Crop Profile for Apples in Ohio

Prepared: October, 1999.

General Production Information

(Rosaceae *Malus domestica*)

- Acres in Ohio (bearing): 7,900 (3)
- Percent of US Acreage/Rank:1.7%/10th: (1)
- Number of Growers: 1,126(1)
- Per Acre Value: $1,880 (3)
- Value of Production in Ohio: $14,858,000(3)

Location of Production

Counties with the most acres in apple orchards are located in the North, Northeast, and Central regions of the state. The following counties are the top apple producers in the state: Columbiana (775A), Licking (662A), Lorain (486A), Ashtabula (485A), Sandusky (479A), Erie (453 A), Mahoning (290 A), Medina (285A), Wayne (272A) and Fairfield (267A). (1)

Production Methods

Proper site selection for apple production is important. The soil should be deep, friable, fertile and have good drainage. The site should also have good air circulation to help avoid late spring frost damage and reduce disease pressure. Site selection can also help determine choice of variety planted. The top varieties planted in Ohio include: Delicious, Golden Delicious, Jonathan, Rome Beauty and McIntosh. New trees, propagated at commercial nurseries by budding or grafting onto rootstock, are planted in early spring. In preparation for planting the soil pH should be adjusted to between 6.5-7. Levels of minor element should also be measured and adjusted accordingly. Incorporation of green manure or organic matter will help increase the soil water holding capacity. There are many different cropping systems utilized by apple growers. Decisions on tree spacing are made based upon the location of the orchard, the type of soil, variety selection and cultural plans. In Ohio the central leader cropping system is most popular, but newer plantings are using a variety of systems depending on rootstock and grower needs. After the new trees are planted, it is critical to keep the surrounding soil moist, free of weeds and protected from deer and voles. In the first few years of growth nitrogen is usually the only nutrient applied unless soil and/or leaf analysis show a deficiency in minor elements such as boron, calcium or magnesium, which are then applied using a foliar spray. Other important activities in maintaining a healthy orchard include irrigation, weed management, pruning, thinning and spraying to prevent premature dropping of fruit. Apple trees in Ohio are pruned during the dormant season (January to April) to remove dead, broken, crossing or competing limbs. Pruning helps to increase fruit size and the amount of nitrogen reaching a growth point. Thinning, usually done chemically, is done because some varieties set more fruit than they can mature. Thinning helps to improve the size of the mature fruit. Finally, sprays of plant growth regulators are used by some growers to prevent premature dropping of fruit to cut down on harvest time and encourage more growth and good color.

The Crop Profile/PMSP database, including this document, is supported by USDA NIFA.

GROWTH STAGES OF APPLES:(4)
Times listed are approximate for northern Ohio. In central and southern Ohio these growth stages occur 1-2 weeks earlier.

- DORMANT – before the growth stars in spring.
- GREEN TIP – when the buds start to break, showing the green color of new leaves. (Early April)
- HALF-INCH GREEN – when new leaves from the buds are ½ inch long. (Mid-April)
- TIGHT CLUSTER – when buds in the cluster are short stemmed and closely packed. (End of April)
- PINK – when flower buds start showing the color of the petals. (Early May)
- BLOOM – when the flowers are open. (Mid-May).
- PETAL FALL – when flowers drop their petals. (Mid- to Late May)
- FIRST, SECOND AND THIRD COVER – 10–14 days after petal fall, 10-14 days after first cover and 10-14 days after second cover respectively. (End of May, Early June and End of June)

Insect Pests

European Red Mite
The adult female mite is red in color and globular in shape while the smaller male is dull green to yellowish brown and narrower in shape with a pointed abdomen. There are often white spots at the base of 6-8 hairs on the back of the mites. The overwintering eggs are red-orange and onion-shaped while the eggs laid during the growing season are yellowish-orange and spherical. The European red mite overwinters as eggs laid on the bark of twigs and branches. Eggs hatch in the spring around the tight cluster stage. The mite larvae and subsequent life forms feed on the leaves of the apple tree, withdrawing fluids and chlorophyll. Heavy feeding causes the leaves to turn bronze by mid- to late July and will result in smaller fruit with poor color. The following year's crop could also be affected if the damage is heavy and early so it reduces the number of fruit buds. There can be 6-8 overlapping generations of mites per season. The pests can be controlled by predatory mites. Good guidelines exist for monitoring mites and deciding on the need for chemical control.

Codling Moth
The adult moth is about 3/8 inch long and well camouflaged on the apple tree bark. It's forewings are gray-brown crossed with light gray and white lines and the wing tips are gold or bronze. The larvae are pinkish-white and have a

brown head. The codling moth overwinters as a larvae. The larvae pupate in the spring around bloom and the adults become active shortly thereafter. Scale-like eggs are laid by the females on or near developing fruit. The larvae emerge and begin to tunnel into the center of the fruit from the side or calyx end, where a brown frass can often be seen. The larvae feed inside the apple as they develop for 3-5 weeks. Larvae leave the fruit to pupate in silken cocoons attached to the bark. Larval feeding renders fruits unmarketable and can promote the development of fruit rot diseases. The most serious damage is caused by the 2nd and 3rd generation larvae. The codling moth can be managed by insecticide application timed using a degree day model that starts after the moths are first caught in the pheromone traps

Plum Curculio

The plum curculio adult is a snout beetle, about ¼ inch long, and dark brown in color with white or gray patches. The snout measures ¼ the length of the body and contains the mouthparts at the end. Each wing cover has 4 prominent humps. The plum curculio larvae are legless, gray-white grubs with a brown heads. Overwintering occurs in the adult stage in ground litter or soil outside the orchard. As the spring night temperatures consistently reach 60°F, the adults become active and migrate into nearby orchards. It is difficult to predict when migration will occur, therefore, good monitoring methods are needed. The females lay eggs in crescent-shaped cuts in the developing fruit causing the initial damage. When the larvae emerge they begin feeding on the apples and can cause premature fruit drop. The larvae leave the fruit when they are fully developed, drop to the ground and pupate in the soil. Adults emerge again in mid-summer and often feed on apples causing round scars.

Spotted Tentiform Leafminer

The adult form of the leafminer is a small golden brown moth with white spots or bands. The young larvae are small, very flat and legless. Older larvae have legs and a head capsule. The leafminer overwinters as a pupa in leaf litter. The small larvae appear first around bloom and begin to feed in a "U" shaped pattern on the undersides of the apple tree leaves. The older larvae feed on both the upper and lower leaf tissue leaving a circular pattern of specks about ½ inch in diameter. High populations of larvae can cause severe defoliation, leading to reduced fruit and terminal growth, early leaf drop, and reduced fruit set the following season. The larvae feed for a month and then pupate within the mine. The adults begin to appear in another month. There are usually 3 generations of spotted tentiform leafminers per season.

Apple Maggot

The adult maggot is a fly with dark bands on its wings and white bands on its abdomen. They also have a large white spot on the thorax. The larva is 1/3 inch when full grown, cream colored and legless. Overwintering occurs in the pupae form while most of the adults emerge in June and July. The adults lay eggs in puncture holes in the apple skin. After the maggots emerge they feed on the apple, tunneling through the flesh and leaving tiny brown trails. The feeding causes the apple fruit to be dimpled, and if it is soft the fruit will soon rot. There is usually only one generation of apple maggots per year, whose population can be monitored with red sticky ball traps.

Rosy Apple Aphids

Rosy apple aphids are small pear-shaped insects that range in color from gray to rose. A characteristic pair of cornicles are present on the 5th or 6th body segment. The mouthparts of all aphids are piercing-sucking. Aphids overwinter as eggs generally laid on twigs, around buds, or in crevices in the bark. Around the green-tip stage, the eggs will hatch and release the first generation of nymphs that are all wingless females. These females give birth to live nymphs and a generation is completed about every 14 days. The aphids feed on the apple tree foliage with the rosy apple aphids doing the most damage. If the population of aphids is large they can cause stunted new growth and a sooty mold to develop on fruit and leaves. The rosy apple aphid will also inject a toxin with its saliva that causes leaves to curl and the fruit to abort or be small and distorted. Even a small number of rosy apple aphids can do much damage. The green apple aphid also occurs in Ohio orchards, but it does not cause significant damage in most cases.

San Jose Scale

The adult female scale is legless and wingless and covered with a circular, gray scale-like cap. The scale covering measures 1/20 –inch across and near its center has a depressed ring surrounding a raised cover. The male scale is a small, yellow, two-winged insect resembling a midge or gnat. The San Jose scale overwinters as a nymph under a scale. The males emerge in the spring and mate with the females. Minute, orange-yellow and oval crawlers with six legs emerge in about one month. The crawler moves about the tree to find a suitable place to settle down permanently, inserts its mouthparts and begins to secrete a waxy shell over its body. As the crawlers feed they cause red, spotted areas on fruit. Infested leaves drop off, limbs lose vigor and die and the fruit develops and undesirable finish from the red spots and the presence of the scale. There are usually at least two generations of the scale each season. Populations of adult San Jose scale can be monitored with pheromone traps and the crawlers with black stick tape. The appearance of the crawlers can be predicted using the degree day model.

Leafrollers

There are four species of leafroller that occur in Ohio orchards; the red-banded leafroller, the oblique-banded leafroller, the tufted apple budmoth and the variegated leafroller. The most serious damage is done by the red-banded leafroller larvae when they feed on apple foliage and fruit. The larvae attach leaves to the surface of the fruit with silk and feed on the apple skin and flesh. There are 3-4 generations of this insect each season with the last generation of the season doing the most damage. Leafrollers are usually effectively controlled in Ohio since no resistance problems exist for any of the four species as do in other states.

Tarnished Plant Bug

The adult tarnished plant bug is mottled brown in color, about ¼ inch long and has wings that fold over its abdomen. They also have a yellow-tipped triangle in the center of their backs. The nymphs resemble the adults but are without wings and are green in color. The tarnished plant bug overwinters as an adult in protected areas under bark or leaf litter. In early spring, the adults feed on young buds or flowers and later on developing fruit. Eggs are laid in the plant tissue and the nymphs emerge in about a week. Both the adults and nymphs use their piercing, sucking mouthparts to extract fluids from the apples. Their feeding results in small deep depressions or dimples in the apples that are noticeable at harvest. Each year several generations of this insect occur.

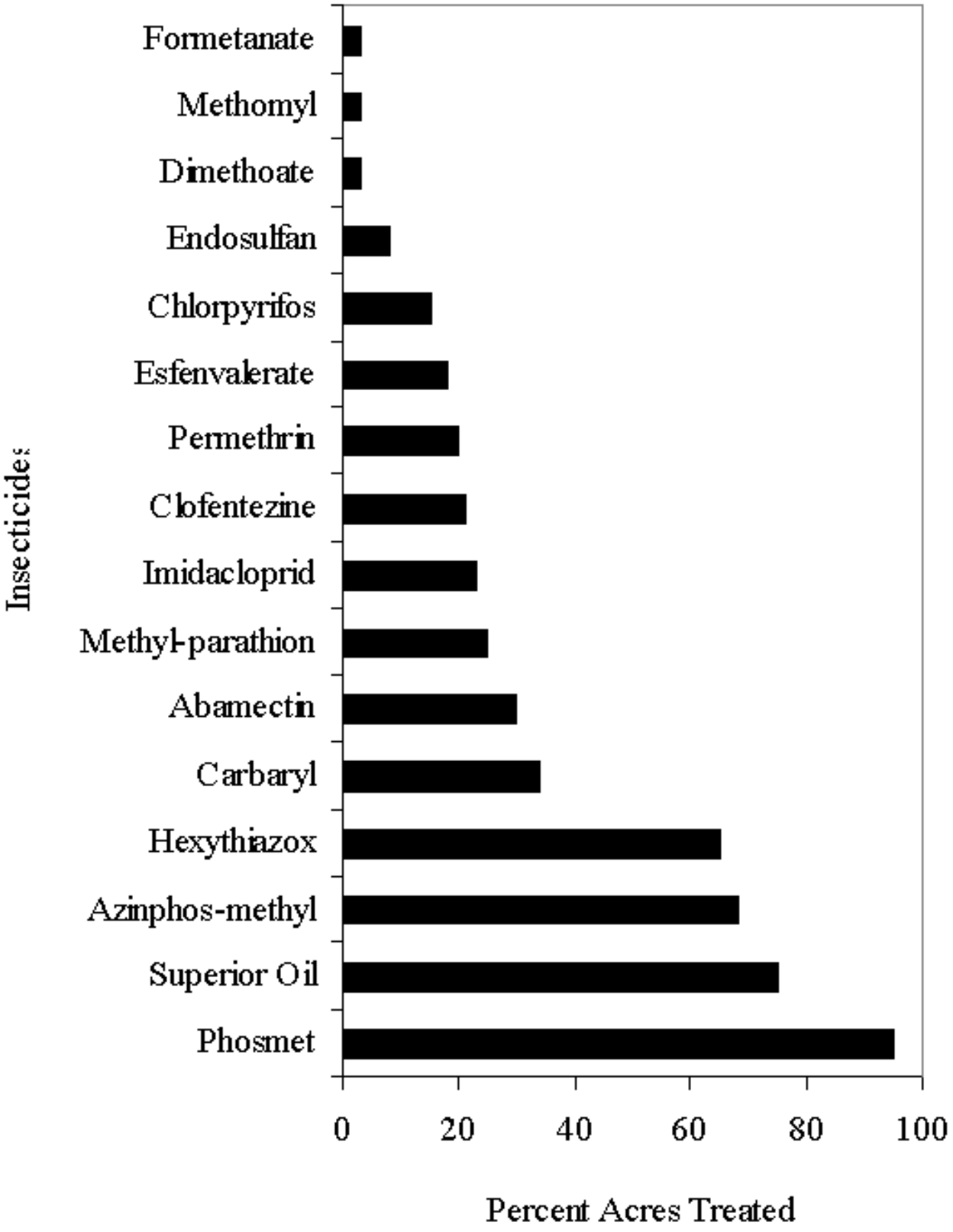
Leafhoppers (White Apple and Rose)

The white apple and rose leafhoppers are similar in appearance. The adults have long slender bodies that are wedge-shaped and have a convex back. The body is light yellow while the head is a little darker. The nymphs are pale white and wingless. Both types of leafhoppers overwinter as eggs. The white apple leafhoppers begin hatching at the pink stage and the nymphs move to the undersides of leaves to feed. The first generation of adults appears in June while the second generation is usually detected at harvest. The rose leafhopper nymphs emerge in the spring and feed first on their wild host, the floribunda rose. In June the adults move apples and the 2nd and 3rd generations feed there. Damage to the apples is caused by the nymphs and adults of both species removing chlorophyll and sap from the lower leaf surface which affects fruit development and bud formation. White apple leafhopper is best controlled at petal fall when populations occur over threshold levels.

Japanese Beetles

The adult Japanese beetle is metallic green with copper colored wing covers. It is 3/8-inch long and has a row of white tufts of hair that project from under the wings on each side of the body. The beetle overwinters as a grub in the soil and pupates near the surface in the spring. The adults emerge from the ground and begin to feed on many different types of plants, including apple trees. The adult beetle feeds on the upper surface of the leaves, chewing the tissue between the veins and leaving a lace-like skeleton. The Japanese beetle can do severe damage if the many are present at one time feeding on the same tree. The beetles are most active over a 4- to 6-week period beginning in late June. There is only one generation of Japanese beetles per season.

Chemical Insect Controls:



Phosmet (Imidan)

Target pests and timing: codling moth (with 1st, 2nd, 3rd and remaining summer cover sprays), plum cucurlio

and red-banded leafroller (at petal fall and with1st, 2nd and 3rd cover sprays) and apple maggot (2)
Percent of acres treated: 95% (7,8)
Average rate and frequency of application: (7,8) Imidan 70WP – 2.2 lbs/A, 4 times
PHI: 7 days (2)
Efficacy rating: Very good (8)
Special uses: Critical broad spectrum insecticide but easy on mite predators. (8)

Superior Oil

Target pests and timing: European red mite and San Jose scale (at green tip however, application delayed until the tight cluster stage will give better control of mites) (2)
Percent acres treated: 75% (7,8)
Average rate and frequency of application: (7,8) Superior Oil – 5 gal/A, once
PHI: 0 days (2)
Efficacy rating: Good (8)
Special uses: Important to help reduce resistance to miciticides by providing early season control.(8)

Azinphos-methyl (Guthion)

Target pests and timing: codling moth (with 1st, 2nd , 3rd and remaining summer cover sprays), plum cuculio, red-banded leafroller (at petal fall and with 1st, 2nd and 3rd cover sprays) (2)
Percent acres treated: 68% (7,8)
Average rate and frequency of application: (7,8) Guthion 50WP –2lbs/A, 4 times
PHI: 14 days (8)
Efficacy rating: Very Good (8)
Special use: Good broad spectrum insecticide, particularly good on plum curculio and easy on mite predators. (8)

Hexythiazox (Savey)

Target pests and timing: European red mite eggs (at green tip) and European red mites (at tight cluster and pink) (2)
Percent of acres treated: 65% (7,8)
Average rate and Frequency of Application: (7,8) Savey WP – 3 oz/A, once (should be applied with a surfactant)
PHI: 28 days
Efficacy rating: Very good on mite susceptible cultivars (8)
Special uses: Important alternative for resistance management in mite control (8) Recommended to be part of a three year rotation using clofentezine or hexythiazox the first year, oil in the second year and abamectin in the third year for resistance management.

Carbaryl (Sevin)

Target Pests: White apple leafhopper and apple maggot (at third cover and summer cover sprays) (2)
Percent of acres treated: 34% (7,8)
Average rate and frequency of application: (7,8)
Sevin – 10 oz/A, once at least 30 days after full bloom to avoid fruit thinning
PHI: 3 days (2)

Efficacy rating: Good

Abamectin (Agri-Mek)

Target Pests: Spotted tentiform leafminer larvae, leafhopper and mites (at petal fall) (2)
Percent of acres treated: 30% (7,8)
Average rate and frequency of application: (7,8)
Agri-Mek 0.15EC – 10 oz/A, once
PHI: 28 days (2)
Efficacy rating: Good (8)
Special Use: Important alternative for resistance management. (8) Most effective if applied with oil or other penetrating surfactants.

Methyl-parathion (Penncap-M)

Target pests and timing: codling moth, plum cucurlio, red banded leafroller, and San Jose scale crawler (with 1st, 2nd , 3rd and remaining summer cover sprays) (2)
Percent of acres treated: 25% (7,8)
Average rate and frequency of application: (7,8)Penncap-M – 4 pt/A, twice
PHI: 24 days (8)
Efficacy rating: Good (8)
Special Use: Particularly effective against San Jose scale (8)

Imidacloprid (Provado)

Target pests and timing: Leafhoppers, Tentiform leafminers and Green apple aphids (at petal fall) (2)
Percent acres treated: 23% (7,8)
Average rate and frequency of application: (7,8) Provado 1.6F – 6oz/A, once
PHI: 7 days (2)
Efficacy rating: Very good (8)
Special Use: Important component of IPM program (8)

Clofentezine (Apollo)

Target pests and timing: European red mite (from delayed dormant to tight cluster) (2)
Percent of acres treated: 20% (7,8)
Average rate and Frequency of Application: (7,8) Apollo SC – 4 oz/A, once
PHI: 21 days
Efficacy rating: Good (8)
Special use: Recommended to be part of a three year rotation using clofentezine or hexythiazox the first year, oil in the second year and abamectin in the third year for resistance management.

Permethrin (Ambush, Pounce)

Target pests and timing: spotted tentiform leafminers (at half inch green) and tarnished plant bug (at pink) (2)
Percent of acres treated: 20% (7,8)
Average rate and frequency of application: (7,8)
Ambush 2EC – 6 oz/A, once

Pounce 3.2EC – 6 oz/A, once
PHI: 14 days
Efficacy rating: Good (8)
Special Use: Effective at killing labeled insects but very hard on natural predators and thus may cause mite outbreaks later in the season (8)

Esfenvalerate (Asana)

Target Pests: Spotted tentiform leaf miner, plum curculio and red-banded leafroller(2)
Percent of acres treated: 18% (7,8)
Average rate and frequency of application: (7,8) Asana XL – 8 oz/A, once
PHI: 28 days
Efficacy rating:
Special Use: May cause mite problem later in season.

Chlorpyrifos (Lorsban)

Target pests and timing: rosy apple aphids (at half inch green), aphids (at pink and petal fall and with 1st, 2nd , 3rd and remaining summer cover sprays) and San Jose Scale. (2)
Percent of acres treated: 15% (7,8)
Average rate and frequency of application: (7,8)
Lorsban 50WP – 2.25lbs/A, once to twice
Lorsban 4EC – 3 pts/A, once to twice
PHI: 28 days (2)
Efficacy rating: Good (8)
Special Use: Effective against crawler stage of San Jose scale.

Endosulfan (Thiodan)

Target pests and timing: Rosy apple aphid and spotted tentiform leafminer adults(at half inch green), aphids (at pink) and leafhoppers (with summer cover sprays) (2)
Percent acres treated: 8% (7,8)
Average rate and frequency of application:
Thiodan 5EC - 1.5pts/A, twice
Thiodan 50WP – 6 bls/A, once
PHI: 21 days (8)
Efficacy rating:
Special Use: useful as an emergency treatment for rosy apple aphids. (8)

Dimethoate

Target pests and timing: Rosy apple aphids (at pink) and green apple aphids (in June) (2)
Percent of acres treated: 3% (7,8)
Average rate and frequency of application: (7,8) Dimethoate - 5lbs/A, twice
PHI: 28 days (2)
Efficacy rating:
Special Use: Hard on natural predators (8)

Methomyl (Lannate)

Target pests and timing: Spotted tentiform leafminers (at petal fall and with summer cover sprays) (2)
Percent acres treated: 3% (7,8)
Average rate and frequency of application: (7,8) Lannate LV – 2 pts/A, once
PHI: 14 days (2)
Efficacy rating:
Special Use: Very harsh on predatory mites.

Formetanate Hydrochloride (Carzol)

Target Pests: Mites and leafhoppers (at petal fall) (2)
Percent of acres treated: 3% (7,8)
Average rate and frequency of application: (7,8) Carzol 92%SP – 3lbs/A, once
PHI: 7 days (2)
Efficacy rating: Good (8)
Special Use: Can be hard on natural predators (8)

Pyridaben (Pyramite)

Target Pests: Mites (2)
Percent of acres treated:
Average rate and frequency of application: Pyramite 60W – 4.4 oz, once
PHI: 25 days (2)
Efficacy rating: Good (8)
Special Use: Effective for summer outbreak of mites. (8)

CULTURAL CONTROLS:(5)
Scouting and monitoring the insect pests of apples using pheromones or sticky traps are important components of apple IPM programs. A weed management program that eliminates alternative hosts for insect pests, especially for tarnished plant bug, is important.

BIOLOGICAL CONTROLS:(5,6)
Mating disruptors, Isomate C-plus and CheckMate CM, are registered for use on codling moths. They are most effective in blocks of apples 5+ acres where the initial infestation of moths is low. Predatory arthropods including; mites, lady beetles, spiders and lacewings are important for helping to manage populations of European red mites, aphids, San Jose Scale and leafhoppers. There are many parasitoids including many species of wasps and flies, which attack the codling moth, apple maggot, leafrollers, spotted tentiform leafminers and Japanese beetles at the egg and larval stage and therefore are important in managing these pests populations.

Diseases

Apple Scab

Scab is caused by the fungus *Venturia inaequalis*. It is the most common disease of apples in the Midwest. The fungus overwinters in infected leaves on the ground. Primary scab spores mature in early spring about the same time as the apple leaves emerge. After minimal periods of wetness, the spores are released and carried by air currents to new leaves and blossoms. The highest rate of spore discharge and leaf/blossom susceptibility occurs between the tight cluster stage and 10 days after petal fall. Rate of infection is dependant upon temperature and length of time the trees are continuously wet. Normally, primary scab lesions appear within 9-17 days after infection. The lesions usually appear first as small, olive-colored areas, which increase in size and darken with age. The primary lesions often take on a velvety appearance as they produce secondary spores capable of causing new infections all season long on leaves and fruit. These spores are spread by wind and splashing rain. Late-season scab on leaves indicates that the disease pressure will be high the following season.

Powdery Mildew

The causal organism for Powdery Mildew is the fungus *Podosphaera leucotricha*. The fungus overwinters in vegetative or fruit buds infected the previous season. Very cold weather will kill these buds and the fungus inside. Therefore, Powdery Mildew is usually more severe after a mild winter. When the buds begin to develop in the spring the fungus resumes its growth and colonizes developing shoots and blossoms causing a reduction in yield. Spores develop giving the white appearance which are responsible for secondary infections. The infections develop on leaves and buds by midsummer and reduce the vigor of the tree. Developing fruit can be infected from the pink stage up to 1-3 weeks after bloom. Infected fruit will develop a web-like russeting rendering them unmarketable. Conditions which promote infection include high humidity (>90%) and temperatures between 50° and 77°F. Powdery Mildew is not as severe as Scab but can cause significant problems on susceptible varieties.

Fire Blight

Fire Blight is caused by the bacterium, *Erwinia amylovora*. The bacterium overwinters in cankers on branches and trunks. In the spring, bacterium oozes from the canker margins and is carried to blossoms by insects and rain. Bees can carry the pathogen as they pollinate the blossoms. In warm and rainy or humid conditions the bacteria multiply quickly. Rain or dew will wash the bacteria into openings at the base of the flower, where it moves systemically to shoot tips and rootstocks. Infected areas become shriveled and blackened as though they were scorched by fire. An infection may progress down a shoot and into the bark of larger limbs where dark, sunken cankers are formed. These cankers slowly enlarge and may eventually girdle the limb. Fire blight infections can be very destructive causing a reduction in yield, the loss of limbs, and even the death of the tree.

Rusts

Three types of rusts infect apples in Ohio: cedar apple rust (*Gymnosporangium juniperi-virginianae*), quince rust (*G. clavipes*), and hawthorn rust (*G. globosum*), with cedar apple rust being the most common and the most problematic. The leaf lesions caused by cedar apple rust develop on the upper surface shortly after bloom. They are pale yellow at first but turn orange as they expand. Eventually, black dots appear in the lesions and tiny fungal tubes emerge on the underside of the leaf. Serious leaf infections can cause defoliation that can weaken the tree and significantly reduce yields. Fruit infections occur commonly at the blossom end. The lesions that develop on fruit are similar to those on the foliage but much larger. Infected fruit are unmarketable.

Fruit Rots

There are many summer diseases that infect the apple fruit. The fungi that cause the diseases are somewhat similar. The fruit rot fungi overwinter in dead or weakened tissue, including fire blight cankers and mummified fruit. They produce large number of spores that are easily spread by wind and rain. Disease development is favored under warm and humid weather conditions. The most common fruit rot diseases are described below.

- **Bitter Rot –** Bitter rot lesion vary depending upon which spore type caused the infection. They vary from a sunken, light brown lesions with concentric circles of spore masses that appear creamy pink under humid

conditions to lesions which more superficial and darker in color. The decay extends in a cone shape towards the center of the apple.

- **Black Rot** – Black rot lesions develop first at the blossom end of the fruit. The lesions are dark brown and often marked by concentric alternating brown and black rings. The lesions expand and can eventually encompass the entire fruit. The rotten spots are fir, leathery and dotted with black fungal fruiting bodies. Optimal conditions for fruit infection are temperatures between 68° and 75°F and 9 hours of wetting. The black rot fungus can also infect the foliage and branches.

- **White Rot** – The lesions caused by the white rot fungus begin as small, circular, tan spots that are often surrounded by a red halo. The lesion extends cylindrically towards and surrounding the apple core. Eventually the entire fruit becomes soft, watery and light brown in color. Infections can also occur on the branches of the tree. Under drought conditions, limb infections can be more severe.

Blister Spot

Blister spot is primarily a disease of the cultivar Mutsu (Crispin) and is caused by the bacteria *Pseudomonas syringae* pv. *papulans*. The disease can appear on Golden Delicious cultivars if they are planted near Mutsu. The bacterium overwinters in the apple buds, leaf scars and diseased fruits remaining on the orchard floor. The initial infections occur about 2 weeks after petal fall and will continue for the next 6 weeks. Small, green and water-soaked raised blisters that develop at the fruit stomata first appear 2-3 weeks after petal fall. The blisters develop into purplish-black lesions that expand to about 3/16 inch as the fruit grows. The disease causes no appreciable reduction in yield but results in blemished and thus unmarketable fruit.

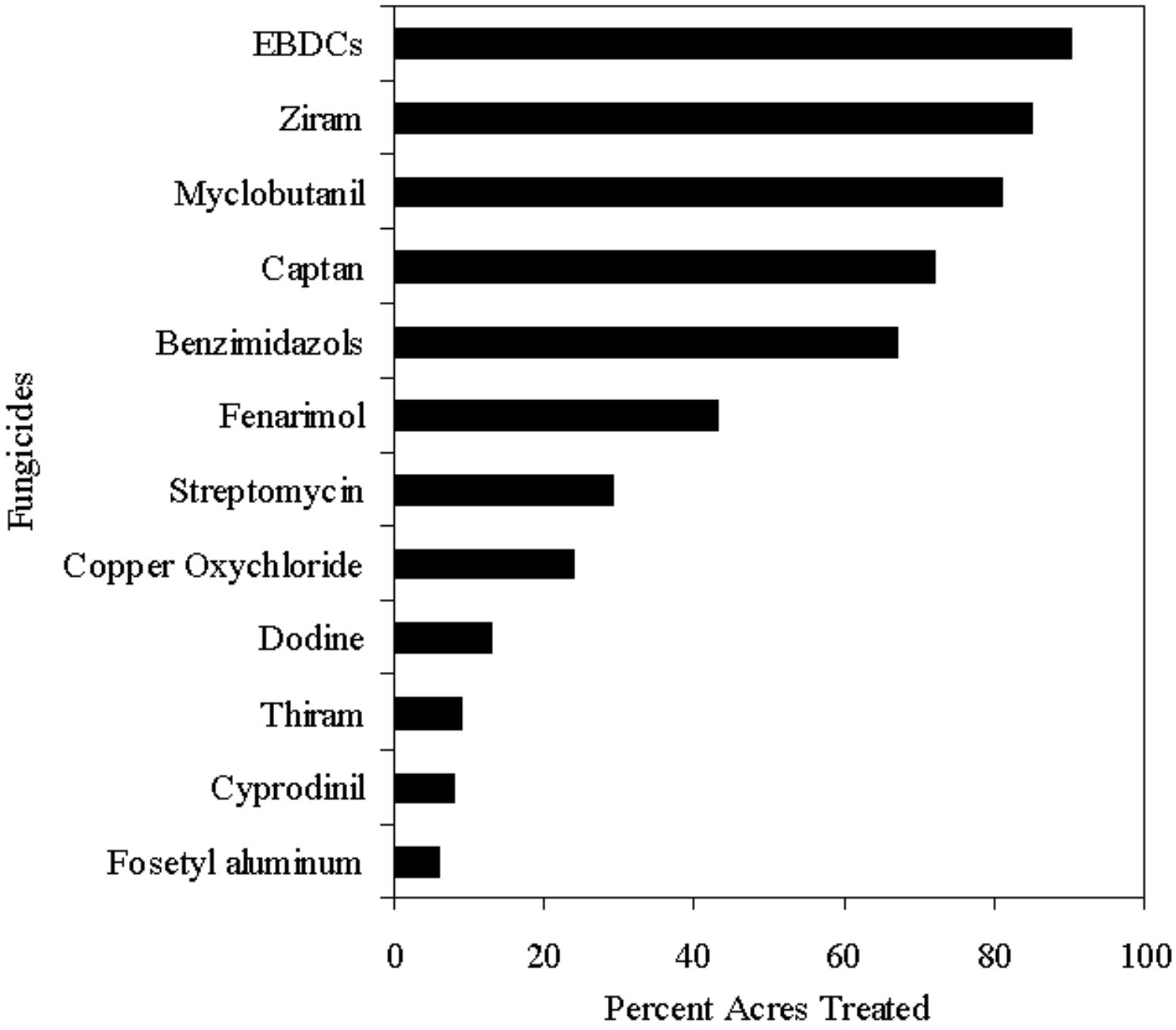
Root, Collar and Crown Rot

Root, collar and crown rots are caused by the soil-borne fungus *Phytophthora cactorum* and other species of *Phytophthora.* The fungus is most commonly found in areas with heavy, poorly drained soils. The fungus infects apple trees on the lower trunk just at or below the soil surface. The bark at the site of infection becomes dark and sunken while the tissue underneath appears reddish brown to dark brown. The leaves of infected trees can be small and pale during the summer and turn red in late fall. Trees suffering from root, collar or crown rot are overall less vigorous in growth and yields.

Fly Speck and Sooty Blotch

These are two separate disease but they usually occur together on the same fruit. Fruit infection usually occurs after the petal fall stage but is most common during mid- to late summer under temperatures between 65° and 80°F and high relative humidity. Fly Speck lesions appear as clusters of tiny, black dots. Sooty blotch lesions look like dark, sooty smudges. These diseases do not cause decay but produce blemishes resulting in unmarketable fruit.

CHEMICAL DISEASE CONTROLS:



EBDC Fungicides: Metiram (Polyram) **Mancozeb** (Dithane, Penncozeb, and Manzate)

Target diseases and timing: Primary Scab (at green tip); Scab (at tight cluster, pink and bloom); Scab and Rust (at pink and bloom) and Scab, Rust and Fruit Rot (with 1st and 2nd cover sprays) (2)
Percent acres treated: 90% (7,8)
Average rate and frequency of application: (7,8) Polyram 80WP – 3 lbs/A, 4 times
PHI: 77 days (2)
Efficacy rating: Good to Very Good (8)
Special Use: EBDC fungicides are interchangeable. Use depends on price. Both are very important protectant fungicides. (8)

Ziram

Target diseases and timing: Primary Scab (at green tip, half inch green, tight cluster, pink, bloom, and petal fall); Scab (at tight cluster, pink, bloom and petal fall); Scab and Rust (at pink, bloom and petal fall); Scab and Fruit Rots (with 1st and 2nd cover spray); Scab, Rust and Fruit Rots (with 1st and 2nd cover spray); and Scab, Fruit Rots, Sooty Blotch and Fly Speck (with 3rd and remaining summer cover sprays) (2)
Percent acres treated: 85% (7,8)
Average rate and frequency of application: (7,8) Ziram 76DF – 3.5 lbs/A, 5 times
PHI: 30 days (8, 2)
Efficacy rating: Good (8)
Special Use: Often combined in spray with Captan and a benzimidazole. (8)

Myclobutanil (Nova)

Target diseases and timing: Primary Scab (at green tip); Scab and Powdery Mildew (at tight cluster, pink and bloom), Scab, Powdery Mildew and Rust (at pink and bloom) and Scab, Powdery Mildew and Rust (with 1st and 2nd cover sprays) (2)
Percent acres treated: 81% (7,8)
Average rate and frequency of application: (7,8) Nova 40WP – 5 oz/A, 3 times
PHI: 14 days (2)
Efficacy rating: Very Good to Excellent (8)
Special uses: Combined with a protective such as an EBDC or Captan, Nova is used in a 10-day extended protectant program. It has a 3-4 day curative activity.

Captan

Target disease and timing: Scab, Rust, Fruit Rots, Sooty Blotch and Fly Speck (2)
Percent acres treated: 72% (7,8)
Average rate and frequency of application: (7,8) Captan 50WP – 3 lbs/A, 5 times
PHI: 30 days (8)
Efficacy rating: Very Good (8)
Special use: Often combined in spray with Ziram. Gives good control of summer diseases. (8)

Benzimidazoles: Thiophanate-methyl (Topsin-M) and **Benomyl** (Benlate)

Target diseases and timing: Scab and Powdery Mildew (at tight cluster, bloom and petal fall) and Scab, Fruit Rot, Sooty Blotch and Fly Speck (with 1st, 2nd, 3rd and remaining summer cover sprays). (2)
Percent acres treated: 67% (7,8)
Average rate and frequency of application: (7,8) Topsin-M 70WSP – 1 lb/A, twice
PHI: 10 days (8)
Efficacy rating: Good (8)
Special uses: Should be used in combination with another fungicide at ½ rate to prevent build-up of resistant strains of the apple scab fungus. The benzimidazoles are similar in activity and are used interchangeably by the growers. However, thiophanate-methyl is used more frequently than benomyl.

Fenarimol (Rubigan)

Target disease and timing: Primary Scab (at green tip); Scab and Powdery Mildew (at tight cluster, pink and

bloom); Scab, Powdery Mildew and Rust (at pink and bloom) and Scab, Powdery Mildew, Rust and Fruit Rot (with 1st and 2nd cover sprays) (2)
Percent acres treated: 43%(7,8)
Average rate and frequency of application: (7,8) Rubigan EC – 8 oz/A, three times
PHI: 30 days (2)
Efficacy rating: Very Good
Special Use: Fenarimol has as similar chemistry to myclobutanil and is used similarly or interchangeably.

Streptomycin/Agromycin

Target disease and timing: Fire Blight (at bloom) (2)
Percent acres treated: 29% (7,8)
Average rate and frequency of application: (7,8) Streptomycin 17 W – 1.25 lbs/A, twice
PHI: 50 days (2)
Efficacy rating: Fair to Good
Special uses: Applied only to the most blight susceptible varieties such as Jonathan.(8)

Copper Oxychloride (C.O.C.S.)

Target diseases and timing: Fire Blight (at dormant) (2)
Percent acres treated: 24% (7,8)
Average rate and frequency of application: (7,8) C.O.C.S. – 4 lb./A, once
PHI: 120 days (8)
Efficacy rating: Fair
Special uses: Applied only to the most blight susceptible varieties. It is used to reduce overwintering inoculum. (8)

Dodine (Syllit)

Target disease and timing: Primary Scab (at green tip, half inch green, tight cluster, pink , bloom and petal fall) (2)
Percent acres treated: 13% (7,8)
Average rate and frequency of application: (7,8) Syllit 65WP – 2 lbs/A, twice
PHI: 7 days (2)
Efficacy rating:
Special uses: Use is limited in Ohio due to concerns about efficacy and resistance. (8)

Cyprodinil (Vanguard)

Target disease and timing: Primary scab (from green tip through petal fall) (2)
Percent acres treated: 8% (7,8)
Average rate and frequency of application: (7,8) Vanguard – 3oz/A, once
PHI: 72 days (2)
Efficacy rating: Good
Special uses: New chemistry that has not been used extensively. It is more expensive than standard protective fungicides.

Fosetyl-aluminum (Alliete)

Target diseases and timing: Root rots (2)
Percent acres treated: 6% (7,8)
Average rate and frequency of application: (7,8) Alliete – 5 lb./100 gal, 3-4 times
PHI:
Efficacy rating: Fair if used preventively.
Special uses:

Thiram

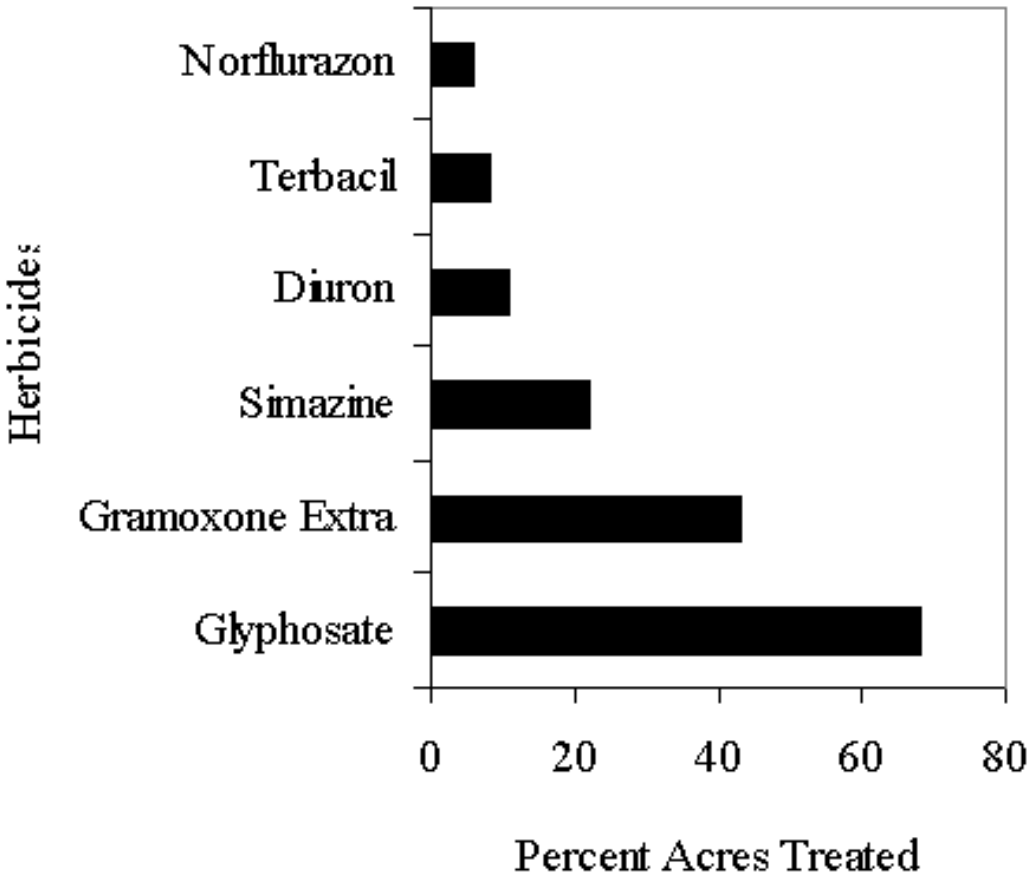
Target diseases and timing: Scab and Fruit Rots (in summer cover sprays) (2)
Percent acres treated: <10%
Average rate and frequency of application: Thiram 65 WDG – 3.5 lbs/A, 5 times
PHI: 0 days (2)
Efficacy rating: Fair
Special uses: Used as a fungicide and deer repellant on young trees. Has been reported to plug the nozzles in sprayers.(8)

CULTURAL CONTROLS:(5)
Choosing a site with good drainage and planting resistant cultivars can help limit disease development in apple orchards. Providing adequate, but not excessive nutrients and pruning out dead, weak or extraneous limbs also helps maintain healthy trees. Good pruning practices also enhance air movement through trees resulting in reduced disease pressure, especially for sooty blotch and fly speck.

Weeds

Broadleaves and grasses

CHEMICAL CONTROLS:



Glyphosate (Roundup)

Target weeds: most annual and perennial grass and broadleaf weeds (2)
Percent acres treated: 68% (7,8)
Average rate and frequency of application: (7,8) Roundup – 1.5 qt/A, once
Efficacy rating: Very Good (8)
Special Use: Used primarily on trees older than three years (2)

Gramoxone Extra (Paraquat)

Target weeds: most annual weeds and top kill of perennial weeds (2)
Percent acres treated: 43% (7,8)
Average rate and frequency of application: (7,8) Paraquat – 1 qt/A, twice
Efficacy rating: Good (8)
Special Use: Used on trees less than three years of age. (2)

Simazine

Target weeds: broadleaf weeds
Percent acres treated: 22% (7,8)
Average rate and frequency of application: (7,8) Simazine – 3 lb/A, once under trees in the spring prior to weed emergence
Efficacy rating:

Special Use:

Diuron (Karmex)

Target weeds: most annual grass and broadleaf weeds (2)
Percent acres treated: 10% (7,8)
Average rate and frequency of application: (7,8) Karmex DF– 2 lb./A, once (7,8)
Efficacy rating:
Special Use: Used on trees at least 1 year old. Important for resistance management. Rotated in use with triazine herbicides (2).

Terbacil (Sinbar)

Target weeds: most annual weeds and grasses (2)
Percent acres treated: 8% (7,8)
Average rate and frequency of application: (7,8) Sinbar – 2.5 lb/A, once in the spring before weeds emerge or during early stage of seedling regrowth or after harvest in the fall.
Efficacy rating:
Special Use: Used on trees established for at least 3 years. (2)

Norflurazon (Solicam)

Target weeds: Annual weeds (2)
Percent acres treated: 6% (7,8)
Average rate and frequency of application: (7,8) Solicam DF – 2.5 lb./A, once in the fall to early spring before weeds emerge
Efficacy rating:
Special Use:

CULTURAL CONTROLS:
Mowing and use of a cover crop are nonchemical alternatives to the use of herbicides. In young trees, mulch can be used to manage weeds.

CRITICAL PEST CONTROLS ISSUES:
Important organophosphates (OP), carbamates (C) or B2 carcinogens (B2) pesticides used for which there are few or no other alternatives or the only alternatives are also organophosphates, carbamates or B2 carcinogens include:

- Azinphos–methyl (OP)
- Formetanate (C)
- Phosmet (OP)
- Thiophanate-methyl (C)
- Methyl-parathion (OP)
- Metiram (B2)
- Clorpyrifos (OP)
- Ziram (B2)
- Dimethoate (OP)
- Thiram (B2)
- Carbaryl (C)

- Captan (B2)
- Methomyl (C)

CHEMICAL OR NONCHEMICAL ALTERNATIVES AND NEW REGISTRATIONS:
Strobilurine fungicides are from a new class of chemicals that was registered for use in 1999. Two strobilurine fungicides are registered for use on apples. The are kresoxim-methyl (Sovron) and triflorystrobin (Flint). These fungicides have good to excellent activity on scab, powdery mildew and rusts. The also have good activity against summer diseases, sooty blotch and fly speck. Sovron has a 30-day PHI and Flint has a 14-day PHI. They will be used widely by Ohio apple growers in the future. They will be useful in preventing the development of fungicide resistance to the sterol-inhibiting fungicides (myclobutanil and fenarimol).

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References

1) *The 1997 Census of Agriculture.* U.S. Department of Commerce, Bureau of the Census. March 1999. Part 35.

2) *Commercial Tree Fruit Spray Guide, 1999.* Ohio State University Extension. The Ohio State University. Columbus, Ohio.

3) Ohio Fruit Report, State Statistics Report. USDA. NASS. January 28, 1999.

4) Crop Profile for Apples in West Virginia.

5) *Midwest Tree Fruit Pest Management Handbook*. 1998. Bessin, R.T., McManus, P.S., Brown, G.R., and Strang, J. G. (eds), University of Kentucky, Lextington, KY. pp 18-46.

6) Davidson, R.H. and Lyon, W.F. 1987. *Insect Pests of Farm , Garden and Orchard*. John Wiley and Sons, New York. pp. 413-447.

7) 1996 Fruit Survey, Pesticide Impact Assessment Program, The Ohio State University.

8) 1999 Apple Growers Focus Group Meeting, The Ohio Fruit Growers Association.

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