated as a wettable powder and applied at a rate of 2.5-6.0 oz./acre for control of cherry leaf spot beginning at the petal fall stage. May not be applied within 7 days of harvest. REI-24 hours.
- **thiophanate-methyl (**Topsin-M 70W**)**-PHI-1 days. Formulated as a wettable powder and applied at a rate of 18.0-24.0 lb./acre when combined in tank mixes with captan. Given the chemical similarity of thiophanate-methyl to benomyl, chances for development of brown rot resistance are high. 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 post-harvest stages.

Cherry Leaf Spot, *Blumeriella jaapii*--2

All commercially acceptable cultivars of cherry are susceptible to cherry leaf spot. This disease primarily affects leaves, causing defoliation, although leaf stems, fruit and fruit stems may also be damaged. Characteristic symptoms include the spread of small dark colored spots over the surface of the

leaf, eventually resulting in a "shot-holed" appearance. Infected leaves turn yellow and fall off. Entire trees can be defoliated by midsummer. Premature defoliation weakens trees and makes them more susceptible to cold injury the following winter. Entire orchard blocks may be killed or bloom severely reduced by winter injury following severe leaf spot infections.

Monitoring: Leaf litter should be examined in early spring, prior to bloom, to estimate potential disease pressure from the over-wintering fungus. During wet humid conditions in the early season, leaves can be monitored for infection and the presence of conidia.

Chemical Control: Fungicides are the primary forms of control for managing cherry leaf spot. Application should begin at petal fall, or after the first leaves have unfolded, with repeat treatments every 7 to 10 days until harvest. Spraying alternate sides of trees on a 7-day schedule, rather than spraying both sides on a 10-day schedule, will improve efficiency of fungicide use. Postharvest applications may be used beginning 2-3 weeks after fruit has been removed from the tree to protect against additional outbreaks of cherry leaf spot. The disease is more difficult to control on tart cherries because of their high susceptibility.

- **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. Benomyl, by itself, is compatible with oil, but the benomyl/captan mix is not. Resistance to the benzimidazole fungicides, benomyl and thiophanate-methyl, is possible. 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 3.0-6.0 lb./acre. Recommended rate if applied separately is 5.0 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 Bravo to any of the stone fruits between shuck split stage and harvest. Non-systemic foliar fungicide formulated as a flowable that can be applied at a rate of 3.1-5.5 pt./acre for control of leaf spot during the petal fall stage. For additional control of leaf spot, applications may be made within 7 days after harvest and again 10-14 days later.
- **dodine (**Syllit 65W**)**-PHI-0 days. Foliar fungicide, which protects against future cherry leaf spot infections when applied during the post harvest stage. Not compatible with lime and other alkaline products. REI- 48 hours.
- **fenarimol (**Rubigan 1E**)**-PHI-0 days. Systemic SIF formulated as an emulsifiable concentrate and applied at a rate of 6.0 fl. oz./acre for leaf spot control. REI-12 hours.
- **fenbuconazole (**Indar 75WSB**)**-PHI-0 days. Systemic SIF used to protect, cure and eradicate cherry leaf spot when applied at a rate of 2.0 oz./acre, as needed, throughout the growing season. REI-12 hours.
- **iprodione (**Rovral 50W**)**-PHI-7 days. Formulated as a wettable powder. For blossom blight control applied during the pre-harvest period at a rate of 2.0 lb./acre. Repeated at no less than 7 day intervals during the pre-harvest period. No more than 4 applications can be made 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 cherry leaf spot. May not be applied within 7

days of harvest. REI-24 hours.

- **thiophanate-methyl (**Topsin-M 70W**)**-PHI-1 days. Formulated as a wettable powder and applied at a rate of 18.0-24.0 lb./acre when combined in tank mixes with captan. Resistance to the benzimidazole fungicides, benomyl and thiophanate-methyl, is possible. REI-12 hours.

Biological Control: None that are commercially effective.

Cultural Control: None that are commercially effective.

Powdery Mildew, *Podosphaera clandestina*--3

Powdery mildew is not normally of economic importance within Virginia given that the majority of cherries produced are sweet rather than tart. In cases where it is present, the fungus appears as whitish, felt-like patches and can result in leaf curling, discoloration and deformity.

Monitoring: Young leaves can be monitored from shuck fall through midseason to assess the damage resulting from infection.

Chemical Control:

- 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.

Black Knot, *Apiosporina morbosa*--4

Black knot disease only occasionally infects cherry varieties (mainly tart), but can be very destructive on plum and prune trees. *Apiosprina morbosa* attacks the woody parts of trees and also new shoot growth resulting in warty black swellings that can lead to breakage and eventual death.

Monitoring: During the dormant period, shoots and fruit spurs of susceptible cultivars should be examined for the presence of developing knots. If found, the risk for subsequent infection is high.

Chemical Control: Sprays should be applied from the bloom through shuck split stages, often coinciding with treatment for other diseases such as brown rot and cherry leaf spot. In addition to chemical treatment, cultural practices will also be necessary for effective control of the disease.

- **benomyl (**Benlate 50W**)**-PHI-3 days. Formulated as a wettable powder and applied at a rate of 18.0-24.0 oz./acre when combined in tank mixes with captan. Benomyl is individually compatible with oil, but the benomyl/captan mix is not. 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 3.0-6.0 lb./acre. Recommended rate if applied separately is 5.0 lb./acre. Should not be used with lime or other alkaline materials or within 4 days of an oil treatment. REI-96 hours.
- **thiophanate-methyl (**Topsin-M 70W**)**-PHI-1 days. Formulated as a wettable powder and applied at a rate of 18.0-24.0 lb./acre when combined in tank mixes with captan. REI-12 hours.

Biological Control: None that are commercially effective.

Cultural Control: Good orchard management practices in combination with chemical treatment are critical for effective control of the black knot disease. These practices include removing wild plum and cherry seedlings from areas along the orchard perimeter and pruning and subsequent removal of infected shoots and limbs from the orchard and destroying the knots prior to bud-break in the spring. Black knot resistant cultivars should be planted in areas with high incidence of this disease.

Nematodes

Although nematode and nematode-related problems are not encountered frequently within Virginia, yearly soil sampling is recommended. If tests indicate high population densities of nematodes, treatment will be required. Failure to reduce the number of nematodes will result in poor orchard vigor, as well as a decline in productivity and life span (5). This may be due to root stunting/death or secondary infections caused by nematode feeding. Nematode pests of cherries include species of *Criconemella* (ring), *Meloidogyne* (root-knot), and *Pratylenchus* (root-lesion) (8). No single practice will eliminate nematode problems from any particular 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 sub-sampling can be found in the ‘Nematode Management’ section of the *1999 Spray Bulletin for Commercial Tree Fruit Growers (VA, WV and MD*

Cooperative Extension) (5).

Chemical Control: Pre-plant soil fumigation and post-plant non-fumigant nematicides can provide effective control against all species which attack cherry 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)* (5).

- **1,3-dichloropropene (**Telone II**)**-Nematicidal fumigant applied at a rate of 27-54 gal./acre for pre-plant control of nematodes. REI-5 days.
- **1,3-dichloropropene + chloropicrin (**Telone C-17**)**-Broad-spectrum fumigant applied at a rate of 30-60 gal./acre for pre-plant 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 cherry 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 6 treatments per year. REI-48 hours.
- **metam-sodium (**Vapam**)**-Broad-spectrum fumigant applied at a rate of 40-80 gal./acre for pre-plant control of nematodes, other soil-borne diseases and weeds.
- **oxamyl (**Vydate L**)**-PHI-14 days. Applied at a rate of 2.0-4.0 pt./100 gal. of water directly to the foliage when non-bearing trees reach full leaf and then at subsequent intervals, not exceeding 4 treatments per growing season. Spray is absorbed and moves systemically through the plant to the roots. REI-48 hours.

Biological Control: None that are commercially effective.

Cultural Control: Planting cherries 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 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 Ext.) (5).

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: (9)

- 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:

- **napropamide (**Devrinol 50-DF**)**-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 well established trees. Additional herbicides may be paired with napropamide for improved control of annual broadleaf weeds. 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 pre-emergence herbicides. Although oxyfluorfen controls small seedlings of annual weeds, it should be combined with an additional post-emergence 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. 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 post-emergence 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 applied 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.

Biological Control: None that are commercially effective.

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 (10). 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.

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)* (5).

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 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 pellet 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 or damaging to farm 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 released 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

Mid-Atlantic Regional Fruit Loop

Office of Pest Management Programs/Pesticide Impact Assessment Program Site

Virginia Tech Pesticide Programs

Virginia Pesticide Impact Assessment Program

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