Crop Profile for Brambles in Virginia

Prepared March, 2000

General Production Information

(*Blackberry, Black Raspberry, Red Raspberry*)

- Approximately 340,000 lbs. of blackberries and 58,000 lbs. of black and red raspberries were produced in Virginia in 1997 on 112 and 57 acres, respectively (1).
- An estimated 90-95% of Virginia's bramble fruits are sold direct to consumers through farmers markets, on-farm markets, and Pick-Your-Own establishments (2).

Production Regions

Production is widely distributed throughout the state of Virginia, with all areas of the state being fairly well represented.

Cultural Practices

The success of a bramble planting is highly dependent upon its location. Optimal sites should have full exposure to sunlight, good air circulation, and well-drained, fertile soils (2%-4% organic matter) with a pH of 6.0-6.5. Sites in close proximity to wild brambles should be avoided given the increased likelihood of these plants to harbor insects and diseases, which will be spread to cultivated plants. If such a site is unavailable, wild brambles should be eliminated from around the chosen site well in advance of planting. Soil samples will help to determine the number and type of nematodes present at the site as well as the nutrient levels within the soil. Sites populated with dagger nematodes (*Xiphinema* spp.), in particular, should be avoided if one nematode per 500 ml of soil is found. Dagger nematodes can transmit ringspot virus diseases that are particularly hazardous to brambles. Most (possibly all) broadleaf weeds, shrubs, trees and crop plants can act as hosts for the Tomato Ringspot Virus (TomRSV), therefore, it may be in the best interests of the producer to select a site on which corn, small

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grains, or other grass species have been grown for several years. This tactic, however, can be effective only if broadleaf weeds are thoroughly excluded from the site during such crop rotations. Soil pH (acidity), phosphorous, magnesium, potassium, and calcium should be adjusted to "Medium-Plus" or "High" levels six months to one year prior to the scheduled transplanting date. Furthermore, site selection (or modification) to avoid even a few days of soil saturation may be one of the most important tactics to include in an "integrated disease management plan." As a result of this plan, it is suggested that brambles be planted on raised beds approximately 14" to 18" inches high (with 2.5'-wide, flat tops, sloping sides, and bases that are 10' to 12' wide). Use of permanent, low-growing sod covers is recommended for the alleys between weed-free bed-tops.

Once bramble plants have been established their needs vary depending on the different groups and types of brambles and among the various cultural systems to which they may be subjected. The application of fertilizer is suggested, however, the rate depends on the ages of plants and extant soil conditions in addition to the above mentioned differences.

In the 1992 survey from which pesticide use data was obtained, treatment acres were used to account for the multiple applications of a given chemical that a grower might use to treat a crop (4). At the time of the survey, it was estimated that producers planted 330 acres of brambles in Virginia (5). That number may have increased in recent years, however, in the case of that particular survey, it was used to determine the approximate average number of applications used per acre on brambles. The calculation can be done by dividing the treatment acres by the acres of brambles reported to be grown (i.e. if the results state that there were 200 treatment acres when the growers reported growing 100 crop acres, then pesticides were used about two times on each acre.

Insect Pests

Insect descriptions found below were modified from information presented in the Virginia Small Fruits web site(6).
Control recommendations were taken from the Pest Management Guide for Horticultural and Forest Crops (1999) (7).

Direct Pests

Eastern Raspberry Fruitworm, *Byturus rubi* Barber

Adult raspberry fruitworms (RF) emerge at about the time raspberry leaves are unfolding, to feed along the midrib of folded leaves, then developing flower buds, and finally to flowers where they feed on pistils and stamens. Females usually deposit eggs on swollen but unopened flower buds; they sometimes lay eggs on developing fruit. Newly hatched larvae tunnel into the flower receptacle and then into the center of developing fruits to feed. When infested fruit is picked, larvae often remain attached to the inner surface of the druplets, causing a fair amount of consumer concern.

Monitoring: RF infestations can be detected by examining foliage for long holes that give leaves a tattered appearance; this symptom indicates the potential for infestation of fruit by larvae. Flower buds can be examined for small holes. The adults tend to be most active and noticeable on plants in the early evening hours.

Chemical Control: Insecticides applied in the early pre-bloom stage (as blossom buds first appear) and again at the late prebloom stage (just before flowers begin to open) provide effective control against the RF. See *Chemical Insect Control* section below for specific recommendations.

Biological Control: No commercially effective controls are available.

Cultural Control: Cultivation of plant rows in late summer or early fall along with good weed control may reduce RF population size and limit the amount of damage resulting from future infestations. Fall-fruiting bramble varieties often escape injury due to the fact that fruitworm larvae drop to the ground for overwintering, in early July.

Green June Beetle, *Cotinus nitida* (Linnaeus)

Green June beetles injure bramble fruit directly and may also reduce plant productivity following intensive leaf feeding. Adults emerge from the soil in early July and August.

Monitoring: No thresholds are currently in use within the commercial industry.

Chemical Control: Usually provides the only truly effective form of control. See *Chemical Insect Control* section below.

Biological Control: No commercially effective controls are available.

Cultural Control: Clean harvesting, which prevents an accumulation of overripe fruit, helps to prevent beetles from being attracted to plantings. Plowing or cultivation can destroy pupae in the soil.

Japanese Beetle, *Popillia japonica* Newman

Japanese beetles (JB) along with other scarab beetles (i.e. rose chafer, Green June beetle, etc.) cause direct fruit injury as well as the characteristic skeletonization of leaves due to feeding. JB emerge in June and July, preferring to feed on ripe berries, especially those that are exposed to full sunlight.

Monitoring: No thresholds are currently in use within the commercial industry.

Chemical Control: Usually provides the only truly effective form of control. See *Chemical Insect Control* section below.

Biological Control: No commercially effective controls are available.

Cultural Control: Clean harvesting, which prevents an accumulation of overripe fruit, helps to prevent beetles from being attracted to plantings. Plowing or cultivation can destroy pupae in the soil.

Strawberry Bud Weevil (Clipper), *Anthonomus signatus* Say

The strawberry bud weevil (SBW) is an important direct pest of brambles within Virginia. The female bud weevil lays a single egg into the unopened bud causing the initial damage. Following oviposition, the female severs the bud from the pedicel, causing it to hang by part of the stem or fall to the ground, thus preventing fruit formation. Larvae develop in the severed buds and reach maturity in 3-4 weeks. Adults emerge in June, feed on flower pollen, then enter aestivation in mid-summer and remain inactive the rest of the season. The SBW has one generation per year in Virginia.

Monitoring: SBW should be sampled on plants during the early blossom/bud stage to determine the necessity of treatment. Thresholds for brambles are currently unavailable.

Chemical Control: See *Chemical Insect Control* section below.

Biological Control: No commercially effective controls are available.

Cultural Control: Overwintering adults emerge early in the season from ground litter commonly found in wooded areas and often migrate to brambles in late April. Therefore, placement of these plants away from overwintering sites may help to reduce SBW damage. Early-fruiting varieties are more likely to suffer attack than later-fruiting varieties.

Tarnished Plant Bug, *Lygus lineolaris* (Palisot de Beauvois

Tarnished plant bugs (TPB) damage brambles by puncturing the bramble fruit, which in turn, stops development in the area surrounding the wound. Often this type of feeding results in irregularly shaped fruit with the characteristic catfaced appearance. Adults become active in early spring and deposit their curved eggs into stems, and leaf midribs. Egg hatch takes place about 1 week later depending on temperature. There are 3 to 6 generations of this pest each year in Virginia.

Monitoring: No thresholds are currently in use within the commercial industry.

Chemical Control: See *Chemical Insect Control* section below.

Biological Control: Predators that feed on the nymphal stages of the TPB include bigeyed bugs, *Geocoris* spp., damsel bugs, *Nabis* spp., minute pirate bugs, *Orius tristicolor*, and several species of spiders.

Cultural Control: Weed control is an important factor in the maintenance of this insect. Overwintered TPBs lay their eggs in weeds in January for a March hatch, therefore control strategies should be carried out in March or early April. During this time, the TPBs are in the nymph stage and are less likely to migrate into bramble or other crops. Mowing or disking of cover crops, especially legumes may also reduce the likelihood of migration.

Indirect Pests

Aphids

Larger Raspberry Aphids, *Amphorophora agathonica* and *A. sensoriata*
Smaller Raspberry Aphid, *Aphis rubicola*

Aphids feed on plant juices from the leaves and stem, resulting in an overall reduction of plant productivity due to leaf stunting and curling. The most damaging aspect of aphid feeding is the spread of viruses. Aphids can pick up a virus by feeding on an infected plant for 15 to 30 minutes, and later inject the virus into healthy plants. The virus then spreads throughout the healthy tissue, resulting in symptoms such as a mosaic pattern on the leaves and/or leaf curl or stunting. The larger raspberry aphid transmits the raspberry mosaic virus complex, while the smaller raspberry aphid transmits the raspberry leaf curl virus. Mosaic virus can cause yield loss of over 50%. Aphid feeding may also result in large amounts of secreted honeydew (feeding by-product) as population size increases. If honeydew is abundant, secondary disease infections may occur that could present the grower with additional management difficulties.

Monitoring: Plants should be scouted for aphids in late spring and early summer, with particular

attention being paid to leaves at the tips of canes. Insecticide applications should be made if more than two aphids per cane tip are detected.

Chemical Control: See *Chemical Insect Control* section below.

Biological Control: Several natural predators of the raspberry aphids include ladybird beetle larva and adults, aphid midges, green lacewings and syrphid fly larvae. However, control by natural predators themselves, may be insufficient to prevent plant injury.

Cultural Control: The *Canby, Titan, Lloyd George,* and *Royalty* varieties are resistant to aphid feeding and should be planted when feasible. Elimination of all wild brambles from within 600 feet of the planting will help to reduce aphid populations within the area.

Blackberry Psyllid, *Trioza tripunctata* (Fitch)

The blackberry psyllid (BP) is very common in the mid-Atlantic region and can cause severe damage if not controlled. Psyllids resemble miniature cicadas in body shape and wing position. BPs injure bramble bushes by sucking plant juices from fruit spurs and leaves, greatly reducing plant productivity. Psyllids overwinter on one of various conifers (i.e. Pinus, Juniperus, Picea, etc.) and then return to brambles in the spring. After adults have been on brambles for 7-10 days, a distortion of the foliage becomes apparent.

Monitoring: No thresholds are currently in use within the commercial industry.

Chemical Control: Spray for psyllid when adults appear on plants. See *Chemical Insect Control* section below.

Biological Control: The ninespotted lady beetle has been recorded as a predator of this species (8).

Cultural Control: Avoid placement of bramble bushes within 250 yards of conifer plantings, given the apparently obligatory winter relationship of the blackberry psyllid with these species.

Gall Midge (*Contarinia agrimoniae*) Felt

Since the 1980's, numerous instances of inadequate fruit-set or poor drupelet development have been observed in blackberry cultivars in Virginia (13). However, the reason for these observations was not initially understood. Further observation revealed gall midge larvae in unopened flower buds and

partially opened blossoms. Gall midge larvae presence can also cause the pistils and stamens of infested buds and blossoms to show varying degrees of necrosis. Injury caused by these pests seems greater in buds that contain more numerous larvae, although, additional work will be necessary in Virginia to more fully understand and hence control outbreaks of the gall midge.

Monitoring: Monitoring techniques are still being developed for this pest.

Chemical Control: Given the novelty of this pest in Virginia, no chemical controls are currently recommended. Preliminary data suggest that soil treatments may be effective although additional work will be needed to confirm this possibility (13).

Biological Control: No commercially effective controls are available.

Cultural Control: No commercially effective controls are available.

Gypsy Moth, *Lymantria dispar* (Linnaeus)

All instars of gypsy moth caterpillars will attack bramble bushes causing defoliation that could be especially damaging to young plants. After emergence, female moths deposit egg masses within the area surrounding bramble bushes for hatch the following year (9).

Monitoring: Bushes should be inspected around petal fall for the presence of gypsy moth larvae. If found, larvae specific control methods should be undertaken.

Chemical Control: See *Chemical Insect Control* section below.

Biological Control: Gypsy moth may be attacked and killed by the fungus, *Entomorphaga maimaiga*. Research is pending as to the large scale feasibility of this method of control.

Cultural Control: Physical removal and subsequent destruction of egg masses will reduce gypsy moth damage. However, this technique is not usually cost-effective within large commercial operations.

Potato Leafhopper, *Empoasca fabae* Harris

Potato leafhoppers affect bramble plants within Virginia by causing what is referred to as "hopperburn" resulting from feeding on the underside of leaves. Hopperburn results from the injection of toxic saliva that reduces the availability of water and nutrients to young leaves by collapsing the xylem and phloem

tubes. This, in turn, causes the edges of infested leaves to curl downward; first turning lighter green, then yellow, and finally brown and necrotic. Young plants and leaves are especially at risk.

Monitoring: Bushes should be frequently inspected for the presence of leafhoppers beginning in mid-May. Although no thresholds are currently available, treatment should be applied following appearance of the first adults.

Chemical Control: See *Chemical Insect Control* section below.

Biological Control: Natural enemies of PLH are present within Virginia, however, they do not generally react fast enough to prevent hopperburn on bramble leaves.

Cultural Control: No commercially effective controls are available.

Raspberry Cane Borer, *Oberea bimaculata* (Olivier)

The raspberry cane borer infests the young shoots of raspberry, blackberry and sometimes rose plants. Ovipositing by adult females followed by cane girdling (6 mm above and 6 mm below the egg puncture) causes shoot tips to wilt in early summer. After egg hatch, the larvae feed on tissue within the cane, resulting in eventual cane death if uncontrolled.

Monitoring: No thresholds are currently in use within the commercial industry.

Chemical Control: Apply chemical treatments just before blossoms open. See *Chemical Insect Control* section below.

Biological Control: No commercially effective controls are available.

Cultural control: Pruning of wilted canes or those with girdling in early spring will help to mediate RCB damage and minimize the amount of tissue removed.

Raspberry Leafroller, *Olethreutes permundana* Clemens

Raspberry leafrollers emerge in April and May from overwintering shelters (rolled leaves or leaf litter) to deposit eggs and feed until their death. Eggs hatch within a couple of weeks resulting in larvae that continue to feed and produce new shelters to protect themselves. Leafroller infestations are common throughout the growing season (2-3 generations/year), and may also build up following harvest. Leaf

feeding results in reduced runner formation, interference with ripening fruit, and plant kill, however, brambles are quite tolerant of the leaf feeding species and can support high population levels without economic loss.

Monitoring: Currently, no thresholds have been established for determining the necessity of chemical treatment. Alternative control methods (biological and cultural) usually provide adequate protection against extreme leafroller damage.

Chemical Control: See *Chemical Insect Control* section below.

Biological Control: Leafrollers have a large complex of parasites that play a major role in lowering pest populations.

Cultural Control: Removal of accumulated plant trash in the spring may limit the potential for a large population buildup in areas with severe leafroller problems.

Raspberry Crown Borer, *Pennisetia marginata* (Harris)

The raspberry crown borer can be a severe pest to bramble plantings throughout its two-year life cycle. Crown borer life cycles begin with egg hatch in late July of the first year and continue through the fall of the second. Following hatch, larvae feed at the base of new canes, girdling the plant and causing gall formation. During late fall, the young larva spin down to the crown to overwinter. In the spring larvae tunnel into the cambium to continue feeding and in the second summer ascend into a cane, girdling it a few inches above the soil surface, and causing it to wilt and break. The pupal stage occurs in late June to early August. Adult moths, mimicking yellowjackets, fly from early to mid July through late September, with females depositing eggs on the first day after emergence.

Monitoring: No thresholds are currently in use within the commercial industry.

Chemical Control: See *Chemical Insect Control* section below.

Biological Control: No commercially effective controls are available.

Cultural control: All wilted canes should be removed in June and July.

Raspberry Sawfly, *Monophadnoides geniculatus* Hartig

Raspberry sawfly larvae severely damage leaves by feeding. Young larvae chew on the edges of leaves while older larvae feed anywhere on the leaves except larger veins. Heavy infestations of these insects may result in total crop loss. Larvae complete their feeding in less than two weeks, construct cocoons, and pupate in the early spring. Adult sawflies emerge to lay eggs in the leaf tissue during May and June.

Monitoring: No thresholds are currently in use within the commercial industry.

Chemical Control: See *Chemical Insect Control* section below.

Biological Control: No commercially effective controls are available.

Cultural Control: No commercially effective controls are available.

Rednecked Cane Borer, *Agrilus ruficollis* Fabricius

The rednecked cane borer produces damage similar to that of the raspberry cane borer, resulting in severe cane injury and death.

Monitoring: No thresholds are currently in use within the commercial industry.

Chemical Control: An insecticide applied just before bloom provides some control by targeting emerging new adult beetles. See *Chemical Insect Control* section below.

Biological Control: No commercially effective controls are available.

Cultural Control: In the early spring, prior to bloom, remove galled canes; prune within a few days after wilted tips appear to minimize tissue removed. Also elimination of wild brambles in close proximity to cultivated patches may reduce pest hosts.

Two-spotted Spider Mite, *Tetranychus urticae* (Say)--1

The two-spotted spider mite (TSM) can be a problem for brambles grown in Virginia. Adult female TSMs overwinter in the ground cover, feeding on various weed species. During the spring, TSMs move from the ground cover into the plant canopy. TSM adults and eggs are typically found on the underside of leaves. Sap feeding by the adults' results in a change in leaf color from green to coppery-bronze and hence reduced production by the plant. TSM populations increase with hotter, dryer weather.

Monitoring: No thresholds are currently in use within the commercial industry.

Chemical Control: See *Chemical Insect Controls* section.

Biological Control: Predators of the TSM available for commercial release include *Phytoseiulus persimilis, Metaseiulus occidentalis,* and *Amblyseius fali*.. Inoculative releases of these predators should be made when the first TSM are detected. Initial releases are usually small, but additional releases may be made into hot spots (clumped areas of infestations) for further control. Following releases of predator mites, it is important to monitor the TSM to determine if they are being maintained below economically injurious levels. Insecticides, miticides, and fungicides should be chosen carefully to prevent death of the predators.

Cultural Control: Bramble types vary in susceptibility to TSM. Elimination of groundcover that fosters the TSM during the winter, may reduce population size for the following spring.

White

White grubs are otherwise known as the larval forms of the scarab beetles (i.e. Japanese beetle, Green June beetle, etc.). These larvae damage bramble bushes by direct feeding on the roots and at the base of the plants.

Monitoring: No thresholds are currently in use within the commercial industry.

Chemical Control: See *Chemical Insect Control* section below.

Biological Control: White grubs are subject to attack by a bacterium, *Bacillus popillae* (milky disease), resulting in death. This biological control agent can protect areas from large larval populations, but it is ineffective against adults.

Cultural Control: No commercially effective controls are available.

Chemical Insect Control

A 1992 pesticide usage survey indicated that insecticides were used on 528.1 treatment acres by 40.0% of growers (see cultural practices for explanation of treatment acres) (4). The results of the specific chemicals that were used at the time of the survey are included in the insecticide descriptions found below.

- **azinphos-methyl (**Azinphos-M 50W**) (**Guthion 50W**)**-PHI-3 days. Applied when buds are breaking or new canes are 6-8 inches long at a rate of 0.25 lb. a.i./acre for control of prebloom leafrollers, with additional sprays being made as needed throughout the season. The same rate is also used (prebloom) for mid-season control of the raspberry sawfly, blackberry psyllid, raspberry cane borer, stinkbug, and TPB. Guthion 50W may be sprayed for aphid control at a rate of 1.0 lb. a.i./acre, while Azinphos-M 50W provides postharvest control of the raspberry cane borer when used to drench the crown of the plant (1.0 pt./plant). Azinphos-methyl was used by 8.6% of the growers surveyed on 121 treatment acres. REI-48 hours.
- **carbaryl (**Sevin 80S**)**-PHI-1 day. Applied at a rate of 1.0 lb. a.i./acre 20 days after petal fall for green June bugs and Japanese beetles. Sevin XLR Plus 44EC provides additional control of these pests when applied at a rate of 2.0 qt. of concentrate/acre. This formulation should not be applied within 7 days of harvest. Carbaryl was used by 28.6% of the growers surveyed on 75.8 treatment acres. REI-12 hours.
- **diazinon (**Diazinon 4EC**)**-PHI-5 days. Applied at a rate of 1.0 lb. a.i./acre for prebloom control of leafrollers. Diazinon was reported by 14.3% for use on 12.3 treatment acres. REI-24 hours.
- **malathion (**Malathion 8EC**)**-PHI-3 days. Applied at a rate of 2.0 lb. a.i./acre for control of aphids, the raspberry sawfly, blackberry psyllid, raspberry cane borer, rednecked can borer, and click beetle. Malathion was used by an average of 28.6% of growers on 319 treatment acres/year (1992). REI-12 hours.
- **pyrethrin (**Pyrellin EC**)**-PHI-0 days. Apply at a rate of 0.01-0.02 lb. a.i./acre in 7-day intervals for mite control. REI-12 hours.

Diseases

Control recommendations were taken from the insect and disease section of the 1999 Pest Management Guide for Horticultural and Forest Crops (7).

Diseases

Anthracnose, *Elsinoe veneta*

Anthracnose, commonly called "cane spot" or "gray bark," is considered an extremely serious disease of black, purple and susceptible cultivars of red raspberry. Severe yield loss may result due to defoliation, wilting of lateral shoots, death of fruiting canes, and reduction in fruit size and quality.

Monitoring: No thresholds are currently in use within the commercial industry.

Chemical Control: See *Chemical Disease Control* section below.

Biological Control: No commercially effective controls are available.

Cultural Control: Sanitation practices will reduce the amount of inoculum present in the following year. Good airflow is also beneficial to disease management and may be improved by the removal of weeds and spindly canes. If possible, all non-cultivated brambles within the vicinity should be removed given that wild plants will also harbor the pathogen. See *Cultural Disease Control* section below.

Fruit Rot, *Botrytis cinerea*

The fungus, *Botrytis cinerea*, causes one of the most common fruit rot diseases of brambles in Virginia. Fruit rot occurs fairly often, affecting petals, flower stalks, fruit caps and fruit. Susceptibility increases as weather conditions become moist, with young blossoms and maturing fruit at the highest risk of infection. Fruit infections first appear as soft, light brown areas, eventually resulting in mummification of the fruit. Mummified fruit becomes covered with a dusty powder, through which the infection continues to be spread.

Monitoring: No thresholds are currently in use within the commercial industry.

Chemical Control: Well-timed preharvest fungicide sprays are important, especially if weather is relatively wet. Sprays will reduce the number of infected flower parts and the amount of young fruit infection. See *Chemical Disease Control* section below for specific recommendations.

Biological Control: No commercially effective controls are available.

Cultural Control: Practices that improve air circulation reduce humidity in the canopy may be beneficial (i.e. pruning, proper site selection, etc.). See *Cultural Disease Control* section below.

Orange Rust, *Arthuriomyces peckianus*

The orange rust fungus, causes a systemic infection of brambles that lasts throughout the lifetime of the plant. Low temperatures and high humidity generally favor orange rust formation, affecting primarily black raspberries and blackberries. Orange spore pustules, from which the disease gets its name, mature and break open in June or July, spreading spores to other plants by the wind. The fungus enters the plant through the leaves and grows internally through the canes, crowns, and roots greatly reducing plant productivity.

Monitoring: No thresholds are currently in use within the commercial industry.

Chemical Control: Currently there is no effective chemical control available for the fungus causing the orange rust disease on brambles.

Biological Control: No commercially effective controls are available.

Cultural Control: It is important to scout plantings early in the season. If spindly emerging canes with fluorescent orange rust lesions are found on the underside of leaves, then the entire plant should be uprooted, placed in a plastic bag, removed and destroyed. Other possible sources of inoculum should also be removed. Some blackberries specifically *Eldorado*, *Raven*, and *Ebony King*, are reported to exhibit resistance. See *Cultural Disease Control* section below.

Phytophthora Root Rot, *Phytophthora* spp.

Phytophthora root rot is now regarded as a major cause of declining red raspberry plantings. While red or purple raspberries are usually seriously effected, blackberries and black raspberries appear to be less susceptible. The disease is favored by wet soil conditions and it can often be observed in low-lying areas of land. At least eight different species of soil-borne fungi belonging to the genus Phytophthora have been found to induce Phytophthora root rot. Symptoms include prematurely yellowed or scorched leaves, stunted canes with weak lateral shoots and red-brown colored roots.

Monitoring: No thresholds are currently in use within the commercial industry.

Chemical Control: See *Chemical Disease Control* section below.

Biological Control: No commercially effective controls are available.

Cultural Control: Good soil drainage and proper cultivar selection are necessary for controlling Phytophthora root rot. See *Cultural Disease Control* section below.

Chemical Disease Control

In general, fungicides were used on an average of 261.5 treatment acres by 28.6% of the growers surveyed during the 1992 growing season (4). Most of the chemicals listed below were used by growers surveyed (see results under individual descriptions). In addition, copper hydroxide and lime sulfur were used by 2.9% of growers on 6.0 treatment acres.

- **benomyl (**Benlate 50W**)**-PHI-3 days. Used to provide control against botrytis, powdery mildew, penicillium, and fruit rot when applied at early bloom at a rate of 0.38 lb. a.i./acre. Additional sprays may be applied at 14-day intervals. Should not apply more than 60 oz. of benomyl/acre/ year. Benomyl was used by 20% of growers on 134.3 treatment acres. REI-24 hours.
- **fosetyl-Al (**Aliette 80 WSP and/or WDG**)**-PHI-60 days. Registered for control of Phytophthora root rot on all bramble crops. Applications should begin at a rate of 5.0 lb. a.i./acre when plants produce 1.0-3.0 inches of new growth or when conditions favor disease development. Applications should continue on a 45-60 day schedule, not exceeding 4 sprays per season. REI-12 hours.
- **lime sulfur (**24%-31% solution**)**-Apply 10.0 gal. spray in late winter or early spring when new growth is less than 0.5 inches long for control of Anthracnose. Lime sulfur was used by 8.6% of growers on 10.3 treatment acres.
- **iprodione (**Rovral 50WP or 4F**)**-PHI-0 days. Applied at a rate of 0.5-1.0 lb. a.i./acre for the control of fruit rot. Should not make more than 4 applications of iprodione per season. Iprodione was applied by 17.1% of growers on 90 treatment acres. REI-12 hours.
- **mefenoxam (**Ridomil Gold 4EC**) (**Ridomil Gold GR**)**-PHI-45 days. Registered for the control of Phytophthora root rot (raspberries only) when applied to the soil surface in a 3.0-ft. band over the row at a rate of 4.0 fl. oz. of the EC or 5.0 lb. of the GR per 1,000 linear feet of row. One application should be made in the spring and another in the fall after harvest. Mefenoxam was reported by 5.7% of growers to be used on 6 treatment acres. REI-12 hours.
- **vinclozolin (**Ronilan 50DF**)**-PHI-9 days. Registered for the control of fruit rots (raspberries only) when applied at a rate of 0.5-1.0 lb. a.i./acre. Should not spray more than 8.0 lb. of vinclozolin per acre per season or make applications through any type of irrigation system. REI-12 hours.

Due to the shortage of other registered fungicides for bramble disease control, some growers have inquired about the use of copper fungicides. The following copper formulations have a federal registration for use on one or more bramble crops:

- BASICOP WP
- C-O-C-S WDG and WP
- Basic Copper "53"
- Copper-Count-N (blackberry only)
- Blue Shield DF and WP (blackberry only)
- Kocide DF and 101
- Champ Flowable
- Kocide 606 (blackberry only)
- Champion WP
- Tenn-Cop 5F
- TOP COP Tri-Basic FL

Given the potential for plant injury when applied during the growing season, caution is advised in using any copper product.

Cultural Disease Control:
In addition to the controls listed previously, both chemical and cultural, it is also necessary to note the importance of obtaining certified bramble plants. Certification offers some assurance to Virginia fruit producers that the plants purchased from certified growers are true to variety and apparently free from injurious insects and serious diseases.

Nematodes

Control recommendations were taken from the nematode section of the 1999 Pest Management Guide for Horticultural and Forest Crops (10).

Plants affected by nematode presence are often stunted and significantly less productive than those that are healthy. The older leaves of infested plants die and few new shoots are produced. Symptoms often appear during the summer and usually occur in hotspots or zones within bramble patches. Nematode feeding initially results in plants with short, stubby roots and swollen root tips, but eventually ends with root death. Nematode control recommendations are listed below.

Monitoring: No thresholds are currently in use in the commercial industry.

Chemical Control: See *Chemical Nematode Control* section below. Each of these formulations is effective on all plant parasitic nematodes and, in the case of Vapam HL is also useful in controlling certain root rot fungi and weed seeds. However, the treatments listed must be applied prior to planting. No recommendations were given for nematode control following bramble planting.

Biological Control: No commercially effective controls are available.

Cultural Control: No commercially effective controls are available.

Chemical Nematode Control

Nematicides were used by 2.9% of the surveyed growers on an average of 2 treatment acres. As stated previously, treatment acres account for multiple applications (4). Survey results indicated that methyl bromide was the only nematicide reported by growers. Outside of some exemptions for critical agricultural uses, pre-shipment, and quarantine uses, as of 2005, methyl bromide will be removed from

production, hence the alternative recommendations listed below. Currently, no alternatives are available to replace the broad-spectrum activity of this chemical.

- **1,3-dichloropropene 94% (**Telone II**)**-Applied directly into the soil at a rate of 24.0-36.0 gal./ acre, 30 or more days prior to planting. Fall application preferred. REI-5 days.
- **1,3-dichloropropene 74% chloropicrin 16.5% (**Telone C-17**)**-Applied directly into the soil at a rate of 27.0-41.0 gal./acre, 30 or more days prior to planting. Fall application preferred. REI-5 days.
- **sodium methyl dithiocarbamate (**Vapam HL**)**-Applied only under special preparative conditions at a rate of 50-100 gal./acre, at least 20 days prior to planting. REI-5 days.

Weeds

Control recommendations were taken from the weed section of the 1999 Pest Management Guide for Horticultural and Forest Crops (11).

The most troublesome weeds for growers in Virginia include yellow nutsedge, dandelion, horsenettle, morningglory species, bindweed species, poison ivy, greenbrier, tall fescue, wild garlic, and bermudagrass (12).

Monitoring: No thresholds are currently in use in the commercial industry.

Chemical Control: See *Chemical Weed Control* section below.

Biological Control: No commercially effective controls are available.

Cultural Control: No commercially effective controls are available.

Chemical Weed Control

In the 1992 survey completed by Virginia Tech in conjunction with Virginia Cooperative Extension, herbicides were used by 37.1% of growers on 91.3 treatment acres (4). As stated previously, treatment acres account for multiple applications. The surveyed growers (see results under individual descriptions) used the majority of chemicals listed below.

- **dichlobenil (**Casoron**) (**Norosac 4G**)**-PHI-1 month. Target weeds include most annuals, fescue, quackgrass, dandelions, dock, and other herbaceous perennials. Applied as dry granules at a rate of 4.0-6.0 lb. a.i./acre in late winter or early spring. Should not be applied within 4 weeks after transplanting, during new shoot emergence, or within range of grazing livestock. Should not apply more than 4.0 lb. of active ingredient per growing season. Dichlobenil was used by 5.7% of growers on 7 treatment acres. REI-4 hours.
- **fluazifop-P-butyl (**Fusilade DX**)**-PHI-1 year. Target weeds include annual and perennial grasses. Applied directly on actively growing grasses at a rate of 0.25-0.38 lb. a.i./acre, in combination with 2 pt. crop oil concentrate or 0.5 pt. non-ionic surfactant. REI-12 hours.
- **glyphosate (**Roundup Ultra**)**-PHI-14 days. Target weeds include annual and perennial grasses plus broadleaf weeds. Applied around the base of crop plants at a rate of 1.5-5.0 lb. a.i./acre. Glyphosate was used by 5.7% of growers surveyed on 6 treatment acres. REI-4 hours.
- **napropamide (**Devrinol 50 DF**)**-PHI-35 days. Preemergent herbicide applied at a rate of 4.0 lb. a. i./acre for control of annual grasses and certain broadleaf weeds. Must be incorporated by rainfall or irrigation within 24 hours of application for optimum results. Napropamide was used by 2.9% of growers surveyed on 5 treatment acres. REI-4 hours.
- **oryzalin (**Surflan 4 AS**)**-Preemergent herbicide applied between harvest and spring at a rate of 2.0-6.0 lb. a.i./acre for control of annual grasses and certain broadleaf weeds. REI-4 hours.
- **paraquat (**Gramoxone Extra**)**-Applied as a coarse directed spray prior to emergence of crop shoots at a rate of 0.6-0.9 lb. a.i./acre. Effective only upon contact with annual weeds. Should not be applied to bramble fruit. Paraquat was used by 14.3% of growers on 4.1 treatment acres. REI-4 hours.
- **sethoxydim (**Poast**)**-PHI-45 days. Applied at a rate of 0.28-0.47 lb. a.i./acre for control of annual and perennial grasses. Registered for use non-bearing plantings of blackberries and both bearing and non-bearing raspberry bushes. Sethoxydim was applied by 11.4% of growers on 18.7 treatment acres. REI-4 hours.
- **simazine (**Princep 4L**) (**Caliber 90**)**-Preemergent herbicide applied between harvest and spring at a rate of 2.0-4.0 lb. a.i./acre for adequate control. Target weeds include annual grasses and broadleaf weeds. Simazine was applied by 17.1% of growers surveyed on 34.5 treatment acres. REI-12 hours.
- **terbacil (**Sinbar 80W**)**-PHI-70 days. Applied only to plantings established for one year or more. Target weeds include annual grasses and broadleaf weeds plus some perennial broadleaf weeds. Should not apply more than 1.6 lb. a.i./acre of terbacil to blackberries or raspberries. Terbacil was used by 2.9% of growers on 16 treatment acres. REI-12 hours.

On-Line Resources

C&P Press Online Crop Protection Reference http://www.greenbook.net/free.asp

Office of Pest Management Programs/Pesticide Impact Assessment Program Site http://ipmwww.ncsu.edu/opmppiap

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

Virginia Small Fruits Page http://www.ento.vt.edu/Fruitfiles/VirginiaSmallFruitSite.html

Virginia Tech Pesticide Programs http://www.vtpp.ext.vt.edu

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