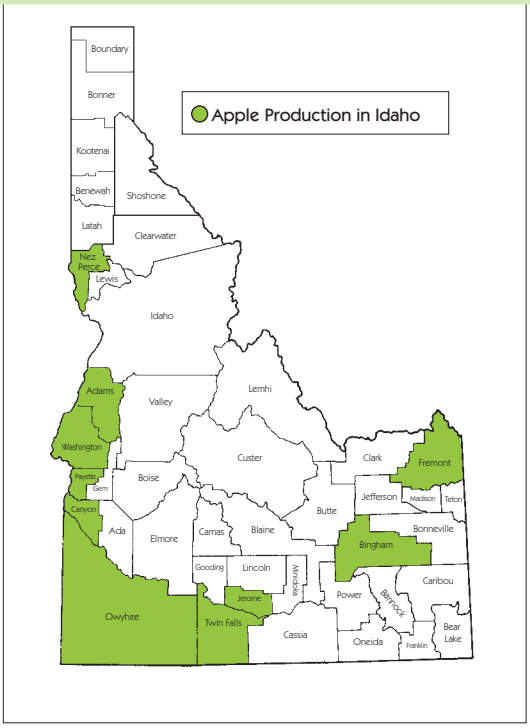
IDAHO CROP PROFILES

Apples

Production Facts

- Apples are the leading commercial fruit crop, representing 62% of the total fruit acreage.
- There are 149 apple growing operations, mostly located in southwestern Idaho, managing 5,705 acres of apples.
- Yield per acre in a given orchard varies from year to year due to weather constraints such as frost, hail, heat and poor fruit set conditions. From 1992 to 1998, Idaho apple production ranged from 75,000,000 to 193,800,000 pounds annually.
- The average annual value of apples produced in the state during 1996 to 1998 was $17,000,000 and ranged between $25,860,000 in 1996 and $9,920,000 in 1998. The price per pound received by growers between 1991 and 1998 ranged from 7.6 to 19.3 cents per pound.



Production Regions

The major region where apples are grown in Idaho is the southwestern counties of Canyon, Gem, Owyhee, Payette and Washington. Apples are also produced in the south-central counties of Jerome and Twin Falls. Canyon County leads Idaho's apple industry with 48% of the state's apple trees. Payette County is second with 33%. Historically, apples were grown in Adams County of southwestern Idaho, Nez Perce and Latah counties in northern Idaho and in the southeastern counties of Bingham and Fremont. Today there is renewed interest in growing apples for local markets in the cold climate areas of Idaho because it is possible to grow newer cool season apple cultivars that can be niche marketed. These apples are competitive in local markets with the dominant cultivars in Idaho such as Red Delicious, Rome and the newer cultivars such as Fuji and Gala. In addition, most cultivars grown in southwestern Idaho do not ripen in southeastern Idaho, during most years.

Cropping Information

Most apples produced in Idaho are packed and sold fresh. Some apples are grown for the processing market, and cull apples can be sold for the production of apple juice. The profitability of the processing apple and apple juice markets has virtually disappeared. The long-term future of these two marketing opportunities is unclear.

Domestic sales continue to be the main market for Idaho apples, but international markets are still very significant due to the potential for higher returns per box. In both of these markets quality is extremely important. One aspect of quality in the international market is the phytosanitary requirements each country promulgates. Some of these phytosanitary requirements have, in the past, served more as trade barriers than as genuine quarantines. Phytosanitary requirements of each country continue to change. For example, Mexico currently has regulations against apple maggot, oriental fruit moth, tufted apple bud moth, plum curculio and various species of Tephretidae fruit fly. As apple growers move toward softer pest management programs, countries with phytosanitary requirements with zero tolerances for secondary pests may reduce marketing opportunities for Idaho apples.

Red Delicious apples remain the dominant cultivar, accounting for 36% of all apples. Rome apples are the second largest cultivar, with 19% of the state total, but newer cultivars such as Fuji and Gala have shown substantial increases since 1993. Fifty-eight percent of Idaho's apple

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trees are now on dwarfing or semi-dwarfing rootstocks, leaving 42% on standard rootstock.

Labor requirements for apple orchards are seasonal and concentrated in three periods: winter (pruning), early summer (hand thinning) and late summer to early fall (picking). Labor availability and worker re-entry requirements are both contributing to the difficulty in getting cultural practices done in a timely fashion.

Cultural Practices

Trees are pruned in the winter, while they are dormant. This operation is usually completed prior to the application of dormant sprays. Proper pruning maintains fruit quality and production over the lifetime of the orchard.

Irrigation, especially overhead systems or high pressure under-tree systems, complicates pest management by triggering disease infections in specific blocks or removing protectant pesticides too soon after application. Over-irrigation constitutes a leaching potential for nitrogen fertilizers.

The most common fertilizer used in Idaho apples is nitrogen. Over-application of nitrogen causes serious fruit quality degradation, so it is rare. Most growers apply no more than 80 pounds of actual N per season to the soil no later than June 30. The rate is based on soil and tissue analysis. Zinc is a micronutrient that should be applied foliarly in the delayed dormant/dormancy period every year.

Apples, in general, require cross pollination by honeybees for optimal fruit set.

Blossom and Fruit Thinning

If not thinned yearly, most apple cultivars will develop an alternate bearing habit, producing a heavy crop one year, then almost no crop the next. Biennial bearing can be reduced if a substantial number of blossoms and small fruit are removed from the spurs on the tree during bloom, or within two to three weeks after petal fall. This allows many of the spurs on the tree to rest, which results in flower bud initiation for the next year's crop. On the remaining spurs, the grower wants to set the "king bloom" and remove several lateral blooms with chemical thinners. Hand thinning is then done to remove additional fruit to achieve the desired crop load. This leaves only the stronger fruit behind, which produces the highest quality and most highly colored fruit at harvest.

Blossom thinners reduce fruit set by interfering with pollination and/or fertilization by damaging the flower stigma tip. Post-bloom thinners induce the evolution of ethylene and stress the fruitlet, which causes abscission. The most successful thinning programs come from combinations using chemical thinners and hand thinning during the bloom and post-bloom period.

Growth regulators are commonly used for blossom and fruit thinning in Idaho apple orchards.

Blossom Thinners

Caustic or desiccating compounds are used to remove lateral blooms.

AMADS (Wilthin)—AMADS is used one time per year and tank-mixed with Regulaid to enhance coverage. The rate used is 2 to 3 pints per 100 gallons of spray volume.

Fruit Thinners

Carbaryl (Carbaryl, Sevin)—This is the current fruit thinner of choice. Carbaryl is applied when the fruit is 10 to 15 mm in diameter. It may be applied more than once, if weather prevented the effectiveness of the first application. The temperature should be a minimum of 70°F for best results. Carbaryl causes the weaker, smaller and secondary cluster blossoms to drop from the tree, leaving the strongest fruit behind.

Ethephon (Ethrel, Ethephon)—This product is often mixed with Amid-ThinW and may also be added to the carbaryl to enhance the thinning activity. Ethrel should not be used to thin 'Red Delicious' because it may have a negative effect on fruit shape.

1-Napthaleneacetamide (NAD, Amid-Thin W)—This product is often mixed with ethephon and also may be added to the carbaryl to enhance the thinning activity.

Naphthaleneacetic Acid (NAA, K-salt)—This product may be used alone. It may also be added to carbaryl to enhance the thinning activity.

Hand Thinning

Thinning the fruit by hand six to eight weeks after bloom is a very common practice. Because it is usually done after most flower bud initiation has occurred, it does little to ensure return bloom. Hand thinning serves to ensure highest fruit quality by spacing the fruit on the limb, reducing fruit clusters to singles and removing fruit that is likely to rub on the limbs. Hand thinning also eliminates fruit that appears damaged by early season insects or diseases.

Other Programs

Prevention of Fruit Drop

It is important to retain the apples on the tree during the final two to three weeks prior to harvest. Chemicals may be applied to help prevent pre-harvest drop of apples. Fruit color and size can be enhanced by allowing fruit to remain on the trees longer without adverse effects on storage life.

Naphthaleneacetic Acid (NAA, K-salt)—This is applied to aid in retention of the fruit on the tree. NAA prevents further loosening from the fruit stem. It is usually applied by aircraft two to three weeks before harvest.

ABG (ReTain)—A plant growth regulator used to retain fruits on the tree and to delay fruit maturity and ripening on the tree and in storage. This is applied four weeks before normal anticipated harvest.

Improvement of Fruit Shape

GA 4+7 & BA (Promalin)—A plant growth regulator which may be applied during the bloom period to improve the shape of the apples.

Integrated Pest Management

Commercial apple production, in Idaho, is predominately driven by some type of integrated pest management (IPM) system. Nearly all commercial apple growers practice IPM using one or several of the following techniques:

- Pesticide selection and timing of applications are used for protection of predatory insects in the orchard system.
- Growers scout their orchards with a visual inspection before making pesticide applications.
- Pheromone disruption is used on nearly 800 acres in Idaho.
- Growers use growing degree day models and pheromone traps to predict optimum timing for pesticide applications based on insect population peaks.

Insect and Mite Pests

Without an effective insect and mite control program, Idaho apple producers would not be able to produce a profitable crop. Most apple insect and mite management is approached using a combination of IPM practices, pheromone disruption and timing of insecticide applications. The orchard pest management programs revolve around the control of codling moth. Leafrollers are also a major, persistent pest in Idaho orchards but are not an economic problem in all locations.

Other pests, which vary in their occurrence from year to year, are western tentiform leafminer, green fruitworm and Lacanobia fruitworm, European red mite, two-spotted spider mite, McDaniel mites, San Jose scale, mullein plant bug, lygus bug, stink bug, green apple aphid, rosy apple aphid and white apple leafhopper. As growers change control programs from the use of broad spectrum insecticides to "softer" more specific control systems, secondary pests may become more serious pests in Idaho apple orchards.

A key component to any apple pest control program is a dormant spray. This usually consists of dormant oil, organophosphate insecticides, and, in certain cases, a fungicide. Some of the pests targeted by this treatment are European red mite, green apple aphid and leafroller species. Diseases such as scab, powdery mildew and fire blight may be treated on the apple varieties that are susceptible to these diseases.

Codling Moth, *Cydia pomonella*

Codling moth is the most economically important insect pest. All apple cultivars are susceptible to this pest. Codling moth attacks fruit directly and is responsible for the proverbial "wormy apple." Larvae bore directly into the fruit, and infested fruit either drop from the tree or are culled at harvest.

Codling moth overwinters in the soil around the base of the tree or in soil debris and in fruit bins, prop piles, wood piles and boxes. In the early spring, adults emerge and lay eggs giving rise to larvae that enter developing fruit. Fruit is susceptible to damage from petal fall through harvest. There are generally two to three generations per year. A female may lay over 100 eggs, mostly on or near fruit. Eggs hatch 8 to 14 days after they are laid. Larvae must find and enter fruit within a few hours after hatching. A "sting" is surface damage to the fruit skin caused by the larva after penetrating the skin. Left uncontrolled, codling moth damage can exceed 80%. In fresh market packed fruit, damage as low as 1% is considered unacceptable. Any codling moth damaged fruit is discarded during sorting in the packinghouse.

Codling moth is monitored with pheromone traps to detect emergence and assess population levels. Codling moth activity can be predicted from the use of pheromone traps along with degree-day phenology models. This monitoring establishes a BIOFIX, which corresponds to the first moth flight. The BIOFIX is used to decide timing and type of treatments for codling moth control.

The first codling moth generation is usually smallest in number, more susceptible to cooler, wetter spring weather and therefore the easiest to control with pesticide sprays. Loss of early control usually leads to increased damage during the remainder of the growing season.

Chemical Control

Azinphos-methyl (Guthion)—This is the most commonly used organophosphate insecticide for codling moth control. Azinphos-methyl also suppresses leafroller and other pests when it is applied to control codling moth. It is the primary insecticide used with pheromone mating disruption. It is applied to 90% of the acres for an average use of 0.9 pounds active ingredient per acre per application at 2.1 times per year.

Phosmet (Imidan)—Phosmet is used as an alternative to azinphos-methyl for codling moth control where pest pressure is low to moderate. It can also be used in orchards when a shorter re-entry interval is needed to allow for hand thinning. It is softer on some predators such as wasps and beetles. It is applied on 22% of the acres, at the average rate of 2.8 pounds active ingredient per acre one time per season.

Chlorpyrifos (Lorsban 50 WP)—This insecticide is only moderately effective for codling moth control. In Idaho orchards, growers only obtain suppression of codling moth with chlorpyrifos. It is applied on 10% of the acres for leafroller control, but growers obtain some codling moth control from these applications. It is used at the rate of 1.5 pounds active ingredient per acre, one time per season. **Note:** As of July 1, 2000, EPA has determined that post-bloom applications of chlorpyrifos cannot be made on apples after December 31, 2000.

Cultural Control

Fruit bins and brush piles contaminated with overwintering codling moth larvae should be placed away from orchards.

Integrated Pest Management

In Idaho apple orchards, codling moth mating disruption has the potential, in combination with a limited chemical control program, to be an effective program for codling moth control. Pheromone dispensers (Isomate-C Plus) must be in place before the first moth flight. This flight usually occurs within a few days of full bloom of Red Delicious. The pheromone dispensers are placed within the top 2 feet of the canopy. If the orchard has a history of codling moth problems or if monitoring indicates pest pressure is too high for pheromones alone to provide control, one or two insecticide sprays are used against the first generation. A border spray or alternate row sprays may be effective in combination with a pheromone program.

Pandemis Leafroller, *Pandemis pyrusana*
Oblique-banded Leafroller, *Choristoneura rosaceana*

Leafrollers are another important pest in apple orchards, especially where codling moth mating disruption is used and broad spectrum insecticide use has been reduced. Historically leafrollers were controlled by treatments applied for codling moth. Leafroller larvae roll leaves and web them together to form protective cases. Larvae feed on leaves, buds and the fruit surface, causing severe damage. The larvae also contaminate the fruit with feces and provide an entry point for rot organisms. However, leafrollers cause the greatest damage by feeding on fruit, causing irregular, shallow scars, which causes this fruit to be culled out.

Pandemis leafroller is the most common leafroller in Idaho orchards. It overwinters as a larva and produces two to four generations per year. Oblique-banded leafroller has two to three generations each year. It overwinters on host trees, mostly as a third instar larva within a closely spun cocoon.

Chemical Control

Chlorpyrifos (Lorsban 50WP, 4E)—Chlorpyrifos is the most effective pesticide used to control leafrollers. Lorsban 50WP is applied during the growing season on 10% of the acres. It is applied at the pre-bloom stage and during the summer when the second generation emerges. Lorsban 4E is applied during the delayed dormant period on 85% of the acres. Lorsban 50WP is applied at 1.5 pounds active ingredient per acre and Lorsban 4E is applied at 2 pounds active ingredient per acre. **Note:** As of July 1, 2000, EPA has determined that post-bloom applications of chlorpyrifos cannot be made on apples after December 31, 2000.

Alternative Control

Spinosad (Success) —This is a new reduced-risk insecticide. It is used on 20% of the acres at 0.094 ounces active ingredient per acre.

Biological Control

Bacillus thuringiensis **(DiPel, Javelin)**—Applied in the spring and summer, this can be effective, but requires two to three applications. Coverage is critical for the effectiveness of this product. Apply when weather forecasts predict a warm weather pattern for three or more days.

Integrated Pest Management

Pheromone traps are available for monitoring leafrollers. They are utilized to detect the emergence of adult moths in the orchard and indicate when to expect the second generation larvae.

Western Tentiform Leafminer, *Phyllonorycter elmaella* Doganlar

Leafminer was discovered in Idaho in the early 1980's. Leafminer damage is restricted to foliage and causes a reduction in photosynthesis. It can indirectly affect fruit quality by retarding sugar development. Insecticide programs using chlorpyrifos to control leafrollers are toxic to the primary leafminer parasitoid, *Pnigalio flavipes,* which may cause outbreaks of leafminer. There are three to four generations of leafminer per year. Most insecticide control programs, when needed, are targeted at the earlier generations to reduce impact on the leafminer parasitoid.

Chemical Control

Pest pressure varies by orchard location within the southwest Idaho growing region. Therefore treatment programs vary by location on a year-to-year basis. When treatment is needed, the following insecticides may be used on an "as needed" basis:

Oxamyl (Vydate 2L)—The first insecticide found to be effective controlling leafminer inside the leaf, it is not considered a good IPM pesticide because it is highly toxic to mite predators. Use rate is 0.5 pound of active ingredient per acre on 5 to 15% of the acres when leafminer numbers become detrimental. Early season applications are utilized so the IPM program is not negatively affected.

Abamectin (Agri-Mek)—This insecticide/ miticide was registered in the mid-1990's. It is effective on all generations of the leafminer. Abamectin applications are made during the peak larval periods. It is also used for control of mite pests. Use rate is 0.014 pounds active ingredient per acre on 5 to 10% of the acres, when needed.

Alternative Control

Spinosad (Success)—This reduced risk insecticide is primarily used for leafrollers on 20% of the acres, with fewer than 5% of additional acres targeted for leafminers. It is useful in IPM programs due to its low toxicity to predators. Use rate is 0.094 pounds active ingredient per acre as needed.

Biological Control

Biological control can play a significant role in the control of leafminers due to the host-parasitoid wasp, *Pnigalio flavipes.* When the wasp numbers are high enough they appear to be effective in suppressing leafminers. However, the host-parasitoid interaction and the pest-environment interaction are not well understood.

Lacanobia fruitworm, *Lacanobia subjuncta*
Green fruitworms, *Orthosia hibisci, Amphipyra pyrqmisoides, Xylomyges curialis*

Lacanobia fruitworm was first recognized as a pest in the mid 1990's and has been increasing in importance since then. It has been present in Idaho orchards, but may have developed resistance to the organophosphate insecticides or increased in numbers due to "softer" spray programs. It is primarily a leaf feeder, but also damages fruit when populations reach high numbers. There are two generations of the fruitworm each year in Idaho. Green fruitworms include several species of Noctuid moths. The caterpillars are generally pale green or dull brown.

Chemical Control

Traditional codling moth cover sprays of azinphos-methyl are not effective in controlling Lacanobia fruitworm. If fruitworm damage or caterpillar numbers are determined to be excessive, caterpillars may need to be treated. Treatment thresholds have not been established, but the following guidelines are utilized to determine when chemical treatment may be necessary:

1. 100 moths per trap per week.
2. Caterpillar feeding is resulting in visible fruit injury.
3. Foliage feeding is observed throughout a fruit block.
4. Larvae are consistently dislodged by limb trapping.

Pest pressure varies by orchard location within the southwest Idaho growing region. Therefore treatment programs vary by location on a year-to-year basis. When treatment is needed, the following insecticides may be used on an "as needed" basis:

Chlorpyrifos (Lorsban 50 WP)—This is used at the average rate of 1.5 pounds active ingredient per acre. In addition to the 10% of the acres treated for leafroller, which will suppress fruitworms, 5% of the acres are targeted specifically for fruitworm. **Note:** As of July 1, 2000, EPA has determined that post-bloom applications of chlorpyrifos cannot be made on apples after December 31, 2000.

Endosulfan (Thiodan)—When fruitworms are considered a problem, endosulfan is used on 15% of the acres at the average rate of 2 pounds active ingredient per acre.

Methomyl (Lannate)—Methomyl is only used as a rescue treatment. It is disruptive to IPM programs. It is used on fewer than 5% of the acres at the average rate of 0.9 pounds active ingredient per acre.

Alternative Control

Spinosad (Success 2SC)—Spinosad is effective only on small caterpillars. It is used on 20% of the acres for leafrollers with an additional 5% targeting specifically fruitworms. It is used at the average rate of 0.094 pounds active ingredient per acre.

Cultural Control

Eliminating weeds from fruit orchards is an important control measure. Removal of those weeds that are known to be preferred host plants, such as dandelions, may help reduce fruitworm numbers.

European Red Mite, *Panonychus ulmi*
Two-Spotted Spider Mite, *Tetranychus urticae*
McDaniel Spider Mite, *Tetranychus mcdanieli*

The European red mite is a common and potentially serious mite found in Idaho apple orchards. They overwinter in the egg stage on the trees. The European red mite can complete five to seven generations per summer, depending on the temperatures. Each generation can be completed in 10 to 25 days. When the temperatures warm up, populations can develop rapidly. When mite numbers are high, they will spread downwind by "ballooning" on silken webbing. The two-spotted spider mite and McDaniel spider mite overwinter as adult females. All of the mites are leaf feeders that remove chlorophyll, reducing photosynthetic capacity. Numbers of these mites can increase quickly if populations are not held in check by predators and when the leaf surfaces become dusty.

Mites are a consideration in IPM programs in all apple orchards. If the predators are destroyed by pesticide applications, mite populations will flare. Synthetic pyrethroids are highly toxic to the predators and are often disruptive to integrated mite control.

Chemical Control

Pest pressure varies by orchard location within the southwest Idaho growing region. Therefore treatment programs vary by location on a year-to-year basis. When treatment is needed, the following insecticides may be used on an "as needed" basis:

Fenbutatin-oxide (Vendex)—This is used to control all species of pest mites at the average rate of 1.0 pound active ingredient per acre. It is used on fewer than 5% of the acres.

Abamectin (Agri-Mek)—Abamectin is applied at the average rate of 0.014 pounds active ingredient per acre on fewer than 5% of the acres. The use rate is dependent upon the time of year and species of mite. Early applications are much more effective for controlling mites.

Hexythiazox (Savey)—This miticide is used only for the control of European red mites. It is used on fewer than 5% of the acres at the average rate of 0.094 pounds active ingredient per acre. It is applied to the orchards up to pink bud stage of flower development.

Pyridaben (Pyramite)—This miticide is primarily used to control European red mites, when needed, at an average rate of 0.165 pounds active ingredient per acre on 5 to 10% of the acres.

Cultural Control

Minimizing dust on orchard roads and controlling weeds in the fall instead of late spring help to prevent mite populations from building up in the orchards. Well irrigated, vigorous trees are less susceptible to mite damage.

Integrated Pest Management

Protection and preservation of beneficial mites and predatory insects is very important to avoid mite "flare-ups" in apple orchards.

San Jose Scale, *Quadraspidiotus perniciosus*

San Jose scale (SJS) may infest branches, shoots, leaves and fruit. Scale has a low occurrence in commercial orchards in Idaho because it is effectively controlled with a delayed dormant oil plus an organophosphate insecticide, which is applied to 90 to 95% of the acres. Uncontrolled populations of SJS can kill trees, and when scale are on the fruit it is unmarketable. SJS has become of increasing concern due to phytosanitary restrictions imposed by export markets.

Mullein Plant Bug, *Campylomma verbasci*

This true bug is a pest only during a short period of fruit development. After that, it becomes a beneficial predator of soft-bodied pest insects and mites for the remainder of the season. Fruit damage is sporadic from orchard to orchard and year to year. Damage is caused when the nymphs feed directly on the fruit. Damage usually occurs during a 5- to 10-day period during bloom and shortly thereafter. Control timing is usually through the bloom period. Growers need to use an insecticide that is safe to honeybees when applied during bloom.

Chemical Control

Pest pressure varies by orchard location within the southwest Idaho growing region. Therefore treatment programs vary by location on a year-to-year basis. When treatment is needed, the following insecticides may be used on an "as needed" basis:

Formetanate hydrochloride (Carzol)—This is used only when the populations are high enough to cause damage to the fruit at the average rate of 0.92 pounds active ingredient per acre on fewer than 5% of the acres.

Chlorpyrifos (Lorsban 50 WP)—Chlorpyrifos is applied only when needed prior to bloom for Mullein plant bug control at the average rate of 1.5 pounds active ingredient per acre on fewer than 5% of the acres. **Note:** As of July 1, 2000, EPA has determined that post-bloom applications of chlorpyrifos cannot be made on apples after December 31, 2000.

Lygus Bug, *Lygus lineolaris*

Lygus bugs feed directly on fruit causing economic losses in apples. Control timing is usually through the bloom period. Growers need to use an insecticide that when applied during bloom is safe to honeybees.

Chemical Control

Pest pressure varies by orchard location within the southwest Idaho growing region. Therefore treatment programs vary by location on a year-to-year basis. When treatment is needed, the following insecticides may be used on an "as needed" basis:

Endosulfan (Thiodan)—This insecticide is used only to control lygus bugs. It is used only on an "as needed" basis at the average rate of 2 pounds active ingredient per acre on 5% of the acres.

Consperse Stink Bug, *Euschistus conspersus*
Green Stink Bug, *Acrosternum hilare*

Stink bugs are considered a casual pest in Idaho apple orchards with widespread sporadic infestations. Chemical control has never been utilized specifically for the control of stink bugs.

Green Apple Aphid, *Aphis pomi*
Spirea Aphid, *Aphis spireacola*
Rosy Apple Aphid, *Dysaphis plantaginea*

Aphids are sporadic pests of apples, but can cause significant economic losses in some orchards almost every season, if not controlled. Most important damage is caused by the excretion of large amounts of honeydew. Aphids are not treated every year.

Chemical Control

Pest pressure varies by orchard location within the southwest Idaho growing region. Therefore treatment programs vary by location on a year-to-year basis. When treatment is needed, the following insecticides may be used on an "as needed" basis:

Imidacloprid (Provado)—This is applied at the average rate of 0.06 pounds active ingredient per acre on 50 to 80% of the acres.

Endosulfan (Thiodan)—This is applied at the average rate of 2 pounds active ingredient per acre on 5% of the acres.

Dimethoate (Dimethoate)—This is applied at the average rate of 1.3 pounds active ingredient per acre on fewer than 5% of the acres.

White Apple Leafhopper, *Typhlocyba pomaria*

Like aphids, leafhoppers excrete honeydew, which can be a problem. The leafhoppers also deplete the chlorophyll in the leaves. Leafhoppers in the orchards, at harvest time, can be aggravating to the pickers. Any thinning sprays containing Sevin result in few or no leafhopper infestations for the season. Chemical control for leafhoppers does not occur every year.

Weeds

Weeds can cause a multitude of problems in apple orchards by reducing the growth of trees, especially young trees as they compete for water, nutrients and space. Weedy orchards have higher humidity and slower drying conditions than weed-free orchards, creating an environment ideal for development of such diseases as scab and crown rot. Weed species include many annual and perennial broadleaf and grassy weeds and some noxious weeds such as Canada thistle and field bindweed. Blooming weeds, especially dandelions, are the biggest problem for growers, both in terms of competition for pollinating insects and pollinator protection when insecticides need to be applied. Weeds may also provide habitat for rodents. Trees will be damaged when rodents feed on the trunks at ground level.

In some cases, apple orchards may benefit from plants on the orchard floor if they are carefully managed. These plants, in a well-maintained ground cover, can help increase water infiltration, reduce soil compaction, maintain soil organic matter content, cool the orchard, and provide habitat for beneficial insects. The increasing use of more efficient, low-volume irrigation systems has increased the need for pre-emergence herbicide use.

Chemical Control

2,4-D (Orchardmaster)—2,4-D is applied post-emergence to 15% of the acres for control of annual and perennial broadleaf weeds. It is used at the rate of 1.0 to 1.4 pounds active ingredient per acre. This may be tank mixed with glyphosate to improve control of grasses.

Glyphosate (Roundup, many generic glyphosate products)—Glyphosate is applied post-emergence to 75% of the acres for control of annual and perennial broadleaf and grassy weeds. It is used at the rate of 0.75 to 1.5 pounds active ingredient per acre. This may be tank mixed with 2,4-D to improve control of broadleaf weeds.

Paraquat (Gramoxone Extra)—Paraquat is applied as a contact herbicide to provide a quick burn-down of primarily annual weeds. It is applied at 0.94 pounds active ingredient on 5 to 10% of the acres.

Simazine (Princep, Simazine)—Simazine is applied at the average rate of 1.8 pounds active ingredient per acre on fewer than 5% of the acres. It is used for annual broadleaf and grassy weeds.

Oryzalin (Surflan)—This is used for annual grasses and broadleaf weeds. It is applied at the rate of 4.0 pounds active ingredient per acre on 5% of the acres.

Norflurazon (Solicam)—This is used for annual grasses and broadleaf weeds at the rate of 2.5 pounds active ingredient per acre. It is applied to fewer than 5% of the acres.

Soil residual herbicides can be mixed with paraquat, 2,4-D or glyphosate when established weeds are present. There are various combinations of soil residual herbicides used based on soil types, soil texture and weeds present. Growers will make their selections of soil residual herbicides to avoid tree damage when soil texture varies, especially on light, sandy soils.

Diseases

Apples grown in the relatively dry climate of Idaho are generally much less affected by diseases such as apple scab than those grown in states with warm, wet summer climates. Yet, diseases can cause severe losses in certain growing areas and during some seasons. Some of the diseases damage fruit by marking it or rotting it, and others damage or kill the tree. Generally, control materials are fairly specific to one disease or to a limited number of diseases. Powdery mildew and fire blight are the two most important diseases that apple growers must contend with in most growing seasons. Apple scab does occur in Idaho in most years, but is not significant except in blocks irrigated by overhead sprinklers. It also can occur in years with unusually wet springs and where the fungus was present the year before.

Powdery Mildew, *Podosphaera leucotricha*

Powdery mildew occurs in all apple growing areas of Idaho. Apple cultivars vary greatly in susceptibility to powdery mildew. *P. leucotricha* overwinters as mycelium in dormant buds infected during the previous growing season. Overwintering in buds is affected by how severe the winter temperatures are, with most infected buds being killed at temperatures below -18°F.

In spring, while fungal mycelium develops over petals, sepals and flower stems, infected blossoms fail to set fruit. On leaves, whitish patches appear over the entire leaf and then over the entire shoot. Shoots infected with mildew are stunted and sometimes killed. Fruit infection usually occurs only on young fruit. Infected fruits are stunted and develop a net-like russetting on the surface. Powdery mildew results in an overall reduction in yield and fruit quality. Severely infected trees can suffer considerable damage in the range of 25 to 50% yield reduction.

Cultural Control

Pruning out infected shoots during dormancy will help reduce the inoculum load the following spring. However, it is difficult to remove all infected shoots, and fungicides are generally needed on susceptible varieties.

Chemical Control

There are several fungicides that can be used for powdery mildew control. The most susceptible varieties in Idaho and most commonly treated for powdery mildew are Rome, Jonathan, Fuji and Gala. Growers can utilize fungicides from the different chemical families below:

Sterol Inhibitor Fungicides

Myclobutanil (Rally)—This fungicide is used at the rate of 2 ounces active ingredient per acre on 25 to 30% of the acres.

Triflumizole (Procure)—This fungicide is used at the rate of 4 to 8 ounces active ingredient per acre on 5% of the acres.

Fenarimol (Rubigan)—This fungicide is used at the rate of 1.5 ounces active ingredient per acre on fewer than 5% of the acres.

Triadimefon (Bayleton)—This fungicide is used at the rate of 3 to 4 ounces active ingredient per acre on fewer than 5% of the acres.

Sulfur Fungicides

Products containing sulfur are often used in rotation or combination with other fungicides to help prevent resistance development in the pathogen. Sulfur products are used on 30% of the acres. Excessive use of sulfur products may also reduce rust mite populations to levels incapable of supporting the beneficial Western predatory mites, leading to temporarily increased European red or two-spotted spider mite populations.

Strobilurin Fungicides

Trifloxystrobin (Sovran, Flint)—These fungicides belong to a new group of reduced risk chemicals with activity on powdery mildew and apple scab. These are good products to use in rotation with sterol inhibitor fungicides. These products are used on 5% of the acres.

Fire Blight, *Erwinia amylovora*

Fire blight can be a serious disease on some apple cultivars, although they are not as susceptible as pear. Fire blight development is influenced primarily by seasonal weather. Warm weather, accompanied by rain and hail, is

ideal for disease development. The climate in most apple growing areas is conducive to disease development. Fire blight causes blossom clusters to wilt and collapse in late spring. Young tender shoots can also be infected. Blight infections kill fruiting spurs, and in some varieties it may move into twigs and branches from infected clusters. In some cultivars, major branches may be killed as cankers expand and girdle limbs. In highly susceptible cultivars, entire young trees may be lost.

Chemical Control

Streptomycin (Agri-Mycin 17)—Streptomycin is used at the average rate of 0.31 pounds active ingredient per acre on 5 to 10% of the acres. This is fully labeled on apples, but there has been documented resistance by *Erwinia amylovora* in Idaho. The level of resistance is continuing to be monitored by growers and by plant pathologists at the University of Idaho. Orchard blocks with streptomycin-resistant populations of *E. amylovora* should not be treated with streptomycin.

Oxytetracycline (Mycoshield)—This is an effective spray material available to Idaho apple growers. It is used only under a section 18 emergency exemption of FIFRA. Mycoshield is used at the rate of 0.17 pounds active ingredient per acre on 5% of the acres.

Copper—Several products containing copper are registered for the control of fire blight during the delayed dormant period of apples. On fire blight-susceptible varieties, it is commonly added to the oil/insecticide delayed dormant spray. This is done on 15% of the acres.

Cultural Control

Apple growers try to avoid excessive shoot growth by carefully managing nitrogen applications to help prevent blight infections. Shoot strikes may be pruned out during the growing season or during the dormant pruning season.

Vertebrate Pests

Voles (*Microtus*) can cause significant damage to an orchard. This damage occurs primarily during the winter season and is worse during winters with heavy snow. The damage occurs when they chew the bark off the lower portions of trunks on younger trees. While some growers try to save these damaged trees with approach grafts or bridge grafts, these methods are very slow and expensive and do not always work well.

Chemical Control

Zinc phosphide (Zinc phosphide treated bait)—These treated baits are most commonly used for short-term, spot reduction of meadow voles in higher population areas of the orchard. A few ounces applied per treatment site is scattered in the area showing vole activity. These baits are applied in the fall, prior to snow cover. If the soil surface is wet, the active ingredient is rapidly diminished. When the bait is spread thinly, non-target animals are rarely exposed. If the voles are under exposed at first feeding, they become bait-shy and are difficult to control.

Chlorophacinone (Rozol Bait)—This is a commonly used anticoagulant. The bait is applied at 10 to 20 pounds per acre to relatively dry soil, in areas with little grass or weed cover. Very often only the areas showing the most signs of vole activity are baited. The voles must feed on these products repeatedly to obtain a critical dose. Rozol is more active in wetter weather, but is generally considered less effective than the faster-acting zinc phosphide. Rozol bait is generally considered safe to non-target animals.

Diphacinone (Ramik Brown)—These pellets are an anticoagulent rodenticide applied at 10 to 20 pounds per acre.

Strychnine (Strychnine-Treated Oat Bait)—This product is available as a pocket-gopher bait and is placed by a hand-held applicator inside the underground runways. This prevents the exposure of non-target animals to either the bait or the gopher carcass.

Aluminum Phosphide—This chemical is registered for gopher control. The pellets are placed into the gopher runs.

Cultural Control/Alternative Control

Weed control and frequent cover crop mowing are relatively effective in keeping vole populations at manageable levels within the orchard. There can be fall migration of voles from the non-orchard land near the orchard, but this is usually confined to the border areas. Added control efforts can often be concentrated in this part of the block. Gophers often work their way into orchards from the surrounding habitat. Trapping in the orchard is a relatively effective, but labor intensive, way to reduce low populations of this pest. Once gophers become established in the block, trapping is supplemental to chemical control.

Biological Control

Cats, dogs, snakes, predatory birds and coyotes all help to reduce the population of rodents. Without biological controls, there would soon be many thousands of voles per acre of orchard. Cover management allows the biological control to take place. Traps and chemical controls are necessary to lower the rodent population in those areas where biological controls have fallen short.

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Using Pesticides

Pesticide Residues—Any recommendations for use are based on currently available labels for each pesticide listed. If followed carefully, residues should not exceed the established tolerances. To avoid excessive residues, follow label directions carefully with respect to rate, number of applications, and minimum interval between application and reentry or harvest.

Groundwater—To protect groundwater, when there is a choice of pesticides, the applicator should use the product least likely to leach.

Trade Names—To simplify information, trade names have been used. No endorsement of named products is intended nor is criticism implied of similar products not mentioned.

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