Crop Profile for Apples in Arkansas

Prepared: February, 2003

General Production Information

- **State Rank**: 32nd
- **Percentage of U.S. Production**: <1%
- **Total acres grown**: 900 acres
- **Cash Value**: $964,000

Production Regions: Apple production is predominantly located in northwest Arkansas (Benton, Carroll and Washington Counties). A historically important crop in Arkansas, the number of acres in production has remained relatively stagnant over the past ten years.

Production Methods: Sites for apple production in Arkansas generally have well drained soils and topography that favors air drainage to reduce the risk of spring frost damage. Higher density plantings are composed of freestanding trees using semi-dwarfing or dwarfing rootstock. Trellis systems are not used in Arkansas but when dwarfing rootstocks are used trees are staked. Drip irrigation is recommended and some growers have adopted the use of overhead sprinklers to provide evaporative cooling during the warmest portions of the growing season. Fertilization is based on monitoring of tissue nutrient content (leaf samples taken between July 15 and July 30) and soil testing. Row middles are planted to permanent sod that reduces erosion, provides support for mechanical traffic during wet conditions, and improves organic matter content of the soil. Sod used is primarily tall fescue, bluegrass, or orchardgrass. Tree row is maintained as a weed-free zone by use of herbicides. Planting occurs in the fall or early spring. The first crop is achieved in the third season with a full crop expected in 5 – 7 years depending on rootstock used and cultural practices. In general, dwarfing rootstocks will have a full crop sooner. Thinning is accomplished by a combination of use of chemical thinning agents and hand thinning. Pruning is accomplished in the dormant season with some summer pruning of interior shoots to improve the light environment within the canopy.

Commodity Destination(s):
Fresh Market 95%
Processing 5%

Plant Growth Regulators
Plant growth regulating chemicals are applied at a rate determined by tree row volume that varies with size of an average tree in the orchard. Plant growth regulators have some characteristics in common: small amounts of chemical achieve the desired effect; growth stage of the tree is critical to achieve desired effect; and weather conditions, plant or fruit maturity and plant vigor strongly influence effect. Combinations of materials may be used to achieve a specific effect. Because of the variability of chemical response, it is recommended that growers use chemicals on a trial basis until they become experienced.

Promalin: Applied at full bloom to improve shape and increase fruit weight of Delicious apples (1 to

2 pints per 100 gallons of water). Also applied used to increase lateral bud break and shoot growth on 1 year old non-bearing trees (1 to 2 pints per 10 gallons of water).

ProVide: Applied at petal fall to reduce russet (10 ounces per acre applied in 100 gallons of water). Also used to reduce fruit cracking (1 to 2 pints in 100 gallons of water) in early June

Chemical thinners: NAA, Carbaryl (Sevin), Ethephon. Used in combination or individually to either completely remove all fruit from trees or to non-selectively remove excess fruit.

Apogee (prohexidione calicum) reduces terminal growth by inhibiting synthesis of gibberellins. Used to reduce vegetative growth, and to reduce later season tree canopy volume and density (increased pesticide efficacy). Also used to control Fire Blight (*Erwinia amylovora*) in trees by inducing resistance through the growth retardation response. Rates of application between 3 and 12 oz. per 100 gallons of dilute spray (62.5 to 250 ppm).

Sucker and Water Sprout Control: Tre-Hold Sprout Inhibitor A-112 (*NAA, ethyl ester*) is used at concentrations of 10,000 ppm and directed to the base of trees or painted on pruning cuts to control unwanted growth in these areas

Drop Control: ReTain or Fruitone (*NAA*) to reduce preharvest fruit drop at or after the onset of fruit loosening or drop

Worker Activities
Virtually all apple trees are pruned by hand during the dormant season. Most apples trees are thinned with chemical applications, but approximately 75% of the apple acres have follow-up hand thinning in March and April after chemical thinning.

Preemergent herbicide applications are applied in early spring, primarily with tractor mounted spray equipment. Postemergence herbicide applications are made in early summer and occasionally after harvest primarily with tractor mounted sprayers although backpack sprayers are occasionally used (30% of apple acres). Row middles are mowed throughout the growing season.

Insecticides and fungicides are applied from early spring up to harvest primarily with orchard blast sprayers.

The entire apple crop is hand-harvested.

Insect Pests

Codling Moth, *Cydia pomonella* L.

The codling moth completes three to four generations per year in Arkansas and is considered to be an important insect pest of apple. Larvae of the codling moth tunnel into fruit and render it unmarketable as fresh fruit. There are five larval instars that feed in the fruit before pupating. Larvae overwinter in silken cocoons usually located under loose bark on the tree trunk or larger limbs. This insect develops above 50°F. Degree-days (DD) can be accumulated to aid in control of this pest. Eggs are laid and will hatch by 250, 1250, 2250 and 3250 DD. Critical periods for control vary depending on temperature at different locations in the state. Damaging populations can occur anytime from the 1st cover spray through harvest.

Cultural controls: Removal of abandoned orchards, which serve as a nursery and point of dispersal for codling moth to nearby orchards, is an important management practice. However, the fate of abandoned orchards is often beyond the control of the owners of nearby orchards. Also,

empty apple bins and walls of packing sheds are ideal overwintering sites for codling moth larvae. Thus, infestations often begin within 100-200 yards of bin storage. Hence, clean out pupae from empty bins before storing in packing sheds. Neither of these practices will eliminate the need for other management programs.

Chemical Control: At 250, 1250, 2250 DD on, apply insecticide sprays to prevent larval entry of fruit. After these sprays, make weekly perimeter inspections of 10 fruit from each of 10 trees for codling moth damage, looking for tunneling and reddish-brown frass. If more than 1% new damage is found, then apply insecticide 10 days after previous spray. Mating disruption is available for this pest using Isomate-C+ at the rate of 400 dispensers/acre. The following compounds are labeled for control of Codling moth: Asana, Avaunt, Confirm, Danitol, Diazinon, Esteem, Guthion, Imidan, Intrepid, Lannate, Sevin and SpinTor. The following mating disruption compounds are registered for control of Codling moth: Isomate C+, Checkmate, Concept, and CM Last Call.

European Red Mite, *Panonychus ulmi* Koch

The European red mite sucks juices from leaves, which causes the leaves to brown or bronze. This loss of chlorophyll can reduce fruit quality, fruit size and lessen fruit set the next season. Because the tree manufactures its food supply largely in the leaves, this feeding can reduce the vitality of the tree. The mite overwinters as eggs on the tree near leaf buds. Eggs hatch during the tight cluster stage. These mites feed only in the apple tree and may produce a new generation every 10 to 14 days.

Cultural controls: During the growing season mites can be transported from orchard to orchard by farm machinery and the clothing of workers. They can be blown in also by the wind. Predator mites (*Neoseiulus fallacis*) can occur in apple trees, but low populations can be augmented by releasing commercially available mites into the trees of this species or *Typhlodromes pyri* to achieve biological control. Removal of watersprouts in the center of trees will reduce populations also.

Chemical Control: Use a 10x-hand lens to monitor for mites in susceptible trees like Red Delicious. Examine 10 leaves each from 10 trees for mites. Treat if you find an average of 2.5 mites/leaf in June, 5 mites/leaf in July or 7.5 mites/leaf in August and less than one predator mite per leaf. The following compounds are labeled for European red mite control: Agri-Mek + oil, Apollo, Ambush, Asana, Danitol, Diazinon, Esteem, Kelthane, Oil, Oil +Lorsban, Pyramite, Savey, Vendex, and Vydate.

Two Spotted Spider Mite, *Tetranychus urticae* Koch

The two-spotted spider mite lives on broadleaf groundcover plants in the orchard floor. They are found worldwide and feed on a wide range of plants. When herbicides are applied to the ground cover or in drought conditions, these mites will move into the trees and compete with the European red mites. They suck the chlorophyll from the leaves and this loss of chlorophyll can reduce fruit size and quality when the mite population builds up. As a rule they have more webbing on the leaves and the leaf bronzing is grayer than that due to European red mite.

Cultural controls: Removal of groundcover under tree canopy in early spring will reduce mite buildup and movement into trees. Predator mites (*Neoseiulus fallacis*) can occur in apple trees, but low populations can be augmented by releasing commercially available mites into the trees of this species or *Typhlodromes pyri* to achieve biological control.

Chemical Control: Use a 10x hand lens to examine 10 leaves each from 10 trees for mites. Treat if you find an average of 2.5 mites/leaf in June, 5 mites/leaf in July or 7.5 mites/leaf in August and less than one predator mite per leaf. The following compounds are registered for control of Two

spotted spider mites: Agri-Mek + oil, Apollo, Ambush, Asana, Danitol, Diazinon, Esteem, Kelthane, Oil, Oil +Lorsban, Pyramite, Savey, Vendex, and Vydate.

Rosy Apple Aphid, *Dysaphis plantaginea* Passerini

Rosy apple aphid (RAA) is an important aphid pest of many cultivars of apple in Arkansas. It can cause leaf and fruit damage. RAA overwinters in the egg stage on apple twigs. Nymphs begin to emerge at the green tip stage. Egg hatch is complete by pink stage, when aphids begin to feed on the new leaves surrounding the fruit bud clusters. Feeding aphids inject a toxin into leaves. The toxin is transported to the fruit and causes fruit to be stunted and malformed. The leaves of the fruit clusters also become curled and twisted. Aphids reside on the leaf underside within the curled leaves. Several generations are completed on apple before aphids disperse in June to alternate hosts, such as plantain. Aphids return to apple in the fall where they lay overwintering eggs. Control of aphids after petal fall is very difficult because aphids at this time are protected within the curled leaves. Cool, wet springs favor this insect because these conditions are unfavorable to their natural enemies.

Cultural Control: Plantain is an alternate host of rosy apple aphid, and control of this orchard floor weed can help to reduce, but not control rosy apple aphid populations.

Chemical Control: Monitor from tight cluster stage through pre-bloom stage by examining 100 fruit clusters in the center of susceptible apple blocks for the first presence of rosy apple aphid. Treatment is recommended if an average of one colony or more per tree is found. Applications between ½-inch green to pink are recommended in susceptible blocks. This controls the aphid before leaf curling occurs. The following compounds are registered for control of Rosy apple aphid: Actara, Ambush, Asana, Danitol, Diazinon, Esteem, Guthion, Oil, Oil + Lorsban, Lorsban, Provado, Sevin, Supercide, and Thiodan (Phaser).

Apple Aphid, *Aphis pomi* De Geer

The apple aphid lives on the apple tree year round. This aphid is found on young trees, watersprouts and the vigorous growing tips. It will curl the leaves and cover leaves and fruit with honeydew. The black fungus that grows on the honeydew can cause discoloration of the fruit.

Cultural controls: Lack of pruning will promote apple aphid populations due to the denser foliage and multiple watersprouts that will result. The new emerged tips on the watersprouts provide a food source for aphids. Thus, removal of watersprouts in the center of trees will reduce aphid populations.

Chemical Control: Select 10 growing shoots on each of five trees in a block and look for aphids. Treatment is recommended if more than four of 50 leaves (8%) are infested with wingless aphids. If aphid predators are present, delay treatment. The following compounds are registered for control of Apple Aphid: Actara, Ambush, Diazinon, Esteem, Guthion, Provado, Pyramite and Thiodan.

Woolly Apple Aphid, *Eriosoma lanigerum* Hausmann

The adult Wooly apple aphid (WAA) is purplish and often found in colonies covered by a woolly mass of fibers. They cluster at wound sites on the trunk and branches of the tree. Susceptible trees on their own roots may also have aphids feed on roots causing root galls and eventually tree death. Colonies above ground cause little damage. Although, this aphid can transmit a disease called apple canker, *Pezicula malicorticis.* This pest is usually spread by infested nursery stock.

This aphid often appears in trees sprayed with formulations that kill aphid natural enemies, such as pyrethroids and carbamates.

Cultural controls: Malling Merton (MM) rootstocks are available that are resistant to

Root attack by WAA. Removal of watersprouts in the center of trees and painting wounds and burr knots will reduce aerial populations.

Chemical Control: Examine abrasions, cuts, and wounds for WAA from petal fall on. Treatment is recommended if several colonies/tree are found. The following compounds are registered for control of foliar WAA: Actara, Diazinon, Phaser, and Thiodan (Phaser).

Oriental Fruit Moth, *Grapholita molesta* Busck

The oriental fruit moth, *Grapholita molesta* (Busck) is an imported insect, introduced into North America from Japan about 1913. The insect attacks practically all orchard fruits but is of particular importance as a pest of peach. Moths are dark gray and about 1/4-inch long. They have a wingspread of about 1/2-inch. Larvae are pinkish-white, brown-headed caterpillars, about l/ 2 inch long when fully grown, with a black anal comb on the top of their last body segment. They have three pairs of true legs and fleshy prolegs on abdominal segments three, four, five and six. There are at least five generations per growing season in Arkansas. Larvae overwinter in crevices on the trees and in packing crates.

Damage is caused by the larval stage. In the spring, larvae burrow into succulent, rapidly growing terminals. The larva enters a tender twig at a leaf axial near the tip and feeds down the central core of the shoot for two to six inches, resulting in the death of the terminal. The dark, wilted terminals are said to be "flagged". A larva attacks only one terminal or fruit to complete its development. When terminals are killed, lateral shoots develop below the dead area and heavily infested trees may appear stunted and bushy. Larvae of later generations may feed on terminals or developing fruit. Fruit feeding increases as the season progresses and terminal twigs harden. Larvae attacking fruit frequently enter near the stem, leaving little or no external signs of entry. They also may enter where two fruit are in close contact or from the side of an individual fruit. Even superficial fruit feeding will provide entry sites for fungus. Once inside the fruit, larvae feed to the pit, in a fashion similar to the plum curculio. The presence of distinct legs on oriental fruit moth caterpillars distinguishes them from legless plum curculio larvae. Also, fruit moth larvae exit the fruit through holes in the side, from which dark frass may exude. Infested fruits break down and are usually unfit for consumption. Early and even some mid-season cultivars frequently escape fruit damage by this pest. After harvest is complete, fruit moth larvae may again develop in the terminals if acceptable succulent growth is available.

Monitoring: Timing management decisions for spraying or using mating disruption requires pheromone trap monitoring. At pink, set out three pheromone traps in each orchard. Check twice weekly for first catch of moths. On the day first moths are caught, begin accumulating daily degree-days (DD base 45º F). Add daily DD values together until it totals 400 DD. That date is when hatch begins and insecticide applications should be applied. Coverage is required from 400 to 700 DD (from April to May) to prevent infestation by this moth larva. The 2nd generation OFM hatches between 1300 to 1700 DD (June), 3rd generation occurs from 2300 -2700 DD (July) and overlaps with later generations until late September.

Cultural control: Good orchard sanitation is also important in reducing oriental fruit moth populations. Prompt removal and destruction of dropped and cull fruits from the orchard and packing shed destroys any larvae infesting these fruit. Also, all fruit should be removed at harvest.

Chemical Control: First-brood fruit moths are normally controlled by late-April to early-May applications of Imidan or Guthion for plum curculio control. Adequate suppression of the first brood (adults developing from overwintered larvae) may give control for the entire season if orchards are

not reinfested from untreated orchards nearby. The summer generations from late-May to mid-August can be controlled by placement in trees of 100 mating disruption dispensers per acre just before second flight begins in late-May. Spray fruit to protect against hatch whenever 5 or more moths are caught per pheromone trap since the last insecticide application. Ambush, Asana, Avaunt, Danitol, Guthion, Imidan, Intrepid, SpinTor and Sevin are registered for this pest. Isomate OFM, Isomate Rosso, 3M sprayable pheromone are used for mating disruption.

Plant bugs *Lygus* spp. and
Stink bugs *Acrosternum hilare* (Say), *Euschistus* spp

Some hemipterous insects known to attack apple include: *Lygus* spp. primarily, the tarnished plant bug, *L. lineolaris* (Palisot de Beauvois); the green stink bug, *Acrosternum hilare* (Say); *Euschistus* spp., primarily the brown stink bug, *E. servus* (Say). Sucking bug pests of apple vary greatly in color, size and shape. Nevertheless, they have certain characters in common. The front half of the forewing is leathery; the back half-membranous. Their mouthparts are the piercing-sucking type.

Tarnished plant bugs are small, oval, fragile-looking insects, green to dark-brown in color, flecked with white, yellow, reddish-brown and black markings and a yellow "V"-shaped marking on the triangular portion of its back. Nymphs are pale-yellow to green. Adults are about 1/5-1/4 inch (5-6mm) long. They pierce young fruit and feed in early season. This causes the fruit to dimple as it matures.

Stinkbugs are broadly shield-shaped, flattened, with a narrow head and rather short legs. The green stinkbug is bright green, sometimes with a visible yellowish-orange to reddish border. It is about 1/2-inch long. *Euschistus* spp. stinkbugs are light grayish-brown to brown, marked with dark brown to black speckles. The brown stinkbug, *E. servus,* has slightly pointed shoulders. They are about 3/8-1/2 inch long. Sucking bugs, as the name implies, feed by sucking sap from plants. Sucking bugs inject a toxic substance into the plant when feeding to break down plant tissues. Their feeding is very destructive to fruiting bodies and other tender plant parts. Earliest injury to apple is caused by the tarnished plant bug, which are active by pink. They feed on swelling fruit and leaf buds, causing the buds to dry up. Cells are destroyed and fruit development inhibited at the feeding site. When fruit buds are damaged, blossoms may never open, or may be deformed, while surrounding tissues continue to grow and expand causing scarring called "catfacing". As the apple increases in size, feeding by plant bugs or stinkbugs causes less scarring and distortion of the fruit. Fruit on the edges of orchards bordering woodlands, fence rows, or fields are usually the first and most severely damaged. Although plant bugs are an annual pest in most orchards, rarely do they damage >2% of fruit. The summer generation of stinkbugs moves into orchards from early June to harvest.

Monitoring: Begin checking weekly for tarnished plant bug by pink. Set out white sticky rectangles from the lowest scaffold limb of fruit trees along the orchard perimeter nearest woods or fence rows. At petal fall, along orchard perimeter set out yellow pyramid traps with capture screens baited with *Euschistus* spp. aggregation pheromone (rubber septum each charged with 50ul methyl 2E, 4Z-decadiendate). Growers can also jar stinkbugs from trees over a ground sheet.

Cultural control: Cultural practices can provide some suppression of sucking bugs. The destruction of broad-leaf winter annual weeds and legumes, in and around orchards is an excellent practice. Legumes such as clover and vetch should be avoided as cover crops. Destruction of early blooming broadleaf weeds before bloom will reduce the number of early catfacing insects moving into orchards. Good weed control improves the performances of catfacing sprays.

Chemical Control: Sprays during pink are sometimes applied where *Lygus* bugs are a major problem. Ambush, Asana, Danitol, Diazinon, Phaser, Thiodan, Avaunt, Guthion, Lannate, and Sevin are registered for plant bugs on apple.

Spotted Tentiform Leafminer, *Phyllonorycter blancardella* Fabricius

This insect infests apple foliage throughout the United States since 1914. Eggs are randomly laid singly on leaves. There are five instar stages before pupation. Adults are small moths with gold, black and white wing patterns. They tend to rest on the underside of leaves during the day and are active at night. The larvae mine the leaves on apple. Each larva can disrupt 4 percent of the leaf area. When population densities are high, defoliation can occur. Average mine density in excess of two per leaf can reduce fruit quality and quantity, decrease size, cause premature leaf and fruit drop, and reduce fruit set the following year.

Monitoring: Pheromone traps need to be in place by pre-bloom, one for every 3-5 acres. Treatment recommendations state, if more than 12 adults are caught by pink stage, apply a pesticide. A hand lens can be used to count eggs on the underside of leaves. Another monitoring method is counting the mines present on the leaves. At petal fall sample 10 terminal leaves from each of five trees counting the number of mines on leaves. Treat if more than two mines per leaf are found.

Cultural controls: A complex of predators and parasitoids exert biological control on spotted Tentiform leafminer, with three parasitoids being quite common in most orchards. Insecticide control of the third generation of spotted Tentiform leafminer is discouraged in order to allow parasitoid survival to reduce the overwintering leafminer population. In abandoned orchards, biological control is nearly 100 percent.

Chemical Control: When you average 1 to 3 larvae per leaf, or more than two mines per leaf you have reached the action threshold. The following compounds are registered for control of Spotted Tentiform Leafminer: Actara, Agri-Mek + oil, Danitol, Lannate, Phaser, Provado, Spin Tor, Thiodan, Vydate, Ambush, Asana, Esteem, Intrepid, Pyramite, and Sevin.

White Apple Leafhopper, *Typhlocyba pomaria* McAtee

The white apple leafhopper hatches before petal fall and begins sucking the chlorophyll from the leaves, resulting in white stippling on the leaf surface. There are five instars for the white apple leafhopper. The adult is a faint yellow with an orange to red tinge on the thorax and head. When feeding is heavy, the entire tree may appear whitish or silvery. Overwintering eggs hatch during the pink to petal fall stage of tree development. This foliage-feeding insect can be tolerated at low populations. Moderate to high populations can cause indirect damage to fruit in the form of black speckling (sooty mold) which grows on their honeydew deposits. An abundance of adult leafhoppers at harvest can also be a nuisance to pickers. This insect develops at temperatures above 45ºF. So first nymph emergence can be expected at 100 DD after 15 March.

Monitoring: Monitoring begins at petal fall by counting the number of white apple leafhopper nymphs on older fruit cluster leaves on each of 10 fruit clusters from 10 different trees.

Chemical Control: If there are more than 2-nymphs/leaf treatment is recommended. The following compounds are registered for control of White apple leafhopper: Actara, Agri-Mek + oil, Avaunt, Danitol, Imidan, Provado, Ambush, Asana, Guthion, Lannate, Phaser, Sevin, Thiodan and Vydate.

Plum Curculio, *Conotrachelus nenuphar* Herbst

The plum curculio, *Conotrachelus nenuphar* (Herbst) is a Native American insect found east of the Rocky Mountains in the United States and Canada. It is a major pest of apple. Adult plum curculio are small brownish-black snout beetles, about 1/4 inch long, mottled with lighter gray or brown markings. Their snouts are slightly curved and about 1/4 the length of the body. Their backs are

roughened and bear two prominent humps and two smaller humps. Larvae are slightly curved, yellowish-white, legless, brown-headed grubs, about 3/8 inch long when fully grown. Both the adult and larval stages of the plum curculio damage fruit. Feeding damage by adults may appear obscure in April, but as the fruit enlarges the old damaged site will enlarge and appear similar to catfacing caused by stinkbugs. These feeding and oviposition sites cause conspicuous scarring of the fruit and may provide entry for rot fungus. The larvae tunnel and feed in developing fruit, usually boring to the seed area.

The plum curculio overwinters as an adult in ground litter or other protected places in and around orchards and in nearby woods or fence rows. They become active when mean temperatures reach 50-60°F for several days (three to four) or when the maximum temperature reaches 70°F for two or more days. This is normally shortly before or about the time apples bloom. Adults' fly to the trees, feed on succulent buds, foliage, blooms or newly formed fruit, mate, and females begin laying eggs after petal fall. Most eggs are deposited just before, during or just after petal fall. The egg hatches in two to twelve days, the average is about five days. The larva feeds in the fruit for eight to twenty-two days. The full-grown larva tunnels out of the fruit, enters the soil and constructs a small earthen cell, usually one to three inches below the surface. It pupates in the cell and after 12 to 16 days in the soil, the whitish pupa ecloses to an adult. First generation adults begin emerging in early-June. The complete life cycle, from egg to emerged adult, may require five to eight weeks depending upon climatic conditions. In the Southeast, there are usually two generations and possibly a partial third generation each year. Second generation adults normally appear in mid-July to August. Adults feed on fruit until cool weather, when they seek overwintering sites.

Monitoring: At bloom for each orchard tie a gray pyramid trap to the trunk of each of four apple trees along the orchard perimeter adjacent to plum curculio overwintering sites (woodlots or fence rows). Once maximum daily temperatures reach 70ºF for two consecutive days in March, begin accumulating daily degree-days (DD). After accumulating 50 to 100 DD, growers often detect the first feeding damage on fruit and may see egg laying begin. Check pyramid traps twice weekly for plum curculio adults. Also inspect 100 fruit along the orchard perimeter for feeding damage**.** An insecticide application is recommended if the traps exceed 0.05 adults per trap per day or if new damage exceeds 1%. Jarring trees over a ground sheet or beating tray can also monitor adult emergence.

Cultural control: Destroy the nearby plum thickets, abandoned peach trees and other alternate host plants as a way to reduce the possibility of spring movement of adults into orchard. Collecting dropped fruit weekly and destroying these will lessen the number of plum curculio that exit fruit to pupate and later emerge as adults in the orchard.

Chemical Control: Control programs should be aimed at the overwintering adults to prevent the laying of first generation eggs. Movement of adults into the orchard continues from 50 to 500 DD after second day in March at or above 70ºF. Summer adults begin emerging from 1100 DD to early August. Sprays for curculio control are normally initiated around early April, with the initial application followed by two or possible three sprays at 10-day intervals. The third spray also controls oriental fruit moth. If the adults are not effectively controlled, additional applications may be necessary to prevent damage by first generation adults and second generation larvae from early June through harvest. In infested orchards, special attention should be given to mid- and late-season cultivars in sprays six, four, and two weeks before harvest. Guthion, Imidan, Phaser, Sevin, or Thiodan are recommended compounds for Plum curculio in apple.

San Jose Scale, *Quadraspidiotus perniciosus* Comstock

San Jose scale, *Quadraspidiotus pernicious* (Comstock), is a pest of apple. Adult females of the San Jose scale are yellow, circular, sac-like, legless insects. They secrete and live beneath a round, gray-brown, waxy scale covering made up of concentric rings surrounding a raised nipple near the

center, about 1/16-inch in diameter. Adult males are tiny, golden-brown, two-winged insects, about 1/25 inch long. They mature under elongate, oval scale coverings, about 1/24 inch long with the raised nipple located near one end. Crawlers are yellow, somewhat oval, about 1/100 inch long, and resemble tiny larval mites. Scale insects suck sap from foliage, twigs, branches and fruit. An initial sign of infestation may be a few red spots on the fruit. This is a cosmetic blemish on the peal only. On heavily infested trees, much of the bark surface of branches or the trunk may be covered with a gray coating of overlapping round scales. Some crawlers move to and settle on fruit causing red spots. If heavy infestations are not controlled, damaged limbs may crack and die. Scale infested terminal twigs normally die first. In severe cases, entire trees may die.

Adult males emerge, fly and mate with females in early to mid-April. Mated females produce live crawlers in mid-May at 450DD (base 51ºF) after male emergence. Crawlers are present two to three weeks from mid-May to late-May. The second crawler generation emerges in mid-July to August.

Monitoring: By 1 April, set out two San Jose scale pheromone traps in the tops of scale-infested trees. Check traps twice weekly and note date that males are captured. Accumulate degree-days (base 51º) after that date. In early May or at 350DD, wrap actively infested branches with double-sided sticky tape. Check traps twice weekly for crawlers and continue replacing tapes until crawlers no longer appear on tape.

Cultural control: In the winter prune out scale-infested branches. Then apply a delayed-dormant spray of 2% summer oil to suffocate adults in infested trees. Annual dormant pruning, especially of large trees, improves spray coverage and reduces the severity of this pest.

Biological control: There are at least 9 hymenopterous parasitoids of SJS that occur in North Carolina. Unfortunately, little is known about the impact of these natural enemies on populations in commercial orchards in Arkansas, other than the fact that they are highly susceptible to pyrethoid insecticides.

Chemical Control: There are pheromone traps available for monitoring emergence of males in early April. At 350 DD after male emergence, wrap double-sticky tape to infested limbs and check them twice weekly with a hand lens for the yellow crawlers. The action threshold is to apply insecticide every 10 days during the crawler emergence period in May (two to three weeks). The following chemicals are registered for San Jose Scale control: Asana, Diazinon, Imidan, Lorsban, Provado and Sevin.

Insecticides Labeled for Apples

Abamectin

Formulations: Agri-Mek 0.15EC

Target pests: Mites, White apple leafhopper, and Tentiform leafminer

Average rate of most common formulations: use with oil

-- Agri-Mek 0.15EC (2.5-5.0 fl oz/A)

Preharvest interval: 28 days

Restricted entry interval: 12 hours

Azinphos-methyl

Formulations: Guthion Solupak 50W, Azinphosmethyl 50W soluble

Target pests: Oriental Fruit Moth, Plum Curculio, Plant bugs, Scale, and Green June Beetle, Aphids, Leafhoppers, Plant bugs, Codling moth,

Average rate of most common formulation: Guthion 50WP

-- Guthion Solupak 50W (0.5-3 lb./A)

Preharvest interval: 21 days

Restricted entry interval: 14 days for thinning or 48 hours for walk through

Carbaryl

Formulations: Sevin 80S, Sevin 4F, Sevin XLR

Target pests: Oriental Fruit Moth, Plum Curculio, Plant bugs, Scale, and Green June beetle, White apple leafhopper, apple aphid, Codling moth, Bagworms, Rosy apple aphid, Tentiform leafminer, Wooly apple aphid, Japanese beetle

Average rate of most common formulations:

-- Sevin 80S (0.75-3.75 lb./A)

-- Sevin 4F (0.5-3.0 qt/A)

-- Sevin 4XLR (0.5-3.0 qt/A)

Preharvest interval: 3 days

Restricted entry interval: 12 hours

Chlorphrifos

Formulations: Lorsban 4EC, Lorsban 50W

Target pests: Rosy apple aphid, Scale, Mites, Plant bugs, cutworms

Average rate of most common formulation:

-- Lorsban 4EC (0.5-1 pt/200-600 gals water)

-- Lorsban 50W (3 lb./A)

Preharvest interval: 14 days or postharvest

Restricted entry interval: 24 hours

Clofentezine

Formulations: Apollo

Target pests: Mites

Average rate of most common formulations:

-- Apollo (4-8 oz/A)

Preharvest interval: 45 days

Restricted entry interval: 12 hours

Diazinon

Formulations: Diazinon 50WP, Diazinon AG600 WBC

Target pests: Scale, Mites, Leafhoppers, Coding moth, Rosy Apple aphid, Green Apple aphid, Woolly apple aphids, Plum curculio

Average rate of most common formulation:

-- Diazinon 50WP+ dormant oil (1 lb/100 gal)+ 2 gal oil for mite eggs and scale

-- Diazinon 50WP (1 lb. in 100 gal water) all other pests listed above

-- Diazinon AG600 WBC (12.75 fl oz in 100 gals water)

Preharvest interval: 21 days

Restricted entry interval: 24 hours

Dicofol

Formulations: Kelthane 50WSP or Kelthane 35

Target pests: Mites

Average rate of most common formulations:

-- Kelthane 50WSP (3-6 lb./A)

-- Kelthane 35 (4-8 lb./A)

Preharvest interval: 7 days

Restricted entry interval: 48 hours

Dormant oil

Formulations: Superior oil

Target pests: Scale and mites

Average rate of most common formulation:

-- Superior oil (1-3 gals/100 gal for scale) or (0.5 gal/100 gals plus Lorsban for scale)

Preharvest interval: postharvest, after leaf fall only

Restricted entry interval: 12 hours

Endosulfan

Formulations: Phaser 50WP, Phaser 3 EC, Thiodan 50 WP. Thiodan 3EC

Target pests: Apple aphid, Rosy apple aphid, Woolly apple aphid, fruitworms,

Tentiform leafminer, White apple leafhopper (1st gen.), Plant bugs

Average rate of most common formulations:

-- Phaser 3 EC (6pt/100gal)

-- Phaser 50WP (2 lb./A)

-- Thiodan 3EC (6 pts/100gal)

-- Thiodan 50 WP (2 lb./A)

Preharvest interval: 21 days

Restricted entry interval: 24 hours

Esfenvalerate

Formulations: Asana XL 0.66EC

Target pests: Codling moth, White apple leafhopper, Tentiform leafminer, Scale,

Oriental fruit moth, Plum curculio, Apple aphid, Rosy apple aphid, Plant bugs

Average rate of most common formulation:

-- Asana XL 0.66 EC (2-5.8 fl oz /100 gal)

Preharvest interval: 21 days

Restricted entry interval: 12 hours

Fenpropathrin

Formulations: Danitol 2.4 EC

Target pests: Japanese beetle, Rosy apple aphid, Spotted Tentiform leafminer,

Plant bugs, White apple leafhopper, Codling moth, Mites, Oriental fruit moth,

Plum curculio

Average rate of most common formulation:

-- Danitol 2.4 EC (10.3-21.33 fl oz /A)

Preharvest interval: 14 days

Restricted entry interval: 24 hours

Fenbutatin-oxide

Formulations: Vendex 50 WP, Vendex 4L

Target pests: Mites

Average rate of most common formulation:

-- Vendex 50 WP (1-1.5 lb./A)

-- Vendex 4L (4-8 fl oz/100 gal)

Preharvest interval: 14 days

Restricted entry interval: 48 hours

Hexythiazox

Formulations: Savey 50DF

Target pests: Mites

Average rate of most common formulation:

-- Savey 50DF (3-6 oz/A)

Preharvest Interval: 28 days

Restricted entry interval: 12 hours

Imidacloprid

Formulations: Provado 1.6 F

Target pests: Aphids (except for Wooly apple aphid), San Jose scale, Leafhoppers

Average rate of most common formulation:

-- Provado 1.6 F (4-8 fl oz/A)

Preharvest interval: 7 days

Restricted entry interval: 12 hours

Indoxacarb

Formulations: Avaunt

Target pests: Codling moth, Oriental fruit moth, White apple leafhopper, Plum

curculio, Plant bugs

Average rate of most common formulations:

-- Avaunt (5-6 oz/A)

Preharvest interval: 28 days

Restricted entry interval: 12 hours

Methidathion

Formulations: Supracide 2E

Target pests: Scale, Rosy apple aphid

Average rate of most common formulations: Do not apply after bloom

-- Supracide 2E (3-12 pt./A)

Preharvest interval: Dormant spray

Restricted entry interval: 48 hours

Methomyl

Formulations: Lannate LV, Lannate SP

Target pests: Rosy apple aphid, Plant Bugs, Codling moth, Cutworm, White apple leafhoppers, Tentiform leafminer

Average rate of most common formulation:

-- Lannate LV (1.5-3 pt./A)

-- Lannate SP (0.5-1 lb./A)

Preharvest interval: 14 days

Restricted entry interval: 72 hours

Methoxychlor * currently on the EPA suspended list April 2002

Formulations: Methoxychlor 50WP

Target pests: Codling moth, Plum curculio, Japanese beetle, Tent caterpillars

Average rate of most common formulations:

-- Methoxychlor 50WP (6lbs/A)

Preharvest interval: 7 day

Restricted entry interval: 12 hours

Registration of label is currently suspended as of April 2002

Methoxyfenozide

Formulations: Intrepid 2F

Target pests: Codling moth, Tentiform leafminer, and Oriental fruit moth

Average rate of most common formulations:

-- Intrepid 2F (12-16 fl oz/A)

Preharvest interval: 14 days

Restricted entry interval: 4 hours

Oxamyl

Formulations: Vydate L

Target pests: Rosy apple aphid, Apple aphid, Tentiform leafminer, Mites, White apple leafhopper

Average rate of most common formulations:

-- Vydate L (2-8 pt./A)

Preharvest interval: 14 days

Restricted entry interval: 48 hours

Permethrin

Formulations: Ambush 25 WP, Ambush 2 EC

Target pests: Apple aphid, Plum curculio, White apple leafhopper, Tentiform leafminer, Plant bugs

Average rate of most common formulations:

-- Ambush 2 EC (1.6-6.4 fl oz/100 gal

-- Ambush 25 WP (1.6-6.4 oz/100 gal)

Preharvest interval: Do not apply after petal fall

Restricted entry interval: 12 hours

Phosmet

Formulations: Imidan 70WP

Target pests: Oriental Fruit Moth, Plum Curculio, Scale, Codling moth, Fruitworms, Japanese beetle,

Average rate of most common formulation:

-- Imidan 70 WP (2.25-3 lb./A)

Preharvest interval: 14 days

Restricted entry interval: 24 hours

Pyridaben

Formulations: Pyramite 60WP

Target pests: Mites, Leafhoppers, Apple aphid, and White apple leafhopper

Average rate of most common formulation:

--Pyramite 60WP (4.4-13.2oz/A)

Preharvest interval: 25 days

Restricted entry interval: 12 hours

Pyriproxyfen

Formulations: Esteem 0.86 EC

Target pests: Codling moth, Scale, Tentiform leafminer, Rosy apple aphid, and Green apple aphid

Average rate of most common formulations:

-- Esteem 0.86 EC (10-16 fl oz/A)

Preharvest interval: 45 days

Restricted entry interval: 12 hours

Spinosad

Formulations: SpinTor 2SC

Target pests: Tentiform leafminer, Codling moth, Oriental fruit moth

Average rate of most common formulations:

-- SpinTor 2SC (4-10 fl oz/A)

Preharvest interval: 7 days

Restricted entry interval: 4 hours

Summer oil

Formulations: Saf-T-Side

Target pests: Scale

Average rate of most common formulation:

-- Saf-T-side (1-1 ½ gals/100 gal)

Preharvest interval: 14 days or postharvest

Restricted entry interval: 4 hours

Tebufenozide

Formulations: Confirm 2F

Target pests: Codling moth, fruitworms

Average rate of most common formulations:

-- Confirm 2F (20 fl oz/A)

Preharvest interval: 14 days

Restricted entry interval: 4 hours

Thiamethoxam

Formulations: Actara

Target pests: Apple aphid, Rosy apple aphid, Tentiform leafminer, Leafhoppers,

Plum curculio

Average rate of most common formulation:

-- Actara (2.0-5.5 oz/A)

Preharvest interval: 35 days

Restricted entry interval: 12 hours

Insecticides Used on Apples

Crop	Class	Insecticide	Trade Name	% Ac Trt. as reported by growers in 1991	% Ac. Trt. In 2002	Avg. # Applic.
Apple	Insecticide	Abamectin	Agri-Mek 0.15EC	Not reported	75	1

Apple	Insecticide	Azinphos-methyl	Guthion Solupak 50W, Azinphosmethyl 50W	75	70	3
Apple	Insecticide	Carbaryl	Sevin80S or 4F or XLR	28	35	2
Apple	Insecticide	Chlorpyrifos	Lorsban 4EC or 50W	31	30	2
Apple	Insecticide	Diazinon	Diazinon 50WP or AG600 WBC	Not reported	50	2
Apple	Insecticide	Dormant oil	Superior oil	29	65	1
Apple	Insecticide	Endosulfan	Phaser 50WP or 3EC, Thiodan 50WP or 3EC	Not reported	55	3
Apple	Insecticide	Esfenvalerate (Fenvalerate?)	Asana XL 0.66EC	0.7	90	1
Apple	Insecticide	Fenbutatin-oxide (Hexakis?)	Vendex 50WP or 4L	2.7	2	
Apple	Insecticide	Methomyl	Lannate LV or SP	Not reported	75	1
Apple	Insecticide	Permethrin	Ambush 25WP or 2EC	8.8	10	1
Apple	Insecticide	Phosmet	Imidan 70WP	39	70	2
Apple	Insecticide	Malathion	Malathion	10	10	1
Apple	Insecticide	Formetanate	Carzol	2.7	1	1
Apple	Insecticide	Oxythioquinox	Morestan	2.7	1	1
Apple	Insecticide	Methyl parathion	Penncap M	6.0	3	1

Diseases

Apple scab, *Venturia inaequalis* (Cooke) Wint.

Apple scab as been described as the most economically important disease of apples in North America. Several factors contribute to disease severity; sanitation, cultivar susceptibility, and the frequency and duration of infection periods. Losses result from pedicel and fruit infections, and indirectly from repeated tree defoliation. Apple scab can be observed on all parts of the apple but particularly the leaves and fruit. Apple scab infection takes place early in the season and dark olive colored spots will appear on the leaves. By late summer these infected leaves will turn yellow with black spots and fall from the tree. As infected fruit enlarge the lesions will become brown and corky. The fruit will develop unevenly and cracks will appear in the skin and flesh. Some apple varieties are resistant to this disease. The fungus will overwinter on leaves and fruit on the orchard floor and can overwinter as mycelium in twig lesions.

Cultural Control: When orchards are planted, the trees should be spaced far enough apart to facilitate air movement when the trees mature. This creates an environment that has dryer foliage. Pruning for open interiors will also allow dryer foliage and better spray penetration. Shredding of leaves after leaf fall with a flail mower will help reduce the inoculum, but will not provide adequate

control alone. Addition of nitrogen to the leaves in the fall will accelerate the rate of leaf decomposition thus reducing inoculum.

Control: Use of weather forecasting to modify and anticipate fungicide applications is a necessary control tool. The following fungicides are registered for apple scab control on apple: Captan, Ferbam Granuflo, Flint, Mancozeb, Nova, Polyram, Procure, Rubigan, Sovran, Syllit, Topsin M, Vangard and Ziram.

Powdery mildew, *Podosphaera leucotricha* (Ell. & Ev.) E.S. Salmon

Powdery mildew occurs wherever apples are grown. It is a problem on the most susceptible cultivars (e.g., Ginger Gold, Jonagold, Rome, etc.). It appears on the tree, leaves and blossoms as a white powder. Economic loss from mildew will vary with climate, cultivar susceptibility and the management practices used. Severely infected terminals are stunted and covered with a mat of mycelium. Infected terminals and lateral buds are more susceptible to winter injury than healthy buds. Infected flower buds will open 5-8 days later than normal buds. When apples are infected during bloom, their growth is stunted and the surface can be covered with russet. This disease will overwinter as mycelium in dormant buds infected during the previous growing season. Nursery trees are particularly vulnerable.

Cultural Control: Plant cultivars that are less susceptible to powdery mildew. Fewer fungicide applications are necessary on less susceptible cultivars. Prune out silver colored terminals during dormant pruning.

Control: Application of recommended fungicide should be made at tight-cluster stage until petal-fall. Disease assessment and forecasting systems along with ergosterol biosynthesis inhibitors should minimize loss. The following fungicides are recommended for powdery mildew control on apple: Bayleton, Flint, Mancozeb, Nova, Polyram, Procure, Rubigan, Topsin M, Vangard, and Ziram.

Fire blight, *Erwinia amylovora* (Burrill) Winslow et al.

Fire blight is a very destructive disease that can reduce yield (through blossom infections), cause loss of scaffold limbs, and even cause death of the tree. Initial infection occurs in blossoms during warm (>64ºF) wet periods. Secondary spread can occur through sucking insects and injuries (i.e. hail). Branch tips appear blighted and will turn brown then black, will droop and hang on the branches. The leaves look scorched as by a fire. Cankers will form and are separated from adjacent healthy bark by a crack. The infected bark may shred. Control is achieved primarily by use of copper bactericides/fungicides applied during the dormant season and with streptomycin, applied during bloom.

Cultural Control: Pruning to remove overwintering cankers will help to reduce the overwintering inoculum. Plant cultivars that resist this disease.

Control: Copper fungicides/bactericides are used once just prior to bud break on susceptible cultivars to reduce the overwintering inoculum and streptomycin is applied during bloom. The following compounds are registered for fire blight control on apple: Agri-mycin, Aliette, Bordeaux mixture, Copper hydroxide, Copper oxychloride sulfate, Kocide, and Streptomycin.

Black rot, *Botryosphaeria obtusa* (Schwein.) Shoemaker and **White (Bot) rot,** *B. dothidea* (Schwein.) Shoemaker

Both *Botryosphaeria obtusa* and *Botryosphaeria dothidea* cause fruit rot. Specifically, *B. obtusa*

causes a firm brown rot, primarily at the calyx end. Whereas, B*. dothidea* causes a soft watery rot and has a leaf spot phase, called frogeye leafspot; black rot and frogeye leafspot tend to be more severe early in the season, although both *B. obtusa* and *B. dothidea* can cause fruit infections throughout the growing season. Infections arise from spores rainfall dispersed from dead wood, mummied apples, etc. in the tree. There is a canker phase of both diseases, although Bot canker tends to be more important. Cultivars do not vary greatly in their susceptibility to the two diseases.

Cultural Control: Pruning to remove cankers and dead wood and removal of mummied fruit is an essential aid in control of these two diseases.

Control: The following compounds are registered for control of Black and White rot on apple: Bayleton, Captan (don't use within two weeks of oil applications), Ferbam Granuflo, Flint, Sovram, and Topsin M.

Bitter rot, *Colletotrichum acutatum* J.H. Simmons,
C. gloeosporioides (Penz.) Penz. & Sacc. in Penz.,
G. cingulata (Stoneman) Spauld. & H. Schrenk

Bitter rot is a very difficult apple disease to stop once infections appear in the orchard because of secondary spread by the copious conidia that are produced on infected fruit. Infections can occur on the fruit throughout the growing season during warm rainy periods and arise from spores produced in dead wood, cankers, mummied apples, etc. in the tree. Control of the disease has been more difficult since restrictions were placed on the use of EBDC fungicides. There is little difference in cultivar susceptibility.

Cultural Control: Removal of dead wood, mummied apples, etc., is essential to aid in control of bitter rot.

Control: The following compounds are registered for control of Bitter rot on apple: Captan, Ferbam Granuflo, Flint, and Ziram.

Sooty blotch disease complex caused by
Peltaster fructicola Johnson, Sutton & Hodges
Leptodontidum elaitus (G. Mangenot) De Hoog

Sooty blotch will cause brown or olive green spots on the leaves. These spots will appear smudgy and will also show up on the fruit. It overwinters on the tree twigs, branches and mummies. When spring rains and mild temperatures arrive this fungus will produce spores. Rain is important in spreading the pathogens, but dew is equally important in symptom development. The diseases have been more difficult to control since restrictions have been placed on the use of EBDC fungicides. Spore production stops once temperatures reach the mid-eighties. Infection occurs from mid-May until harvest. This disease is external on the fruit peel and does not alter the taste or make the apple inedible. It looks unsightly and can result in fruit being downgraded from fresh market to processing or juice grades.

Cultural Control: Cultural practices such as an open tree structure, pruning during the dormant as well as summer season, and fruit thinning are important to reduce the drying time within the canopy and improve fungicide penetration into the canopy. Removal of reservoir hosts, especially wild blackberries, aids in reducing the inoculum.

Control: The following compounds are registered for control of Sooty blotch on apple: Captan, Ferbam Granuflo, Flint, Sovran, Topsin M and Ziram.

Flyspeck, *Zygophiala jamaicensis* E. Mason

This fungus will appear on the fruit as a cluster of ten to thirty black shiny raised spots. It overwinters on the tree twigs, branches and mummies. Spring rains and mild temperatures activate spore production. Infection occurs from mid-May until harvest. This disease is external on the fruit peel and does not alter the taste or make the apple inedible. These spots can be rubbed or polished off the fruit. It looks unsightly and can result in fruit being downgraded from fresh market to processing or juice grades.

Cultural Control: Cultural practices such as proper tree structure, pruning during the dormant as well as summer season, and fruit thinning are important to reduce the drying time within the canopy and improve fungicide penetration into the canopy. Removal of reservoir hosts, especially wild blackberries, aids in reducing the inoculum.

Control: The following compounds are registered for control of Flyspeck on apple: Captan, Ferbam Granuflo, Flint, Sovran, Topsin M and Ziram.

Alternaria blotch, *Alternaria mali* Roberts

Alternaria blotch is a foliar disease of apple, fruit infections are rare. The disease primarily affects the leaves, causing a small, round, blackish leaf spot, somewhat sunken and bordered by cracks. First infections are usually noticed in early June and the disease increases in severity during warm, wet periods throughout the summer. The mycelium overwinters in dead leaves on the ground, in mechanical injuries to twigs, and in dormant buds.

Cultural Control: Recommended sanitation procedures are to destroy diseased shoots by pruning and to plow fallen leaves into the soil.

Control: Sovran is the only compound recommended for control of Alternaria blotch on apple.

Brooks fruit spot, *Mycosphaerella pomi* (Pass.) Lindau

This is a minor disease of apple in Arkansas. This disease is characterized by small, slightly sunken, green spots primarily located at the calyx end of the fruit. Infection is by ascospores produced in leaves during the period from first through third cover and discharged during rainy periods. Cultivars vary in their susceptibility with Delicious being relatively resistant, whereas Golden Delicious, Rome, Stayman and Gala are susceptible. Brooks fruit spot appears earlier in the season than the physiological disorders that can be confused with this disease and causes little browning of the flesh underneath the lesion.

Following leaf fall, this fungus colonizes leaves and overwinters in dead leaves on the ground.

Cultural Control: None

Control: Brooks fruit spot is usually controlled with fungicide sprays during the early cover spray period. The following compounds are registered for control of Brooks fruit spot on apple; Captan, Ferbam Granuflo, Sovran and Topsin M.

Blister spot, *Pseudomonas syringae* pv. *papulans*

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.

Control: Aliette and Bayleton are registered for control of Blister spot on apple.

Phytophthora crown, collar and root rot, *Phytophthora* spp

Phytophthora crown rot primarily affects trees propagated on size-controlling rootstocks and trees planted in heavy, poorly drained soils. The disease is characterized by brick red, necrotic lesions on the roots, collar and crown tissues that eventually girdle the tree and cause its death. Tree death is usually greatest during the third to fifth growing seasons. The disease does not cause significant losses in most orchards, but some growers have lost 5-10% of their trees by the fifth growing season.

Cultural Control: Planting on beds (berms) on well-drained sites will reduce the likelihood of infection. The most susceptible rootstocks should be avoided, especially in sites not well drained. Site selection and soil water management are the most important factors in preventing this disease.

Control: An integrated approach employing cultural practices, host resistance and chemical treatments is recommended. Fungicide protection should be applied as a preventative measure since irreversible damage can occur before symptoms are noticeable. Apply Ridomil or Aliette when conditions exist for disease development and yearly applications are recommended on apple cultivars propagated on susceptible rootstocks planted in heavy or poorly drained soils.

Cedar apple rust, *Gymnosporangium juniperi-virginianae* Schwein.

Cedar apple rust is prevalent wherever eastern red cedar (alternate host) occurs. Cedar apple rust will cause brown to rusty-orange spots on the leaves and fruit. With susceptible cultivars there is the possibility of serious crop loss and grade reduction. This disease first appears as small, yellow-orange lesions on the upper leaf surface, on petioles, and young fruit. Cedar apple rust galls swell on cedar trees during spring rains and become reddish-orange jelly like and release spores. Apple leaves 4-8 days old are the most susceptible to infection. Fruit is susceptible from the tight-cluster until just after petal-fall.

Cultural Control: Plant cultivars that are resistant to cedar apple rust. Removal of eastern red cedar trees within ¼ mile of orchard can reduce the inoculum but not eliminate it. The spores can be carried long distances on air currents.

Control: Fungicide application is recommended during the infection period. The following fungicides are registered for control of cedar apple rust on apple; Bayleton, Ferbam Granuflo, Flint, Mancozeb, Nova, Polyram, Procure, Rubigan, Sovran, Vangard, and Ziram.

Fungicides Labeled for Apples

Captan

Formulations: Captan 50 W

Target pests: Scab, Black rot, Brooks fruit spot, Fly speck, Bitter rot

Average rate of most common formulations: Captan should not be used with lime or other alkaline materials. Do not use it with oil or within four days of an oil spray.

--Captan 50W (4-6 lb./A)

Preharvest interval: 0 days

Restricted entry interval: 96 hours

Copper Hydroxide

Formulations: Blue Shield 50WP, Kocide 101, Kocide DF, Kocide 4.5LF, Kocide 2000

Target pests: Fire blight, Phytophthora rot

Average rate of most common formulation:

-- Blue Shield 50WP (4-6 lb./A)

-- Kocide 101 (4-16 lb./A), before green tip

-- Kocide DF (4-16 lb./A)

-- Kocide 4.5 KF (2.66-10.66 pt./A)

-- Kocide 2000 (3-12 lb./A)

Preharvest interval: 21 days

Restricted entry interval: 24 hours

Cyprodinil

Formulations: Vangard WG

Target disease: Scab, Cedar apple rust, and Powdery mildew

Average rate of application:

-- Vangard WG (5oz/A)

Preharvest interval: 72 days

Restricted entry interval: 12 hours

Dodine

Formulations: Syllit 65WP

Target diseases: Apple scab

Average rate of applications:

-- Syllit 65WP (1-2 oz/A)

Preharvest interval: 7 days

Restricted entry interval: 48 hours

EBDC

Formulations: Mancozeb 80WP, Polyram 80 DF

Target disease: Scab, Cedar apple rust, Black rot, Bitter rot, Flyspeck and Sooty blotch

Average rate of application:

-- Mancozeb 80WP (3 lb.)

Preharvest interval: 77 days

Restricted entry interval: 24 hours

Fenarimol

Formulations: Rubigan EC

Target disease: Scab, Powdery mildew and Cedar apple rust

Average rate of application:

-- Rubigan EC (8-12 fl oz/A)

Preharvest interval: 30 days

Restricted entry interval: 12 hours

Ferbam

Formulations: Ferbam Granuflo

Target pests: Scab, Cedar apple rust, Sooty blotch, Flyspeck, Brooks fruit spot, Black rot, Bitter rot

Average rate of most common formulations:

--Ferbam Granuflo (3-8 lb./A)

Preharvest interval: 7 days

Restricted entry interval: 24 hours.

Fosetyl AL

Formulations: Aliette WDG

Target pests: Phytophthora root rot, Fire blight, and Blister spot

Average rate of most common formulation:

--Aliette WDG (2.5-5 lb./A) after budbreak, four sprays per season

Preharvest interval: 14 days

Restricted entry interval: 12 hours

Kresoxin-methyl

Formulations: Sovran 50WG

Target disease: Powdery mildew, Black rot, Scab, Alternaria blotch, Brooks fruit spot,

Flyspeck, Sooty blotch, White rot, and Cedar apple rust

Average rate of most common formulation:

-- Sovran 50WG (6.4 oz/A)

Preharvest interval: 30 days

Restricted entry interval: 12 hours

Metalaxyl

Formulations: Ridomil Gold EC

Target pests: Phytophthora root rot

Average rate of most common formulation:

-- Ridomil Gold EC (½ pt/100 gal) for drench, consult label for trunk diameter chart

Preharvest interval: 45 days

Restricted entry interval: 48 hours

Myclobutanil

Formulations: Nova 40WP

Target diseases: Powdery mildew, Cedar apple rust, and Apple scab

Average rate of applications:

-- Nova 40WP (1.25-2 oz/A)

Preharvest interval: 14 days

Restricted entry interval: 24 hours

Streptomycin

Formulations: Streptomycin

Target diseases: Fire blight

Average rate of applications:

--Streptomycin 17W (60 to 100 ppm)

Preharvest interval: 50 days

Restricted entry interval:

Thiophanate

Formulations: Topsin-M WSB

Target pests: Scab, Flyspeck, Powdery mildew, White rot, Sooty blotch, Black rot,

Brooks fruit spot

Average rate of most common formulations: limited site fungicide

--Topsin-M WSB (1-1.5 lb./A)

Preharvest interval: 0 day

Restricted entry interval: 12 hours

Triadimefon

Formulations: Bayleton 50DF

Target diseases: Powdery mildew and Cedar apple rust

Average rate of applications:

-- Bayleton 50DF (1.25-2 oz/A)

Preharvest interval: 45 days

Restricted entry interval: 12 hours

Trifloxystrobin

Formulations: Flint 50WG

Target diseases: Apple scab, Cedar apple rust, Powdery mildew, Sooty Blotch,

Flyspeck, Bitter rot, and White rot

Average rate of applications:

-- Flint 50WG (2-2.5 oz/A)

Preharvest interval: 14 days

Restricted entry interval: 12 hours

Triflumizole

Formulations: Procure 50WS

Target diseases: Cedar apple rust, Apple Scab and Powdery mildew

Average rate of applications:

-- Procure 50WS (1.25-2 oz/A)

Preharvest interval: 14 days

Restricted entry interval: 12 hours

Ziram

Formulations: Ziram 76DF

Target pests: Scab, Cedar apple rust, Sooty blotch, Flyspeck, Bitter rot

Average rate of most common formulations:

--Ziram 76 DF (6-8 lb./A)

Preharvest interval: 14 days

Restricted entry interval: 48 hours

Fungicides Used on Apples

Crop	Class	Fungicide	Trade Name	% Ac Trt. as reported by growers in 1991	% Ac. Trt. In 2002	Avg. # Applic.
Apple	Fungicide	Captan	Captan 50W	97	90	2
Apple	Fungicide	EBDC	Mancozeb 80WP, Polyram 80DF	Not reported	60	1
Apple	Fungicide	Myclobutanil	Nova 40WP	85	80	1
Apple	Fungicide	Streptomycin	Streptomycin	20	30	1
Apple	Fungicide	Benomyl	Benlate	22	60	1
Apple	Fungicide	Sulfur	Sulfur	10	20	1
Apple	Fungicide	Copper sulfate	Bluestone	7.8	75	1

Weeds

Most orchards are managed by use of a noncompetitive grass strip between rows and a 6 to 8 ft. wide vegetation-free strip down tree rows which is maintained by use of herbicides. The vegetation-free strip reduces the effect of weeds on crop growth and minimizes the effect of voles during the dormant season. Several herbicides are available to apple growers. Preemergence herbicides control germinating weeds but do not give good control of emerged weeds. Postemergence herbicides give good control to weeds that have already emerged and are best used when the weeds are actively growing. Effective timing is critical in the efficacy of herbicide use. Early application of herbicides to control weed growth during the first 6 – 8 weeks of crop growth will keep the vegetation-free strip relatively weed free until harvest. There are two common herbicide application timing routines. A Fall/Spring split application in which a preemergence herbicide is used in the fall after harvest that will give good control until the early summer. The spring another application of a preemergence herbicide is used to continue weed growth suppression until the fall. The alternative routine is a delayed preemergence application where a broad spectrum postemergence herbicide is used in March to eliminate winter annual weeds. Once summer annual weeds are present and at least 2 to 3 inches in height an application of a postemergence herbicide is made along with a preemergence herbicide. Follow-up is required with a postemergence herbicide to control escaped weeds like bermudagrass, johnsongrass, etc.

Herbicides Labeled for Apples

Preemergence control

Dichlobenil

Formulations: Casoran 4G or Norosac 4G

Target weeds: grasses and broadleaf weeds

Application: Single application of 150 lb./ acre soil surface applied in late winter to weed free soil.

Restricted entry interval: 12 hours

Comments: Apply only to plants 4 weeks after transplanting or 3 months before or after grafting.

Diuron

Formulations: Karmex 80WDG

Target weeds: grasses and broadleaf weeds

Application: One application per year: 2-4 lb. in 25-40 or more gallons of water/acre applied in spring before weeds emerge.

Restricted entry interval: 12 hours

Comments: Apply only to trees established 1 year or more. Do not treat varieties grafted to full dwarf rootstocks. Do no use on soils with less than 1% organic matter. Do not apply more than 4 lb. per acre per year.

Napropamide

Formulations: Devrinol 50 DF

Target weeds: grasses and broadleaf weeds

Application: Single application of 8 lb. in at least 20 gallons of water/acre. Apply in late fall to spring on weed free soil.

Restricted entry interval: 12 hours

Comments: Do not apply within 35 days of harvest.

Norflurazon

Formulations: Solicam 80 DF

Target weeds: grasses and broadleaf weeds

Application: Single application of 2.5 lb. (sandy or light-colored soil) to 5 lb. (heavy or dark-colored soil) in at least 20 gallons of water/acre. Apply to clean soil surface from fall to early spring when crop is dormant.

Restricted entry interval: 12 hours

Comments: Requires rainfall or irrigation within 4 weeks of application for product activation. Application may result in temporary bleaching or chlorosis of leaves from which the plant will recover.

Oryzalin

Formulations: Surflan 4 AS or Oryzalin 4 AS

Target weeds: grasses and broadleaf weeds

Application: Single application of 2.0 to 4.0 qt. in 20 to 40 gallons of water/acre applied to soil. Apply in the fall or early spring before weeds emerge or fruit set.

Restricted entry interval: 12 hours

Comments: Do not apply to newly planted trees until soil has settled and no cracks are present. Requires rainfall or irrigation of 0.5 to 1.0 inches to activate product.

Oxyfluorfen

Formulations: Goal 2XL

Target weeds: grasses and broadleaf weeds

Application: Single application of 2.0 to 8.0 pt. in a minimum of 40 gallons of water/acre. Apply only to dormant bearing and non-bearing trees.

Restricted entry interval: 24 hours

Comments: Do not spray foliage. Do not apply if leaves or fruit are present or if buds have begun

to swell or until after final harvest. Rainfall is needed within 3 to 4 weeks to activate product.

Pendimethalin

Formulations: Prowl 3.3EC

Target weeds: grasses and broadleaf weeds

Application: Single application of 2.4 to 4.8 qt. in a minimum of 20 gallons of water/acre applied to soil. Apply to weed free soil.

Restricted entry interval: 12 hours

Comments: Apply only to dormant, nonbearing trees. Do not apply if buds have begun to swell. If no rainfall occurs within 21 days of application, irrigate to incorporate.

Pronamide

Formulations: Kerb 50WP

Target weeds: grasses and broadleaf weeds

Application: Single application of 2.0 to 8.0 lb. in 20 to 40 gallons of water/acre. Applied during the cool, wet season (soil temp. <55° F but before soil freezes). Application rate is dependent on soil texture, lower rates on coarser textured soils.

Restricted entry interval: 12 hours

Comments: Do not apply to fall planted trees established less than one year or spring planted trees established less than 6 months old. Restricted use pesticide.

Simazine

Formulations: Princep 4L, Princep 90WDG

Target weeds: annual broadleaf weeds

Application: Single application of 2 to 5 lbs./treated acre(90WDG); 2 to 4 qt./treated acre(4L). Apply in the fall or early spring before weeds emerge or fruit set.

Restricted entry interval: 12 hours

Comments: Do not apply to sandy, loamy sand, gravelly soils, or exposed subsoils. Use only on trees that are at least 1 year old.

Terbacil

Formulations: Sinbar 80WP

Target weeds: grasses and broadleaf weeds

Application: Single application of 2.0 to 4.0 lb. per acre in a minimum of 20 gallons of water. Apply in fall or early spring before weed growth begins or fruit set occurs.

Restricted entry interval: 12 hours

Comments: Apply only to trees established 3 years or more. Do not apply within 60 days of harvest. Do not use on soils of less than 1% organic matter or where roots are exposed.

Postemergence control

2,4-D Amine

Formulations: Orchard Master, Formula 40, others

Target weeds: broadleaf weeds

Application: Apply as multiple applications (1-2) in established plantings as a directed spray to actively growing weeds. Apply 2-3 pt. per acre.

Restricted entry interval: 12 hours

Comments: Do not use on newly planted trees. Do not contact foliage, limbs or stems. Research indicates best results are achieved in winter, before bud break. Do not apply within 2 weeks before or after bloom, apple blossoms are very sensitive to 2,4-D.

Bentazon

Formulations: Basagran liquid

Target weeds: some broadleaf weeds and yellow nutsedge

Application: Apply as multiple applications (1-2) in established plantings as a directed spray to actively growing weeds. Apply 1.5 to 2 pt../ acre plus crop oil concentrate.

Restricted entry interval: 12 hours

Comments: May require sequential applications for perennial grass control. Grasses need to be actively growing. For use in non-bearing orchards that will not be harvested within one year of treatment.

Clethodim

Formulations: Select 2EC

Target weeds: grasses

Application: Single application of 6 to 16 fl. oz./ acre soil plus crop oil concentrate containing at least 15% emulsifier at 1% v/v

Restricted entry interval: 12 hours

Comments: For use in non-bearing orchards only. May be applied as a spot treatment. Grasses need to be actively growing.

Fluaziflop

Formulations: Fusilade DX 2EC

Target weeds: grasses

Application: Apply as multiple applications (2-4) in established plantings as a directed spray to actively growing weeds. Apply 12 to 24 oz. with crop oil concentrate at 1 qt. in a minimum of 25 gallons of water/acre.

Restricted entry interval: 12 hours

Comments: For use in non-bearing orchards that will not be harvested within one year of treatment. Low spray volumes (10gpa) generally improve control.

Glufosinate

Formulations: Rely 1L

Target weeds: grasses and broadleaf weeds

Application: Apply as multiple applications (2-4) in established plantings as a directed spray to actively growing weeds. Apply 3.0 to 6.0 qt. in a minimum of 20 gallons of water/acre.

Restricted entry interval: 12 hours

Comments: Do not apply to orchards established less than 1 year. Do not allow spray to contact desirable vegetation, including green shoots or foliage, as severe damage will result. Do not apply within 14 days of harvest.

Glyphosate

Formulations: Roundup Ultra

Target weeds: grasses and broadleaf weeds

Application: Apply as a single preplant broadcast application to control perennial weeds prior to establishment or as multiple applications (2-4) in established plantings as a directed spray or wiper application (20% solution in water) to actively growing weeds. Apply 0.5 to 2 qt. in 10-40 gallons of water/acre depending on weed species.

Restricted entry interval: 12 hours

Comments: Do not allow spray to contact desirable vegetation, including green shoots or foliage, as severe damage will result. Do not apply within 14 days of harvest.

Paraquat

Formulations: Gramoxone Extra, BOA

Target weeds: grasses and broadleaf weeds

Application: Multiple applications (2-4) of 2.0 to 3.0 pt. in 30 to 100 gallons of water/acre. Apply as a directed spray to weeds.

Restricted entry interval: 12 hours

Comments: Do not allow spray to contact desirable vegetation, including green shoots or foliage, as severe damage will result. Use low pressure during application to produce a coarse spray. Add non-ionic surfactant at 1-2 pt. or crop oil at 1 gallon per 100 gallons of water for best results. Restricted use pesticide.

Sethoxydim

Formulations: Poast EC

Target weeds: grasses

Application: Multiple applications (2-3) of 1.5 to 2.5 pt. plus 2 pt. of a crop oil concentrate in 10-20 gallons of water/acre. Apply as a directed spray when grass is actively growing.

Restricted entry interval: 12 hours

Comments: Low spray volumes generally improve control. Do not apply within 14 days of harvest.

Sulfosate

Formulations: Touchdown 5

Target weeds: grasses and broadleaf weeds

Application: Apply as a single preplant broadcast application to control perennial weeds prior to establishment or as multiple applications (2-4) in established plantings as a directed spray or wiper application (20% solution in water) to actively growing weeds. Use an approved surfactant or wetting agent containing at least 75% active ingredient at 2 qt. per 100 gallons of water to improve coverage of weed foliage. Up to 6.4 pt. in 10-30 gallons of water/acre/year depending on weed species.

Restricted entry interval: 12 hours

Comments: Do not allow spray to contact desirable vegetation, including green shoots or foliage, as severe damage will result. Do not apply within 14 days of harvest.

Herbicides Used on Apples

Crop	Class	Herbicide	Trade Name(s)	% Ac Trt. as reported by growers in 1991	% Ac. Trt. in 2002	Avg. # Applic.
Apple	Herbicide	2,4-D	Many	Not reported	50	1
Apple	Herbicide	Glyphosate	Roundup Ultra	7	50	1
Apple	Herbicide	Oryzalin	Surflan 4AS, Oryzalin	39	46	1

			4AS			
Apple	Herbicide	Paraquat	Gramoxone Extra, BOA	15	58	1
Apple	Herbicide	Sethoxydim	Poast EC	1	1	1
Apple	Herbicide	Simazine	Princep 4L, Princep 90WDG	24	75	1

Vertebrate

Voles are compact rodents that can have deleterious effects on orchards by feeding on roots and girdling trunks. This damage occurs both above the ground and below. Control measures should be applied year round.

Zinc phosphide

Formulations: Prozap Zinc Phosphide Oat Bait

Target pests: prairie voles and pine voles

Application: Broadcast – apply at a rate of 10 pounds per acre using mechanical spreaders.

Restricted entry interval: 12 hours

Comments: Zinc phosphide is an acute dosage rodenticide. It presents a serious nontarget risk, including the applicator (highly toxic to birds and mammals). Restricted used pesticide.

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