Crop Profile for Blueberries in Michigan

Revised: May, 1999

General Production Information

- Michigan ranks 1st among states for cultivated blueberry production (3).
- Michigan produced 76 million pounds in 1997, almost 44% of US total (3).
- The blueberry yield in 1997 was 4,470 pounds per acre. The yield over the last five years is 3954 pounds per acre (3).
- Farm-level value was more than $53 million, second among fruit species in Michigan (3).
- The 1997 price per pound was 70 cents, the average over the last five years was 60 cents (3).
- 72% of Michigan blueberries were frozen or canned (3).
- Michigan had 17,000 bearing acres in 1997, up from 16,500 in 1996 (3).
- Fresh market outlets utilized 28% of the 1997 blueberry crop, while 72% was processed (3).

Production Regions

Van Buren (Southwest Michigan), Ottawa (west central Michigan) and Allegan (southwest Michigan) counties have about 83% of Michigan's acreage. Van Buren County has 37% of Michigan acreage with 6,560 acres in productions; Ottawa has 31% with 5,550 acres, Allegan has 15% with 2,700 acres; Muskegon has 6% with 1,090 acres; Berrien has 6% with 985 acres; and the rest of the state has 5% with 915 acres (1).

Cultural Practices

Blueberries require fairly specific soil and climatic conditions. It takes between eight and 12 years for blueberries to reach full production. They require an average growing season of 160 days and late spring or early fall frost can damage plants. The best blueberry soils in Michigan are acidic (pH below 5.5) and very sandy. Blueberries will also grow in soils high in organic matter, such as a peat type of soil.

Organic matter increases the water holding capacity of sandy soils. Sixty-five percent of the blueberry acres in Michigan are irrigated or able to be irrigated.

Irrigation is important because blueberry root systems are shallow and lack root hairs; this puts them at a disadvantage when the soil dries out. Overhead irrigation is also important to mediate spring frosts. Blueberry soils are often found in topographically low areas so blueberries are very susceptible to spring frosts. Spring frosts are probably the major factor in determining the total production of blueberries for a region in any given year. In a year with numerous or widespread frosts blueberry yields are very low and prices are high. In years with few frosts over production will result in low prices. Because of the low topography of blueberry sites waterlogged soils are a problem in the spring and aircraft are used for early season pesticide applications. Many smaller growers do not own their own sprayers but depend on commercial pesticide applicators with aircraft for their insecticide and fungicide applications.

Four varieties account for 84% of the state's acres of blueberries. The four are Bluecrop, Jersey, Rubel and Elliott. Bluecrop, and Rubel are midseason varieties and Jersey and Elliot are late-season varieties. Plants are set in early spring at 4 to 5 feet apart with rows 10 to 12 feet apart. Blueberries require regular pruning to produce high yields of large fruit. The most fruitful blueberry canes are four to six years old and 1 to 12 inches in diameter at the base. Pruning is used to manage bush size and shape. Blueberry twigs require at least 15% full sunlight to initiate flower buds.

Costs of establishing and maintaining a blueberry planting are high, but returns from well managed plantings on suitable sites can be substantial. The common row and plant spacings require between 1,000 and 1,200 plants per acre. Two-year-old blueberry plants cost between $1 and $2, so it will cost between $1,000 and $2,400 per acre for plants alone.

No crop will be harvested the first two years. Properly managed plantings will yield 400 to 800 lb/acre the third season and 1,400 to 2,000 lb by the fourth year. Full crops of 4,000 to 6,000 lb/acre are generally harvested after six to eight years, although mature plantings can yield in excess of 10,000 lb/acre under optimal conditions. Well-maintained blueberry bushes remain productive for at least 15 to 20 years.

Blueberry Insect Pest Complex

Blueberries suffer relatively few pests in comparison to apples. Early season pests include cutworm and spanworm that attack buds, oblique-banded leafrollers that attack young shoots, leaves and flower clusters. Cranberry fruitworm and cherry fruitworm attack the young fruit during and after bloom. Blueberry maggot attacks the fruit in mid summer before harvest. Other midsummer pests include Japanese beetle rose chafer, canker worms and tussock moth larvae. Aphids can be a problem as a virus vector

Insect Pests

Blueberry Maggot

Biology: Blueberry maggot is the most important blueberry pest in Michigan because processors will reject any load of blueberries in which they discover a single maggot. This zero tolerance makes it essential for growers to be certain that their fruit is free of maggots. The blueberry maggot feeds inside ripening fruit and may remain there for some time after harvest. Infested berries can not be separated from sound berries during harvest and packing, and maggots may emerge from the berries at the point of sale. The blueberry maggot feeds on all varieties of blueberries. Continuous migration from the wild makes it difficult to keep cultivated blueberries free of maggots if they are grown near areas containing stands of wild plants. This insect overwinters in a brown, puparium, about 1/8 inch long, buried in the soil 1 to 2 inches deep. Adult flies emerge over a prolonged period from late June to early August. The female flies do not begin laying eggs until about 10 days after emergence. Flies alight on fruit to lay one egg per berry under the fruit skin just as the fruit begins to turn blue. The egg hatches in about one week. Maggots feed for about three weeks inside ripening and harvested fruits. There is one generation per growing season.

Determining the onset of adult fly activity is essential to the control of blueberry maggot, as protective sprays must be applied before the 7-10 day pre-oviposition period ends. Regular monitoring of blueberry maggot emergence is done with yellow baited sticky traps. This serves three purposes: to detect blueberry maggot populations before they reach a damaging level; to optimize timing of insecticide sprays; and to reduce the amount of insecticide by spraying only those areas actually infested.

Chemical Controls: Adult blueberry maggot flies are controlled during fourth, fifth and sixth cover with Imidan and Malathion. Because the egg is laid inside the fruit no chemical control is possible for the egg or larvae. See insecticides below for use rates.

Alternatives: None

Cultural Control Practices: No effective practices currently exist. Disking can reduce the population of pupa.

Biological Controls: Parasitism and predation do not effect maggot infestation, so pesticides are needed to produce clean fruit.

Cranberry fruitworm

Biology: The cranberry fruitworm is a serious pest of blueberries in eastern U.S. Some fields have suffered 50 to 75% losses of fruit, with earlier varieties usually being the most infested. Infested berries may be harvested without detection, resulting in inspectors or consumers finding larvae in packaged berries. Wild blueberries and cranberries are often heavily infested with the cranberry fruitworm; if

commercial fields are nearby they will likely have problems with this pest. Weedy, unkept plantings are also likely to have higher populations of this insect.

This insect overwinters in the soil as a fully grown larva within a cocoon made of silk and soil particles. The larvae pupate in the spring and complete development. Adult moths emerge, mate and lay eggs during the period from bloom through late green fruit. Adults are small, night-flying moths with dark grayish-brown wings. The eggs are deposited on the berries, almost always on or inside the calyx cup (blossom end) of unripe fruit. Eggs hatch in about five days. The eggs are very small and difficult to see without a hand lens. Young larvae move to the stem end of the fruit, enter, and feed on the flesh. A single larva may feed within as many as eight berries to complete its development; they move from one berry to another within a cluster and usually web the berries together with silk. The larvae attain a length of about 3/8 inch and are usually greenish, sometimes light brown along the back. The frass of the larvae fills the tunnels in the berries and cling to the silk webbing, producing very messy feeding sites, which easily distinguish cranberry fruit worm damage from cherry fruitworm damage. Once larvae are fully grown, they drop to the ground and spin a hibernation chamber where they overwinter. There is only one generation per year.

Chemical Controls: Guthion, Imidan and Sevin all provide adequate control when application timing is appropriate. The control period is often 7-8 weeks in duration and begins prior to complete petal fall. None of the aforementioned insecticides may be used during the pollination period. Applications 10 and 20 days after blossom drop are important for cranberry fruitworm control. Carbaryl provides excellent control of cherry fruitworm and is preferred where cranberry fruitworm and cherry fruitworm are both present.

Alternatives: None

Cultural Control Practices: No effective practices currently exist.

Biological Controls: Bacillus thuringiensis can be used to control cranberry fruitworm**.** Bts may be used effectively at egg hatch to control first instar larvae. Growers with severe infestation of cranberry fruitworm infestations during bloom use Bts. Bts are moderately effective if weather conditions are right following application.

Japanese Beetle

Biology: Leaves are skeletonized during mid- to late-summer by adult beetles. During harvest, adult beetles can end up as contaminants if they are shaken out along with the berries. There is one generation per year. Larvae, or grubs, develop in pastures, lawns, and other types of turf, where they live in the soil and feed on roots of grasses. Adults begin emerging in late June; they feed on the upper surface of blueberry foliage. Adults also feed on sassafras, raspberries, grapes, and peaches. The adult beetle is

about 1/2 inch long and copper-colored, with metallic green markings and tufts of white hairs on the abdomen. Larvae are soft white grubs with six legs and a brown head, usually found in a curled position. Adults cause significant direct and indirect yield loss via feeding injury to the berries and associated decay from fruit rotting pathogens. There is a zero tolerance for Japanese beetles in processing blueberries. The adults are hard to remove because they are similar in weight and size to blueberries. Adult beetles will quickly reinfest sprayed fields.

Chemical Control: While several insecticides could provide good control of adult beetles, only those with relatively short PHI=s (i.e., Imidan) may be used due to the frequency of harvest. No insecticides are labeled for control of the larval stage of this pest.

Alternatives: Traps are available and may be used for monitoring emergence of adults. The use of traps as a management technique has not provided adequate control, and has in all instances exacerbated the problem by attracting more beetles to the site than would have normally migrated there.

Cultural Control Practices: Traps are available and may be used for monitoring emergence of adults. The use of traps as a management technique has not provided adequate control, and has in all instances exacerbated the problem by attracting more beetles to the site than would have normally migrated there.

Biological Controls: The use of entomopathogens and bacterial agents have not been successfully developed into a commercially viable management strategy.

Cherry Fruitworm

Biology: The cherry fruitworm causes severe damage to blueberries in Michigan. It causes its injury by boring into the fruit. The larvae bore through the epidermis shortly after they hatch. This early injury can be detected in a few days. The larvae may feed extensively just below the surface. A maturing larva may damage more than one fruit.

The cherry fruitworm has one generation per year. It overwinters as mature larvae in hibernacula on the tree. The larvae pupate in the spring. The average length of the pupal stage is 29 days. The appearance of the first adults will vary with seasonal conditions. The moth flight starts two to four weeks after petal fall and extends for two to three weeks. The moths are most active during dusk and late evening. The adult moths mate immediately after emergence, after which the female is ready to lay eggs. The eggs are laid on the unripe fruit. The incubation period is 10 days.

Chemical Control:

Alternatives:

Cultural Controls:

Biological Controls:

Oblique Banded Leafroller

Biology: The oblique banded leafroller is a major pest of blueberries. It has many wild hosts and also infests apple, pear, cherry, plum, peach, rose, raspberry, gooseberry, currant, strawberry and many weeds.

Leafrollers are the larvae or caterpillars of a few species of small moths. The name Aleafroller@ is derived from their habit of rolling leaves for shelter. Early in the growing season, these brown or green worms feed on floral buds, blossoms and leaves. When full grown (2 to 3/4 inch long), the larvae seal up the leaf shelter, form a cocoon (a glossy brown case) and undergo metamorphosis. One to two weeks later, they emerge from the shelter. The adults vary in color from brown to yellow, but they are all about 2 inch long. The adults mate and lay eggs and the cycle repeats. Most leafrollers have at least two cycles, or generations, per year. Larvae of the summer generation feed on leaves, green berries and ripe berries. Feeding injury to berries is common. This damage predisposes the tissue to attack by fungal pathogens. Leafrollers are often a problem in terms of being a contaminant in harvested fruit. Most processors and consumers alike have a Azero tolerance policy@ for this pest.

Chemical Controls: Guthion, Lannate, Sevin and Imidan all have efficacy against the larvae of various leafroller species. Early season applications before bloom are based on field scouting. Late season application timing is based on a degree-day model used in conjunction with pheromone trap monitoring and scouting.

Alternatives:

Cultural Control Practices: Pheromone-based monitoring systems have been developed to improve application timing.

Biological Controls: Bacillus thuringiensis can be used to control oblique banded leafroller**.** Bts may be used effectively at egg hatch to control first instar larvae. Its utility declines as larval size increases.

Insecticides on blueberries:

Phosmet (organophosphate)

- **Formulations**: Imidan 70WP
- **Pests controlled**: blueberry maggot, plum curculio, blueberry tip borer, oblique banded leafroller, cranberry fruitworm, cherry fruitworm and Japanese beetle (4).
- **% crop treated**: 27% average with a low of 10% in 1991 and increasing to 46% in 1997 (10)
- **Type of application**: air blast sprayer or aerial application.

  Application rates: 0.81 average with a low of 0.68 lbs ai in 1991 and a high of 0.94 lbs ai in1997 (10).
- **Timing**: first cover through pre-harvest (4)
- **Number of applications**: 1.6 times on average with 1.1 applications in 1991 to 1.9 times in 1997 (10).
- **Preharvest interval**: 3 days
- **Use in IPM programs:** Phosmet is easier (less toxic) on beneficial insets than other OP insecticides so its use is less likely to result in aphid problems.
- **Use in resistance management programs:** Preferred OP for late season use because of efficacy on Japanese Beetle and other pests and short PHI.
- **Efficacy issues:** Phosmet use has increased with the longer PHI of carbaryl.

Malathion (organophosphate)

- **Formulations:** Malathion LV Concentrate, Aqua Malathion 8EC
- **Pests controlled:** blueberry maggot, aphids (4)
- **% crop treated:** 83.5% average, high of 92% in 1991 to a low of 74% in 1997 (10)
- **Type of applications:** Air blast sprayer or aerial application.
- **Application rates:** 0.98 lbs ai (10)

- **Number of applications:** 3.65 per season (10)
- **Timing:** fourth cover through pre-harvest (4)
- **Preharvest interval:** Malathion LV is 0 days, Malathion 8EC is 24 hours.
- **Use in IPM programs:** Principle use is blueberry maggot control. Preferred OP when maggot is the only pest of interest.
- **Use in resistance management programs:** Low toxicity material easy on beneficial insects.
- **Efficacy issues:**

Azinphos-methyl (organophosphate)

- **Formulations:** Guthion 2S, Guthion 50WP
- **Pests controlled:** plum curculio, blueberry tip borer, oblique banded leafroller, cranberry fruitworm, cherry fruitworm, and blueberry maggot (4)
- **% crop treated:** 61.5% average with 55% in 1991 and increasing to 77% in 1997 (10)
- **Type of applications:** Air blast sprayer or aerial application.
- **Application rates:** 0.5 lbs ai (10)
- **Number of applications:** 1.4 per season (10)
- **Timing:** Pink bud, first cover through third cover for plum curculio, blueberry tip borer, oblique banded leafroller, cranberry fruitworm and cherry fruitworm; and fourth cover through sixth cover for blueberry maggot (4)
- **Preharvest interval:** 7 days, limit of 3 applications.
- **Use in IPM programs:** Pre and post bloom sprays for control of the early season pest Complex.
- **Use in resistance management programs:**
- **Efficacy issues:**

Carbaryl (carbamate)

- **Formulations:** Sevin 80S, Sevin 50WP, Sevin XLR+
- **Pests controlled:** plum curculio, blueberry tip borer, oblique banded leafroller, cranberry fruitworm, cherry fruitworm, white marked tussock moth and canker worms (4)
- **% crop treated:** 22.5% average, with a low of 13% in 1993 and a high of 39% in 1997 (10)
- **Type of applications:** Air blast sprayer or aerial application.
- **Application rates:** 1.54 lbs ai (10)
- **Number of applications:** 1.8 per season (10)
- **Timing:** first cover through third cover for plum curculio, blueberry tip borer, oblique banded leafroller, cranberry fruitworm, cherry fruitworm; and pre-harvest for white marked tussock moth, oblique banded leafroller and canker worms. Carbaryl was the primary material for Japanese beetle control when the PHI was 3 days (4).
- **Preharvest interval:** 7 days.
- **Use in IPM programs:** Carbamate insecticides are now used primarily to control canker worms and tussock moths where they are more effective than OP materials.
- **Use in resistance management programs:** Rotated with OP insecticides for early season control of the fruitworm leafroller complex. Also used to control Japanese beetle because of its quick knock down of this pest. Use on Japanese Beetle has declined since the PHI has been lengthened for one to seven days. This material no longer guarantees beetle free fruit.
- **Efficacy issues:** Recent label changes have dramatically reduced late season use.

Methomyl (carbamate)

- **Formulations:** Lannate 90SP, Lannate LV
- **Pests controlled:** oblique banded leafroller, spring canker worm, aphids, white marked tussock

moth and canker worm (4)

- **% crop treated:** 53.25% (10)
- **Type of applications:** Air blast sprayer.
- **Application rates:** 0.49 lbs ai average with a low of 0.34 lbs ai in 1991 and a high of 0.57 lbs in 1997 (10)
- **Number of applications:** 1.8 per season (10)
- **Timing:** pink bud for oblique banded leafroller and spring canker worm; first cover through third cover for oblique banded leafroller and aphids; and pre-harvest for white marked tussock moth, oblique banded leafroller and canker worm (4)
- **Preharvest interval:** 3 days, use not allowed on U-pick farms after the beginning of U-pick operations.
- **Use in IPM programs:** methomyl is generally avoided since it disrupts beneficial insets and often leads to aphid infestations.
- **Use in resistance management programs:** Used primarily as a rescue treatment to control major insect problems because of broad spectrum of control and short PHI. May also be used to control OP resistant oblique-banded leafroller.
- **Efficacy issues:** Used to control tussock moth and canker worm infestations because of better control than OP materials.

Biological Controls:

Bacillus thuringiensis

- **Formulations:** various
- **Pests controlled:** oblique banded leafroller, cranberry fruitworm and cherry fruitworm (4)
- **% crop treated:** 12% average with a low of 5% in 1995 and a high of 22% in 1997 (10)
- **Type of applications:** Air blast sprayer or aerial application.

- **Application rates:** not applicable
- **Number of applications:** 2.4 per season (10)
- **Timing:** full bloom through third cover (4)
- **Preharvest interval:** 0 day
- **Use in IPM programs:** Only insecticide used during bloom to control fruitworm complex.
- **Use in resistance management programs:** Used in rotation with OP insecticides to control fruit worms and oblique banded leafroller.
- **Efficacy issues:** Less than lethal doses and weather conditions influence efficacy. Not effective on later (larger) instars of larvae.

Diseases

Early season controls before are targeted for the control of mummyberry. Bloom sprays are targeted for mummyberry and bloom infections of fruit rots. Mid season sprays are targeted for the control of stem cankers and twig blights. Preharvest sprays are targeted for controlling fruit rots.

Mummy berry

Biology: Mummy berry is caused by the fungus *Monilinia vacinii-corymbosi* that overwinters in fruit mummies on the ground. In early spring fungal fruiting cups (apothecia) grow from overwintering mummies on or near the soil surface. Ascospores from fruiting cups infect leaves shortly after buds open. A second type of spore (conidia) is produced in about 3 weeks on blighted flowers and shoots. The spores are spread to healthy flowers by wind, rain and insects. Infected flowers turn brown and wither, leaf and shoot growth expanding from newly opened leaf buds is blackened in the center and eventually wilts and dies. The death of the infected shoots is called shoot blight or primary infection. Infected berries look like healthy ones in early development stages, but as they near maturity they become a reddish buff or tan color. Mature mummied berries are gray shriveled, and hard. Usually the diseased berries fall before healthy ones are harvested. Native stands of blueberries are an important source of disease inoculum.

Chemical Controls: Fungicide applications for mummyberry control are targeted at early and late green tip, late green tip, pink bud, 25% bloom and full bloom. Funginex (triforine) gives excellent control of

both primary and secondary stages of the disease; however, this fungicide hasn=t been manufactured since 1996 and supplies are nearly exhausted. Indar (fenbuconazole) provides excellent control, but is currently not labeled for blueberries (Sec. 18 granted in 1998 and 1999 seasons). Benlate (benomyl) plus Captan applications do not control primary infections. Bravo (chlorothalonil) gives only poor to moderate

Alternatives: None

Cultural Control Practices: Cultural controls can be used to reduce inoculum levels in the spring. In very small plantings, mummies can be raked up and burned. In larger plantings, mummies can be buried by cultivating in the row and disking between rows or by covering them with a new layer of mulch at least 2 inches in thickness. The goal of cultivation is to bury the mummies so they do not germinate. This should be accomplished prior to budbreak. The resident fungus population in the field becomes highly adapted to the cultivar in the field. The fruiting bodies of the fungus often emerge the same day the buds begin to show green tissue susceptible to infection. Native stands of blueberries can be an important source of windblown spores. Eradication of wild blueberries in areas adjacent to the commercial fields will reduce the disease inoculum in the immediate vicinity.

Biological Controls: None

Fusicoccum (godronia) canker

Biology: *Fusicoccum* is a fungus that infects blueberry stems causing dieback and plant decline. Losses from this disease can be serious. The fungus overwinters in cankers on stems and crowns of infected plants. Conidia account for nearly all infections and disease spread. Conidia are released during wet weather and dispersed by splashing rain. Infection occurs from bud swell (early spring) through early leaf drop in the autumn. Natural openings in the bark may also serve as infection sites. Infections appear on current year=s stems at bud sites or wounded areas as small reddish-brown areas in early spring. Cankers enlarge each year and eventually may girdle stems, causing them to wilt and die. Cankered branches should be pruned out and destroyed.

Chemical Control: Fusicoccum canker is a season-long disease. Repeated applications of protectant fungicides are required to manage this disease. Benlate plus captan are the main fungicides used to control this canker. Bravo is also used up to 25% bloom.

Alternatives: None

Cultural Control Practices: Sanitation is essential. Cankered branches should be pruned out and destroyed. A fungicide program should be used where incidence of the disease is high. Varieties differ in their resistance to this disease. The cultivars Jersey and Bluecrop (. 75% of the Michigan acreage) are

highly susceptible.

Biological Controls: None

Phomopsis canker

Biology: Phomopsis canker is caused by the fungus *Phomopsis vaccinii.* This canker occurs in the southern Lower Peninsula and can be devastating to bushes, where winter injury and spring frosts have occurred. Injuries from mechanical harvesting or pruning may also serve as portals for infection. A phomopsis canker appears as an elongated, flattened canker. The conidiospores are spread by slashing rain during the growing season from bud-break through September. After the stems have been infected for a season, they will wilt during the summer months. This one year lag between infection and stem collapses makes control difficult.

Chemical Control: Phomopsis canker can be controlled with Benlate plus captan, Bravo or with Aliette. All three products provide good control. Aliette is used to control phomopsis during green tip, and to control phomopsis canker, anthracnose and alternaria during pink bud through fourth cover and again at pre-harvest.

Alternatives: None

Cultural Control Practices: Since mechanical damage and cold stress seem to be necessary for Phomopsis infection, avoid careless pruning and cultivating, and do not fertilize late in the summer. Pruning the weakest canes to the ground is best for long-term production of the bush. Keep the plants well-watered through prolonged periods of dry weather in the summer. Avoiding stress will help prevent this disease.

Biological Controls: None

Alternaria leaf spot and fruit rot

Biology: Alternaria leaf spot and fruit rot is caused by the fungi *alternaria sp***.** The fruit rot's major effect is a leaky, watery fruit rot near harvest. The earliest symptom is the presence of a blackish, dark-greenish sporulation on the blossom end of the fruit. This appears a week or two before harvest. The fungus overwinters in and on the twigs and in debris on the ground. Infections occur after the fruit begins to ripen.

Chemical Controls: Reducing the severity of the leaf spot. A fungicide program beginning at bloom and continuing at two week intervals until harvest is usually effective. During the pink bud stage Benlate plus Captan tank mix, Bravo or Aliette can be used. During the 25% bloom stage the following

fungicide can be used: Benlate plus Captan, Bravo or Aliette. During full bloom, first cover and second cover stages Benlate plus Captan or Aliette can be used. During third cover Benlate plus Captan or Aliette can be used. During fourth cover Aliette can be used. During pre-harvest Captan or Aliette can be used.

Alternatives: None

Cultural Control Practices: There are three cultural control measures that can be taken: harvest frequently to prevent overripe fruit; cool berries rapidly after harvest; and avoid wounding or bruising fruit during harvest.

Biological Controls: None

Anthracnose

Biology: Anthracnose is caused by *Colletotrichum gloeosporioides.* This disease is usually a post-harvest fruit rot, but infection can occur as early as bloom. The fruit are symptomless until they begin to ripen. The earliest symptom is the presence of a shoot blight. Usually causing a few blossom clusters to turn brown or black. Spores are not formed on these blossom clusters. When fruit is ripening and turning blue there are vast numbers of spores on each fruit that spread to other fruit on the bush by rain or after harvest, when one fruit touches another. The fungus overwinters in and on twigs. The spores can cause blossom cluster blight. The ripening fruit is the most susceptible tissue.

Chemical Controls: A fungicide program beginning at bloom and continuing at 7 to 10 day intervals until harvest is usually effective. During the pink bud stage and 25% bloom stage the following fungicides can be used as controls; Benlate plus Captan tank mix, Bravo or Aliette. During full bloom and first cover stages Benlate plus Captan or Aliette can be used. During the second, third, and fourth cover stages a Captan Benlate mix or Aliette can be used. During pre-harvest captan or Aliette can be used.

Alternatives: None

Cultural Control Practices: There are several cultural control measures that can be taken: harvest frequently to prevent overripe fruit; coop berries rapidly after harvest; thoroughly prune bushes to remove dead twig tips and wood to reduce inoculum; and avoid over head irrigation.

Biological Controls: None

Fungicides Used:

Triforine

- **Formulations:** Funginex 18.2 EC
- **Pests controlled:** mummyberry (4)
- **% crop treated:** 58% (10)
- **Type of applications:** Air blast sprayer or aerial application
- **Application rates:** 0.26 lbs ai (10)
- **Number of applications:** 1.8 per season (10)
- **Timing:** green tip, pink bud, 25% bloom, full bloom (4)
- **Preharvest interval:**
- **Use in IPM programs:**
- **Use in resistance management programs**
- **Efficacy issues:** An excellent control of mummyberry with good systemic action allowing aerial sprays applied by air raft to be effective. It is no longer manufactured and supplies are nearly exhausted.

Fenbuconazole

- **Formulations:** Indar 75 WSP (Sec 18)
- **Pests controlled:** mummyberry (4)
- **% crop treated: 50%,** use pattern should be the same as Funginex.
- **Type of applications:** Air blast sprayer or aerial application
- **Application rates:** 2 oz ai, Limited to 5 applications/year for a total of 10 oz.

- **Number of applications:** 2, use pattern should be the same as Funginex.
- **Timing:** Green tip, pink bud, 25% bloom and full bloom.
- **Preharvest interval:**
- **Use in IPM programs:**
- **Use in resistance management programs:** Should be tank mixed with a protectant or rotated with a fungicide with a different mode of action to delay resistant fungus strains.
- **Efficacy issues:** currently a Sec 18 for 1998 and 1999. Effective at a small dose in relation to other fungicides registered in blueberries.

Benomyl

- **Formulations:** Benlate 50WP
- **Pests controlled:** fusicoccum canker, phomopsis canker, alternaria fruit rot, and anthracnose (4)
- **% crop treated:** 47.8% (10)
- **Type of applications:** Air blast sprayer or aerial application
- **Application rates:** 0.48 lbs ai (10)
- **Number of applications:** 2.1 per season (10)
- **Timing:** green tip and pink bud through sixth cover (4)
- **Preharvest interval:** 21 days
- **Use in IPM programs:**
- **Use in resistance management programs:** Should be tank mixed with captan to reduce the development of resistant fungal strains.
- **Efficacy issues:** provides good control of phomopsis canker when used with captan

Captan

- **Formulations:** Captan 50WP, Captec 4L
- **Pests controlled:** fusicoccum canker, phomopsis canker, anthracnose and alternaria fruit rots (4)
- **% crop treated:** 71.5% (10)
- **Type of applications:** Air blast sprayer or aerial applications
- **Application rates:** 2.03 lbs ai (10)
- **Number of applications:** 3.75 per season (10)
- **Timing:** pink bud through pre-harvest
- **Preharvest interval:** 0 days
- **Use in IPM programs:**
- **Use in resistance management programs:** The only protectant fungicide commonly used in blueberries. Should be used as a tank mix partner with benomyl o increase the spectrum of control and prevent resistance to benomyl.
- **Efficacy issues:** provides good control of phomopsis canker when used with benomyl

Ziram

- **Formulations:** Ziram 76DF
- **Pests controlled:** mummy berry shoot blight, fusicoccum canker, phomopsis canker, anthracnose and alternaria fruit rots. (4)
- **% Crop treated:** 21% (10)
- **Type of applications:** Air blast sprayer or aerial application.

- **Application rates:** 2.5 lbs ai. (10)
- **Number of applications:** 3.75 per season (10)
- **Timing:** Bud break through bloom or first cover. (4)
- **Preharvest interval:** Do not use later than 21 days after full bloom.
- **Use in IPM programs:**
- **Use in resistance management programs:**
- **Efficacy issues:** Provides good control of phomopsis canker when used with benomyl.

Fosetyl-al

- **Formulations: A**lliette 80 WDG
- **Pests controlled:** phomopsis canker, anthracnose and alternaria fruit rots (4).
- **% crop treated:** 14% (numbers for 1997 only) (10)
- **Type of applications:** Air blast sprayer or aerial application.
- **Application rates:** 3.22 lbs ai (10)
- **Number of applications:** 1.2 per season (10)
- **Timing:** green tip, pink bud through second cover, fourth cover through per-harvest (4)
- **Preharvest interval:** 0 day
- **Use in IPM programs:** Only systemic fungicide for fruit rots and canker diseases.
- **Use in resistance management programs:** Different mode of action than other registered blueberry fungicides.
- **Efficacy issues:** provides broad spectrum control of summer diseases, good control of phomopsis canker and mid season fruit rots. Expense is the major drawback to widespread use.

Chlorothalonil

- **Formulations:** Bravo Weatherstik
- **Pests controlled:** fusicoccum canker, phomopsis canker, anthracnose, alternaria fruit rots and mummyberry (4)
- **% crop treated:** 19% (numbers for 1997 only) (10)
- **Type of applications:** Air blast sprayer or aerial application.
- **Application rates:** 2.4 lbs ai (10)
- **Number of applications:** 1.5 per season (10)
- **Timing:** green tip through petal fall (4)
- **Preharvest interval:** 42 days.
- **Use in IPM programs:**
- **Use in resistance management programs:** Because chlorothalonil has a different mode of action, it should be rotated with other mummyberry fungicides to reduce the likelihood of DMI resistance in mummyberry.
- **Efficacy issues:** only poor to moderate control of mummyberry and it causes spotting of the fruit when applied during the late bloom period.

Weeds

Blueberry root systems are shallow and lack root hairs; this puts them at a disadvantage when competing for water nutrients. Thus, good weed control is essential if optimum growth and yields are to be realized. Control weeds 1 to 2 years before planting. Plow sod, plant grain and green manure crops to destroy weeds and their seeds and incorporate nutrients according to the soil test. Plant cover crops to increase organic mater by mowing and plowing or rototilling the crop into the upper soil surface. Use herbicide

and cultivation in grain cropping systems to reduce weeds. Where persistent or perennial weeds need to be controlled, apply herbicide on non cropped land. In row weed control eases fruit harvest.

Chemical Controls:

Diuron

- **Formulations:** Karmex 80DF
- **Pests controlled:** annual grasses and broadleaves (4)
- **% crop treated:** 34.5%, has increased from 26% in 1995 to 50% in 1997 (10)
- **Type of applications:** Directed spray, banded application
- **Application rates:** 1.18 lbs ai (10)
- **Number of applications:** 1 per season (10)
- **Timing:** preemergence (4)
- **Preharvest interval:** 60 days
- **Use in IPM programs:** Rotated with triazine herbicides.
- **Use in resistance management programs:** Rotated or tank mixed with triazine herbicides to control triazine resistant weeds.
- **Efficacy issues:** Seems to last longer than simazine.

Glyphosate

- **Formulations:** Roundup Ultra
- **Pests controlled:** annual and perennial weeds (4)
- **% crop treated:** 16.5% (10)
- **Type of applications:** Directed spray, banded application with protected spray boom to

minimize contact with blueberry shoots, and spot treatment.

- **Application rates:** 0.76 lbs ai (10)
- **Number of application:** 1 per season (10)
- **Timing:** postemergence (4)
- **Preharvest interval:** 14 days
- **Use in IPM programs:** Used to spot treat problem weeds and woody perennials.
- **Use in resistance management programs:**
- **Efficacy issues:** Used to control perennial weeds need to be applied with a hooded sprayer to reduce drift and protect blueberries.

Hexazinone

- **Formulations:** Velpar 90SP
- **Pests controlled:** herbaceous and woody plants (4)
- **% crop treated:** 5% in 1997 (10)
- **Type of applications:** Directed spray, banded application.
- **Application rates:** 0.29 lbs ai (10)
- **Number of applications:** 1 per season
- **Timing:** spring before blueberry plants begin active bud development
- **Preharvest interval:** Apply before growth begins in the spring.
- **Use in IPM programs:** Used to control problem perennials such as brambles.
- **Use in resistance management programs:** Rescue treatment when perennial weeds turn blueberry rows into thickets.

- **Efficacy issues:** cannot be applied to soils >85% or more sand, cannot be applied to blueberry plants <5 years old, cannot be applied in successive years. Narrow application window in spring.

Norflurazon

- **Formulations:** Solicam 80DF
- **Pests controlled:** annual weeds
- **% crop treated:** 1% in 1995 and 9% in 1997
- **Type of applications:** Directed spray, banded application.
- **Application rates:** 1.68 lbs ai
- **Number of applications:** 1 per season
- **Timing:** preemergence or post emergence
- **Preharvest interval:**
- **Use in IPM programs:**
- **Use in resistance management programs:** Different mode of action, rotated or tank mixed with triazine herbicides to control triazine resistant weeds.
- **Efficacy issues:** should be incorporated, does not control established weed. Used primarily on young plantings when few other materials are registered.

Paraquat

- **Formulations:** Gramoxone Extra
- **Pests controlled:** annual and perennial weeds
- **% crop treated:** 6.5%

- **Type of applications:** directed spray, banded application with protected spray boom to minimize contact with blueberry shoots.
- **Application rates:** 0.39 lbs ai
- **Number of applications:** 1 per season (10)
- **Timing:** post emergence (4)
- **Preharvest interval:**
- **Use in IPM programs:**
- **Use in resistance management programs:**
- **Efficacy issues:** no soil action. Primarily used as a burn down treatment for emerged annuals.

Simazine

- **Formulations:** Princep 90 WG, Princep 4L
- **Pests controlled:** germinating annual weeds (4)
- **% crop treated:** 30% (10)
- **Type of applications:** Directed spray, banded application
- **Application rates:** 1.3 lbs ai, has increased from 0.77 in 1991 to 1.65 lbs in 1997. (10)
- **Number of applications:** 1 per season (10)
- **Timing:** spring, postemergence (4)
- **Preharvest interval:**
- **Use in IPM programs:**
- **Use in resistance management programs:**

- **Efficacy issues:**

Terbacil

- **Formulations:** Sinbar 80WP
- **Pests controlled:** annual weeds (4)
- **% crop treated:** 31% (10)
- **Type of applications:** directed spray, banded application
- **Application rates:** 0.67 lbs ai (10)
- **Number of applications:** 1 per season (10)
- **Timing:** spring (4)
- **Preharvest interval:**
- **Use in IPM programs:** Controls a broader spectrum of weeds including many hard to kill perennials than most other soil-applied materials.
- **Use in resistance management programs:** Rotated or tank mixed with triazine herbicides to control triazine resistant weeds.
- **Efficacy issues:** blueberries must be at least 1 year old, moves readily in sandy soil. Easier to over apply than other soil active materials.

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