INTERMOUNTAIN Commercial Tree Fruit Production Guide 2026-27

A publication for commercial fruit producers of the Intermountain West

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2026-2027 INTERMOUNTAIN TREE FRUIT PRODUCTION GUIDE

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CHAPTER 1 INTEGRATED PEST MANAGEMENT METHODS

Integrated pest management (IPM) involves collecting information about a pest and crop to ensure that you administer the most economical, effective, and environmentally sound pest management decision. IPM integrates as many suitable pest management options as possible.

The components of IPM are:

1. Knowledge of the pest (identification, biology, life cycle)
2. Monitoring for pests and injury
3. Deciding whether to treat based on thresholds
4. Implementing a set of control tactics
5. Record-keeping (scouting results, treatments applied, treatment results)

Monitoring Techniques and Supplies

Monitoring for insects and diseases and for plant or fruit injury is essential for effective pest management. Knowing which pests are active and when, optimizes pesticide treatments. Regular monitoring provides information on:

- early pest problems
- which pest life stage is active
- presence or absence of natural enemies
- when to implement control measures
- whether pest control actions are working

How Often and Where to Monitor

From spring through early summer, monitor once per week, and then every other week until late summer. Ideally, scouting should occur on the same day each week. Plan to spend up to an hour, depending on the orchard size, to do a thorough job.

Walk sections of the selected block in a diagonal or zig-zag pattern. Randomly select at least four trees of each cultivar in a block of 10 acres in size. The more trees that can be inspected, the better. Also include trees from known hotspots and orchard borders.

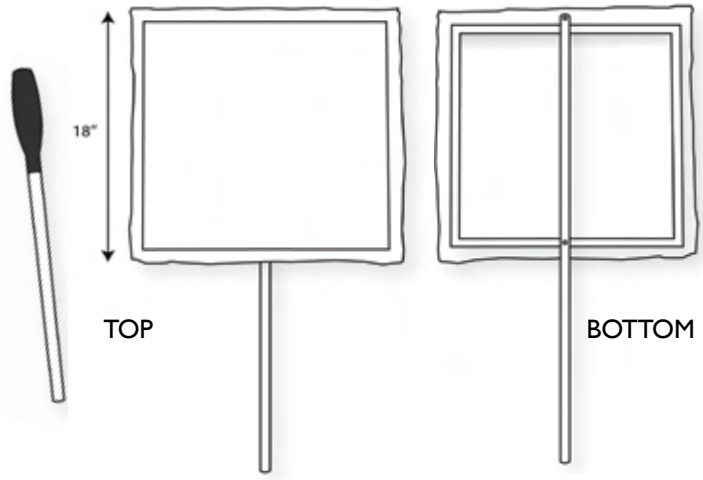
How to Monitor

Examine each tree for overall health and for insect or disease activity. On leaves, look for chewing injury, spots, changes in color, or stippling. On fruit, look for spots, dimples, and rot. On the stems and root collar, look for discoloration, oozing, cracking bark, and holes. Check to be sure the tree is not being over- or under-watered.

- After this visual inspection, use a **beating tray** to perform a closer inspection for insects. A beating tray is a large (approximately 18" x 18") flat surface on which to observe insects.

  To use, hold the tray under a limb and strike the limb with a padded stick three times. Examine the dislodged insects visually or with a hand lens.

- Use a **hand lens** in the range from 10x-30x magnification to identify pests. To focus on the pest you are viewing, hold the lens approximately 1-2 inches above the specimen. You can either look down through the hand lens from above, or bring your eye directly to the hand lens.



A beating tray can be made by cutting window screen framing to size and covering the frame with white or light blue cloth using screen spline. Screw a 2 foot aluminum pipe to the top and bottom of the screen to make a handle. The padded stick is simply a strong stick (such as a broom handle) padded on one end with a duct tape-wrapped cloth.

Using a hand lens greatly helps in identifying insects. Aphids, for example, look very similar to campylomma nymphs, and are difficult to tell apart with the naked eye.

Some pests, including codling moth and peach twig borer can be monitored with **pheromone traps**.

Many of the harmful tree fruit pests are moth species. Female moths release a pheromone scent to attract males for mating, and the scent is specific to each species or group. Lures are loaded with a synthetic version of the pheromone for the target insect. They are placed on a sticky liner that slides into a triangular trap.

Although slightly more expensive, orange Delta traps are easier to use and last longer than wing-style traps.

A minimum of two traps per species should be placed in each orchard. Orchards greater than 20 acres should have one trap every 10 acres.

Orange delta traps are easy to use, last several years, and are not as attractive to honeybees as white traps.

Hang at least one trap on the edge and at least one near the center of the orchard to determine if moths are immigrating from outside sources and/or overwintering within the orchard. Suspected "hot spots" need additional traps.

Make sure the trap entrance is parallel to the prevailing wind and clear of twigs, leaves and fruit (to prevent birds from hopping into trap).

In spring, check traps every 1 - 2 days until the first consistent moth catch (1-2 moths caught two nights in a row). Record this date; it is called the biofix and is used in insect phenology models

Traps that all fruit growers in the Intermountain West should hang, check weekly, and record catch data.

Trap	When to Hang	Where to Hang	Expected Biofix	Longevity of Lure
codling moth (CM)	apple first pink	upper tree canopy (apple, pear)	apple full bloom	30 days (regular) 60 days (L2 or LL)
peach twig borer (PTB)	mid to late April	upper tree canopy (peach, nectarine, apricot)	early to mid May	30 days (regular) 60 days (L2 or LL)
greater peachtree borer (GPTB)	peach shuck fall	lower tree canopy (peach, nectarine)	late June to early July	30 days
obliquebanded leafroller (OBLR)	mid May	mid tree canopy (apple, cherry)	late May to mid June	30 days
western cherry fruit fly (WCFF)	green stage of fruit	southwest side of tree; mid-canopy (cherry)	used for monitoring only	ammonium carbonate bait: 3 wk

After biofix, check traps weekly and record the numbers of moths for future evaluation.

Essentials of pheromone lures and traps:

- Traps are sold as "large plastic delta" or "wing-style." We recommend the delta traps for ease of use (sticky liners easily slide in and out) and durability (reusable for several years). Orange or red-colored traps are less attractive to bees.
- *Prices*: Lures range from $1.50 each (for 30-day) to $5.00 each (for long-life and specialty lures). Wing-style traps are approximately $2 each, and delta traps, $5.00.
- Delta traps last up to 5 years, wing-style traps last less than 1 season. Lures last 30 to 60 days, depending on the type purchased.
- Label your delta trap with the insect lure used and to avoid cross-contamination, and do not use it for another species.
- Change the pheromone lures based on manufacturer's recommendations and change the sticky liners after excess debris has collected on the surface.
- Some lures (codling moth) are designed to be used in conjunction with mating disruption; see table on page 11 for more information.
- Store lures in the freezer at all times until deployment in the field or they will lose effectiveness. Properly stored lures last 2 years.

Use Pherocon AM yellow sticky traps with AC lure for **western cherry fruit fly**.

Fruit flies are attracted to the yellow color of the trap, and AC (ammonium carbonate) increases the effectiveness. AC is purchased separately, and sold in small containers or Ziploc pouches. They are attached to the yellow trap with a twist-tie or staple.

A minimum of two traps should be placed in each orchard, in the border and interior. Suspected "hot spots" should be monitored separately.

Place traps on the southern side of trees to catch the earliest emerging flies, at least 6 ft high, in the mid to upper third of the tree canopy. Remove fruit, leaves, and twigs within 6 inches of the trap. Check the traps weekly and keep a record of fly catches.

Yellow sticky traps are used for cherry fruit fly. The ammonium carbonate lure makes the trap more attractive.

Essentials of pheromone lures and traps:

- *Prices*: Traps are approximately $2 each, and additional baits are $1 each.
- Change traps every 3 to 4 weeks or when they become covered with debris. Refill or replace AC bait containers as needed.

Pest Identification

If you find a pest or symptom that you are unsure of, there are resources to help you.

Utah:

- Send a plant or insect specimen to the Utah Plant Pest Diagnostic Lab (extension.usu.edu/pests/uppdl) at 5305 Old Main Hill, Logan, UT 84322. The fee is $10+, and a submission form, which is available online, must accompany the specimen.
- Contact your local county extension agent (extension.usu.edu).

Colorado:

- Send specimens to the main campus at Plant Diagnostic Clinic, E215 Plant Sciences Bldg., Colorado State University, Fort Collins, CO 80523-1177. Sample fees range from $15-30 and must be accompanied by a form (970-491-6950, agsci.colostate.edu/agbio/plantclinic/).

Idaho:

- Send disease specimens to the Idaho State Department of Agriculture Plant Pathology Lab 2230 Old Penitentiary Road, Boise, ID 83712, with a form. (Prices vary depending on diagnostic

service.) Forms and more information can be found here: agri.idaho.gov/main/laboratories/plant-pathology-laboratory.

Montana:

- Send plant and arthropod specimens to the Schutter Diagnostic Lab, Montana State University, 119 Plant Bioscience Building, Bozeman, MT 59717. Forms and shipping instructions are available at diagnostics.montana.edu. Routine diagnoses are free, but fees apply for multiple samples, out of state services, and special diagnostic services.

Retailers of Monitoring Supplies

Alpha Scents	Great Lakes IPM
West Linn, OR	Vestaburg, MI
503-342-8611	800-235-0285
alphascents.com	greatlakesipm.com

Pest Monitoring Toolkit

1. 10x-30x magnification hand lens
2. Orange delta traps and codling moth, greater peachtree borer, and/or peach twig borer pheromone lures
3. Extra sticky liners for traps
4. Pherocon AM yellow sticky traps plus external ammonium carbonate lure
5. Beating tray and padded stick
6. Vials of alcohol, tweezers, a small paintbrush, plastic containers, and pruners for collecting unknown specimens.

Thresholds for Treatment

Pest monitoring provides information on pest activity and population size. To decide if control is required, pest density must be related to the potential crop damage and balanced against the cost of treatment. If the cost of treatment is more than the crop loss, do not treat. Activity of natural enemies must also be considered when determining whether to treat. For pests like aphids or spider mites, natural enemies can potentially keep these populations below economic injury levels. For specific pest threshold levels, see the Pest Biology chapters.

Determining Treatment Timing: Using Degree Days and Insect Phenology Models

Degree days (DD) are a measurement of heat units over time, calculated from daily maximum and minimum temperatures. Degree days are used to predict insect life cycles, and in turn, time insecticide treatments to those life cycles. Insects are exothermic ("cold-blooded") and their body temperature and growth are affected by their surrounding temperature. Every insect requires a consistent amount of heat accumulation to reach certain life stages, such as egg hatch or adult flight. Degree days interpret that heat accumulation.

The minimum temperature at which insects first start to develop is called the "lower developmental threshold", or baseline. The maximum temperature at which insects stop developing is called the "upper developmental threshold," or cutoff. The lower and upper thresholds vary among species, and have been determined for many tree fruit pests. These values are used in calculating species-specific degree days.

Entomologists have studied biological development over time (phenology) of several fruit insect pests, discovering exact degree day values that correlate to key phenological events, such as egg hatch or adult flight. This predictive information is known as an **insect phenology model**. Insect models are useful in timing insecticide treatment because the entire life cycle (or key events) of the insect is known.

Calculating Degree Days

In general, degree days can be calculated using a simple formula for the average daily temperature, calculated from the daily maximum and minimum temperatures, minus the baseline (lower developmental threshold):

[(daily maximum temperature + daily minimum temperature)/2] – baseline temperature.

Models used in tree fruit pest management

Insect	Lower threshold	Upper threshold	Start accumulating DD	Calculation method
codling moth	50	88	biofix	single sine
peach twig borer	50	88	biofix	single sine
greater peachtree borer	50	87	March 1	single sine
western cherry fruit fly	41	none	March 1	single sine
walnut husk fly	41	none	March 1	single sine
pear psylla	41	none	Jan. 1	double sine
European red mite	51	none	March 1	single sine
oblique-banded leafroller	43	85	biofix	single sine
San Jose scale	51	90	use codling moth biofix	single sine

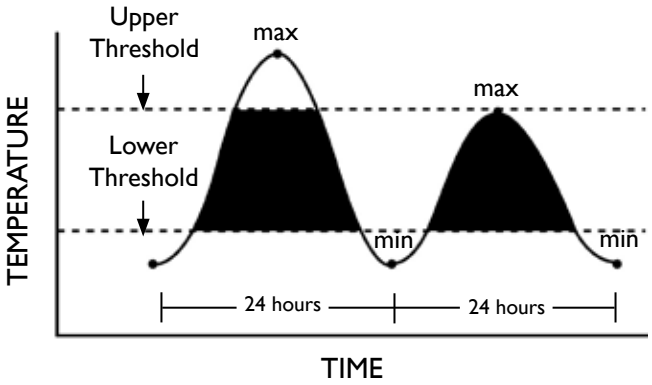
For example, a day where the high is 72˚F and the low is 44˚F would accumulate 8 degree days using 50˚F as the baseline:

$$[(72 + 44)/2] - 50 = 8.$$

The sine wave method yields a more precise calculation. This method still uses the daily minimum, maximum, and baseline temperatures (lower threshold), but also incorporates the upper threshold into the calculation. It is based on the assumption that temperatures of a 24-hour day follow a sine wave curve. The number of degree days is then calculated as the area under this curve within the lower and upper temperature thresholds.

With more precise temperature sensors, the degree day total for a single day is calculated from max/min temperatures recorded hourly or even every minute. No matter the precision, the calculated value is added to the prior value and so on, resulting in an accumulated number from a set starting point. The set starting point can be a fixed date or an event such as the date of first moth flight, called biofix (which is determined by using pheromone traps). For an average growing season in northern Utah, areas will accumulate approximately 2500-3500 degree days (with a baseline of 50˚F).

Degree Days Using Horizontal Cutoff



This diagram is a visual representation of degree days using the sine wave method of calculation, with a horizontal cutoff. The area in black under the curve represents the number of degree days that fall between a lower and upper temperature threshold, for each 24-hour period.

Treatment timing is useful by forecasting degree day values for a given location, using either forecasted daily highs and lows, or 30-year average highs and lows. This information is only an approximation of a future event, but is highly useful in planning.

Obtaining Degree Days

There are a variety of ways to acquire degree days, from dataloggers, online calculators, or printed newsletters from your local Extension service.

- Biophenometers are instruments that calculate degree days every few minutes and are highly accurate. Many brands allow you to manually input the target pest's upper and lower thresholds.

Options in Utah:

- IPM pest email advisories (pestadvisories.usu.edu) provide accumulated and forecasted degree days for a variety of sites across northern Utah, and are delivered via email.
- Utah TRAPs (Temperature Resource and Alert for Pests, climate.usu.edu/traps) is a degree day calculator for a variety of locations in northern Utah. Also available as a mobile app.

Options in Idaho:

- Idaho participates in the Pacific Northwest and Treasure Valley Pest Alert Network (register at tvpestalert.net/), providing fruit tree and small fruit pest advisories.

Options in Colorado:

- The Western Colorado Research Center provides general fruit information and contact information on their fruit page website: aes-wcrc.agsci.colostate.edu/pomology.
- CropWorx is a private company in Eckert, CO that provides pest alerts, at cropworx.net/pest-alert.

Options in Montana:

- Pest advisories are available at Missoula County Weed District and Extension (missoulaeduplace.org/pest-alerts) and MSU's Western Agricultural Research Center (agresearch.montana.edu/warc).
- Montana stations are available on the Utah TRAPs website.

Timeline of insect degree days/calendar date/plant phenology for key life stages of orchard insects.

Dates are estimated for northern Utah, western Colorado, southern Idaho, and western Montana. Degree days are provided for a lower temperature threshold of 50, unless otherwise noted.

Insect or Mite	Life stage	Event/Activity	Degree Days, Date, or Phenology Range
Boxelder Bug	adult	adults find hosts	April
	adult	2nd gen. nymphs full grown	Aug - Sept
	adult	most migration before overwintering	Oct
Campylomma Bug	eggs	egg hatch	1st pink of apple
	nymphs	time to monitor 1st gen.	mid-April - early June
	nymphs	summer gen. nymphs active	June - Sept
	adults	adults active	late-may - late Sept
Codling Moth	pre-emergence	hang trap	100 - 150
	adult	moth emergence begins; get biofix	175 - 290
			degree days post biofix:
	larvae	egg hatch begins	220 - 250
	adult	1st flight peak	325 - 581
	larvae	period of greatest egg hatch	340 - 640
	larvae	egg hatch ends 1st gen.	920
	eggs	egg laying begins 2nd gen.	1000 - 1050
	larvae	egg hatch begins 2nd gen.	1100
	larvae	max hatch period 2nd gen.	1320 - 1720
	adult	2nd flight peak	1337 - 1977
	larvae	egg hatch ends 2nd gen.	2100
	larvae	egg hatch begins 3rd gen.	2160
European Red Mite (*base 51*)	eggs	1st egg hatch	100 - 168
	nymphs	summer egg hatch	424 - 572
Flatheaded Appletree Borer	adult	adult flight period	June - Aug

Continued. Timeline of insect degree days/calendar date/plant phenology for key life stages of orchard insects.

Insect or Mite	Life stage	Event/Activity	Degree Days, Date, or Phenology Range
Greater Peachtree Borer	pre-emergence	hang trap	400
	adult	moth emergence begins	575 - 650
	adult	moth flight period	mid June - Oct
Green Apple Aphid	eggs	egg hatch	¼" green
	nymphs	start scouting	petal-fall - hardened terminals
	nymphs	population builds up	late May - early June
Green Fruitworm	adult	moth emergence begins	early spring
	larvae	hatching	spring
Green Peach Aphid (base 39)	nymphs	eggs hatch	pink - full bloom
Leaf Blister Mites	adults	adults move to new leaf growth	early spring
	adults	adults enter bud scales to overwinter	Aug - Sept
Lygus Bug (base 54)	eggs	egg laying	252 - 300
	nymphs	egg hatch	371
	adult	summer gen. adults begin	623
Obliquebanded Leafroller (base 43)	pre-emergence	hang trap; get biofix	May
	larvae	peak egg hatch	600 - 1000
	adult	2nd gen. moth emergence begins	1480 - 1683
	adult	2nd gen. flight peak	1784 - 2108
Peach Twig Borer	pre-emergence	hang trap	300 - 330
	adult	moth emergence begins; get biofix	400 - 450
			degree days post biofix:
	larvae	5-28% egg hatch; best time to treat	300 - 400
	adult	2nd gen. moth flight begins	900 - 1080
	larvae	2nd gen. egg hatch; time to treat	1200 - 1360
	adult	3rd gen. flight begins	1760
	larvae	3rd gen. egg hatch; time to treat	2140 - 2340
Pear Psylla	adult	adults active	0 - 49
	egg	1st gen. egg laying	1 - 72
	larvae	1st gen. egg hatch	60 - 166
	adult	1st hardshell stage observed	312
	larvae	2nd gen. egg hatch	584 - 750
Pear Sawfly	eggs	look in terminals	April
	adults/eggs	adults emerge/ lay eggs	early June
	larvae	larvae feed	June
	adults	2nd gen. adults emerge	late July - Aug
Prionus Root Borer	adults	adult emergence	July
	adults	active in summer months	summer

Continued. Timeline of insect degree days/calendar date/plant phenology for key life stages of orchard insects.

Insect or Mite	Life stage	Event/Activity	Degree Days, Date, or Phenology Range
Root Weevil (base 40)	pupae	pupal development begins	564
	adult	adult emergence begins	1056
	eggs	1st egg laying	1498
	adult	first leaf feeding observed; apply treatment	early summer
	larvae	treat overwintering larvae	late summer - early fall
Rosy Apple Aphid	nymphs	overwintering eggs start hatching	56
	adults	wingless adults active	early bloom - late June
	adults	migrate to weed hosts	late June - early July
	eggs	adult female lays eggs for overwintering	late summer - early fall
Rust Mite	adults	adults active (decline in hot weather)	1st bloom - early fall
San Jose Scale	pre-emergence	hang trap	120 - 150
	adult	adult male emergence begins; get biofix	177 - 322
			degree days post biofix:
	crawlers	crawlers begin hatching	300 - 413
	crawlers	treat crawlers	600 - 700
	adult	2nd gen. flight peak	1426 - 1776
	crawlers	2nd gen. crawlers emerge	1916 - 2104
Spider Mite (McDaniel's, Two-spotted)	adult	rapid reproduction in high heat	mid to late summer
Western Tentiform Leafminer	adult	adult emergence begins	early spring
	eggs	egg-laying begins	pink
	eggs	egg-laying peaks	bloom
	larvae	first mines observed	early - mid May
	adult	1st summer gen., followed by 2 more overlapping generations	early June - late summer
Stink Bugs	adult	adult emergence period	May - June
Walnut Husk Fly (base 41)	adult	adult emergence begins	1890
	eggs	egg-laying begins	2480
	larvae	egg hatch begins	2700
Western Cherry Fruit Fly (base 41)	pre-emergence	hang trap	750 - 800
	adult	adult emergence begins; watch trap	900 - 950
	adult	treat when fruit develops first salmon blush	fruit color salmon blush
	adult	3% of flies emerged	1060
	adult	last adult catch	3049
White Apple Leafhopper	nymphs	egg hatch	first pink
	adult	2nd gen. egg hatch	late July - early Aug
Woolly Apple Aphid	nymphs & adults	first observation above ground	June - July
	nymphs & adults	first treatment if population was high last year	early - mid Jul

CHAPTER 2 SPECIAL PEST MANAGEMENT PROGRAMS

Mating Disruption

Mating disruption (MD) is an alternative pest control option for codling moth, peach twig borer, and greater peachtree borer in the Intermountain west. MD is used by both certified organic and conventional growers. The cost of an established mating disruption program is the same or less than a spray program.

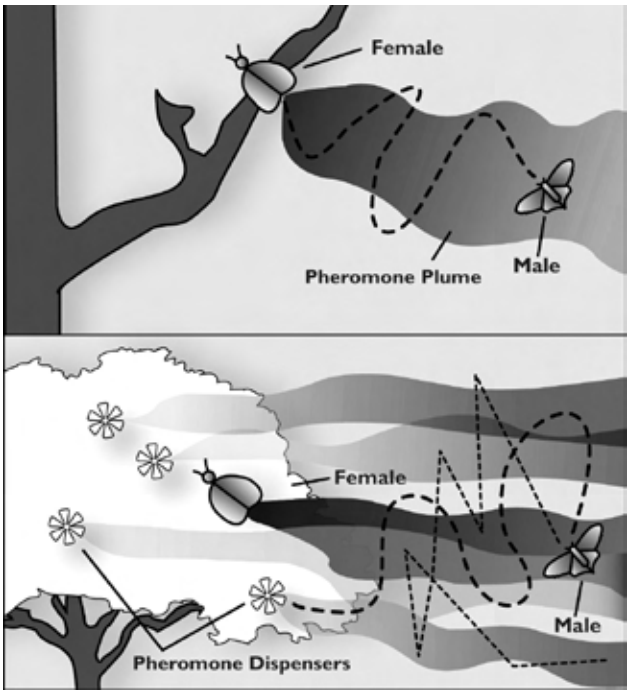
In the wild, male moths find female moths for mating by following the species-specific scent (called a pheromone), that females exude. Under MD, an orchard is saturated with that same female pheromone, "confusing" males and preventing them from finding females. Mating never occurs or is significantly delayed. When MD is used for several years, the target pest population declines and insecticide sprays may be unnecessary. MD works best in large areas, and expanding MD to cooperating, neighboring orchards will improve effectiveness.

When starting a new MD program, it is important to first know the initial pest population level. Use monitoring traps for at least one season to determine general pest levels, outside pest pressure, and hot spots. The first two years of MD will almost always require a full spray program at the same time, to bring pest population levels down.

Mating disruption devices are called "dispensers". Most dispensers target just one pest, and are applied by hand either by twisting, looping, clipping onto a branch, or attaching to a post. Sprayable MD products are also available.

General MD guidelines:

- All dispensers last only one season.
- Hang them singly and evenly in the orchard canopy, according to the product label.
- Hang high-density dispensers on sturdy branches so that they remain attached, even in high winds.
- Hang low-density dispensers on posts or tall pipes at the height of the canopy and away from foliage.
- Store leftover dispensers in the freezer for up to one year to use the following spring.



Female moths emit a chemical blend (pheromone) that forms a plume. Male moths follow the plume to find their mates **(top)**. In the presence of mating disruption, the female moth's plume is mixed with the plumes of pheromone dispensers, which inhibits the male's ability to find the female **(bottom)**. The male may either fly randomly and not approach a moth at all **(thin dotted line)** or home in on a dispenser or even a female **(thick dotted line)**. The idea is that mating is either delayed or prevented.

- For new MD orchards, double the application rate on the borders and at "hot spots".
- As moth populations decline, there is the option of reducing the application rate of high-density dispensers (not on the borders) to save costs.
- Monitor the target pest using pheromone traps to determine pest pressure and the need for supplemental sprays.

Codling Moth Mating Disruption

Codling moth mating disruption works best in large, contiguous areas of orchard or isolated locations (minimum 5 to 10 acre blocks). Dispensers should be placed in the orchard at bloom. Ideally, a biofix (first moth flight) for each orchard should be determined by hanging a pheromone trap in a nearby, non-mating disrupted site. It is impossible to get an accurate biofix within an orchard that has been historically using

mating disruption due to the low moth population. The biofix date is used to determine the timing for supplemental sprays (see pages 4-5).

Monitor codling moth using large plastic delta traps with a sticky liner and lure (see table on page 2). High load codling moth lures must be used because the high concentration of pheromone in disrupted orchards masks traps using standard lures. Traps should be used according to the following guidelines:

- Hang traps at Red Delicious bloom
- Hang in upper third of tree canopy
- One trap/10 acres (minimum 2 traps per orchard), plus traps in hot spots
- Check traps once/week, and count and remove moths, or keep a running tally for each generation or since the last insecticide spray

Peach Twig Borer Mating Disruption

Peach twig borer mating disruption works best in large, contiguous areas of orchard (minimum 5 to 10 acre blocks). Mating disruption dispensers should be placed in the orchard according to manufacturer recommendations. Ideally, a biofix (first moth flight) for each orchard should be determined by hanging a pheromone trap in a nearby, non-mating disrupted site at petal fall, and checking it daily until moths are caught two nights in a row. The biofix date is used to determine the timing for supplemental sprays (see pages 4-5). It is impossible to get an accurate biofix within an orchard that has been historically using mating disruption due to the low moth population.

Monitor peach twig borer using large plastic delta traps with a sticky liner and lure (see table on page 2). There are no specialized high load lures; only standard lures are available. Traps should be used according to the following guidelines:

- Hang traps at petal fall
- Hang in upper third of tree canopy
- One trap/10 acres (minimum 2 traps per orchard), plus traps in hot spots
- Check traps once/week, and count and remove moths, or keep a running tally for each generation or since the last insecticide spray

Greater Peachtree Borer Mating Disruption

Greater peachtree borer mating disruption is successful in orchards 1 acre or larger. Mating disruption dispensers should be placed in the orchard at or before first moth flight (usually around June 20 in northern Utah), or, dispensers can be hung at the same time as peach twig borer dispensers. Mating disruption for this pest is so successful that after a few years, the moth population will decline to almost zero, and monitoring traps will not catch any moths. As a result, some growers use peachtree borer MD only every two to three years.

Monitor greater peachtree borer using large plastic delta traps with a sticky liner and lure (see table on page 2). There are no specialized high load lures; only standard lures are available. Traps should be used according to the following guidelines:

- Hang trap in early June
- Hang in lower third of tree canopy
- One trap/10 acres (minimum 2 traps per orchard), plus traps in hot spots
- Check traps once/week, and count and remove moths, or keep a running tally

Causes of Failure

- Using MD in a small area (less than 10 acres for codling moth or peach twig borer)
- Not increasing MD dispenser rates in “hot spots” such as along borders or areas upwind of strong prevailing winds
- Applying MD dispensers after biofix (first moth flight)
- Not applying MD dispensers according to labeled recommendations
- Not applying supplemental insecticides when necessary
- Not monitoring for sudden increases in moth populations and/or fruit injury
- Not maintaining sanitation practices (e.g., removing cull piles and bins)
- Using MD in newly planted orchards, which are not ideal for mating disruption because the pheromone quickly dissipates due to lack of foliage

Characteristics of mating disruption dispensers tested in the Intermountain West.

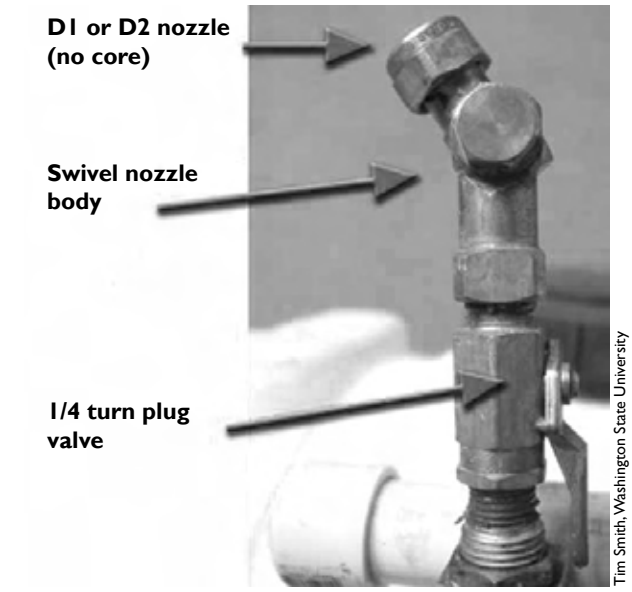
Brand	Type	Rate	Hang at:	Cost (approx)	Effectiveness	Notes
CODLING MOTH - APPLE, PEAR						
Isomate-CM Flex	hand-applied loops	200-400/ac	apple full bloom	$100/acre (at 400/ac rate)	very effective	hang high in tree
Checkmate CM-XL	hand-applied clips	200/acre	apple full bloom	$100/acre	somewhat effective	hang high in tree
Checkmate CM-O Puffer and Isomate CM Mist Plus	battery-powered aerosol device	1/acre	apple full bloom	$120/acre	effective on blocks 30-35 acres or greater and with low CM pressure	hang high on mounted posts or in tree; requires addition of hand-applied dispensers on outer rows; distributor will map where dispensers should go
PEACH TWIG BORER - PEACH, NECTARINE, APRICOT						
Checkmate PTB-XL	hand-applied clips	200/acre	biofix (around shuck split), or June 15	$70/acre	effective	dispensers last 90 days: where summers are longer/hotter, dispensers will run out of pheromone before the season's end, requiring a spray before hanging or after dispensers run out
Isomate-PTB TT	hand-applied loops	200/acre	one month before expected biofix	$100/acre	effective	trap catch may be higher, but USU research shows that injury level is no different between the PTB brands
GREATER PEACHTREE BORER - PEACH, NECTARINE						
Isomate-P	hand-applied twists	100/acre	biofix (early June to early July)	$40/acre	very effective	hang dispensers in lower third of tree canopy; no supplemental spray needed; dispensers will last through a hotter than normal summer

Lure types for monitoring pests in mating disrupted orchards

Lure name	Longevity	Threshold to Apply Supplemental Spray	Notes
CODLING MOTH - APPLE, PEAR			
1x lure (standard lure)	30 or 60 days	---	this lure should not catch any moths in a successful MD orchard; only use if you suspect MD failure; can use this lure in non-MD site to get biofix
10x; Mega lure	21 days	not determined	this lure has a high load of pheromone
Trece CM-DA Combo	60 days	10 moths (cumulative)	this lure captures males and females; trap catches will be higher than 10x lures
Trece DA	60 days	not determined	this lure only captures females; not recommended
PEACH TWIG BORER - PEACH, NECTARINE, APRICOT			
1x lure	30 or 60 days	none has been determined	because it is not a high load lure, these traps should not catch any moths in a successful MD orchard
GREATER PEACHTREE BORER - PEACH, NECTARINE			
1x lure	30 days	2 moths per trap per 7 days (average)	because it is not a high load lure, these traps should not catch any moths in a successful MD orchard

GF-120 for Western Cherry Fruit Fly

GF-120 is a product that combines the insecticide, spinosad, with an attractive molasses-like bait. Spinosad is used in Success and Entrust, but in GF-120, it is used at a much lower concentration and different formulation. GF-120 is approved for use in organic production, and can be applied up to the day of harvest. It works by killing the adults upon ingestion, not the larvae within the fruit.



Tim Smith, Washington State University

GF-120 should be applied with an ultra low-volume sprayer that will produce large droplets. The droplets do not need to cover the entire tree. A 10 to 15-gallon spray tank with auxiliary sprayer and 12-volt pump can be mounted onto a four-wheeler, and sprayed on at a driving speed of about 6 to 7 mph. Swiveling nozzles (to account for different sized trees) are mounted on either side, or a double-swivel nozzle body can be used. Because the product is thick and gooey, it should be mixed outside the tank first in a five-gallon bucket with an electric mixer.

GF-120 won't provide 100% control if the orchard has heavy fruit fly pressure from neighboring farms or backyard trees. Use yellow sticky traps baited with ammonium acetate to monitor for pest population size. One application of imidacloprid near harvest (Admire Pro, generics) may be necessary to kill maggots in the fruit for the first 1 to 2 years of a new GF-120 program.

Advantages of GF-120:

- Highly effective after 2 years of use in a widespread area
- Applied with a four-wheeler, saving gas and time
- Cheaper than many conventional insecticides; the bait and application costs about $20/acre
- Safe on natural enemies, groundwater, and has low mammalian toxicity
- Thorough coverage is not necessary
- Application time is quick, easy, and only requires minimal personal protective equipment

Disadvantages of GF-120:

- Must use at least 2 years (with supplemental sprays) to be effective alone
- Must make sure pressure from neighboring orchards is low
- Must reapply every 7 days
- Must reapply after rain

Codling Moth Virus

Apple and pear growers looking for an organic option for codling moth control should consider the codling moth granulosis virus (CpGV), sold in a product called Cyd-X or Madex (Certis). The virus is naturally occurring, specific to codling moth, and does not harm beneficial insects, amphibians, reptiles, birds, or mammals.

A single ounce of a CpGV suspension can contain up to 3 trillion microencapsulated viral particles. To be effective, the virus must be ingested by codling moth larvae. Once inside the larval gut, the virus multiplies, and after a few days, feeding stops and the larva dies. New viral particles ooze out of dead larvae, and spread to the surface of the fruit, able to cause new infections in other larvae.

Used alone, this biocontrol option gives only moderate control (from 60% to 80% control). In organic orchards, the CpGV virus should be used alternatively with oil or Entrust (spinosad) and/or with mating disruption, or it can be used in conventional orchards to reduce chemical inputs.

Cyd-X / Madex is available for Utah, Idaho, Colorado, and Montana growers: 4 oz/acre, Cropworx in Eckert, CO, 970-835-3335, or online at www.cropworx.net.

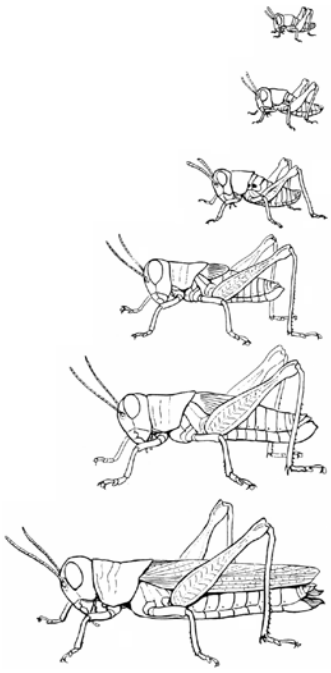
Some points to remember when using codling moth virus:

- Thorough coverage is very important because codling moth larvae are on the surface of the fruit for a very short amount of time.
- Use the highest rate on the first application; afterward, use a lower rate at shorter intervals (every 7 days).
- Apply in late afternoon or on a cloudy day to prevent initial breakdown of the product by the sun.
- Some surface feeding damage (stings) may occur because the larvae are not killed immediately; if this type of injury is unacceptable, use granulosis virus for the first generation only.
- Store the product in a refrigerator or freezer to reduce degradation of the virus.
- Can be mixed with most other pesticides, except for Bt or antibiotics.
- Can be used up to the day of harvest; 4 hour re-entry interval.
- Resistance to the virus has been reported in other countries, so growers should not overuse this product.

Grasshopper Control

In mid to late summer, adult grasshoppers have caused serious fruit damage in some Intermountain West areas. The best time to treat grasshoppers is in mid-spring, while they are still nymphs. Treating as wide an area as possible is the key to success. Adult grasshoppers can travel great distances and may not remain in one area long enough for an insecticide to be effective.

If a treatment is warranted, target open fields, roadsides, hedgerows, drainage ditches, and other weedy areas. Some options include:



Grasshoppers molt 5 times to reach the adult, winged stage.

1. Bait + insecticide:

- wheat bran plus carbaryl
- grasshoppers eat the bait as they are foraging for food
- easy to apply, but expensive
- selectively kills only grasshoppers and other foraging insects
- must be reapplied frequently and immediately following wetting events (rain, sprinkler irrigation)
- very effective option if used early

3. Sprays (malathion, carbaryl, diflubenzuron):

- less expensive
- adheres to plant material
- malathion and carbaryl kill on contact, or when grasshoppers eat foliage
- diflubenzuron is an insect growth regulator and must be ingested; it is slower to kill

Sometimes a state's department of agriculture may subsidize or coordinate grasshopper spray programs in severe grasshopper years. USDA-APHIS covers control programs on public lands. In bad years, state and federal aid may be available in planning and conducting a Cooperative Rangeland Grasshopper Management Program.

Birds and Bats for Pest Suppression

Some bird and bat species can be useful allies in running a successful IPM program. They are motivated, efficient, and cost-effective pest predators. There are ways to manage or manipulate the farm to attract the best and hungriest.

Some of the most common and hard-working **song birds** for orchards are:

- Bluebirds – They eat large numbers of a variety of insects including grasshoppers, and nest in boxes or cavities.
- Chickadees – They eat more insects, including scale, aphids, and leafhoppers, per bird (up to 900/day) than any other, and nest in boxes or cavities.
- Woodpeckers – They feed on borers, bark beetles, and overwintering codling moths by extending their long tongue into tight crevices, and nest in cavities.
- Wrens – They eat grasshoppers and other insects and nest in cavities, boxes, or other locations.

In orchards (particularly organic), birds such as juncos, flycatchers, swallows, and sparrows have shown to help regulate codling moth densities by feeding on diapausing larvae. A study of a California apple orchard showed up to 83% predation of codling moth larvae by birds during the winter (Baumgartner 2000). To attract and keep birds in larger orchards, maintain diverse habitats (border planting mixes, alternate row plantings), leave a few older apple trees or large dead limbs for cavity nesters, and provide water and nesting boxes.

Birds of prey feed on small mammals (mice, voles, gophers) and birds. The kestrel is a small hawk that is an excellent predator for mouse control. Kestrels will return to boxes year after year, but are highly territorial. Barn owls (found in limited numbers in the Intermountain West) feed on large rodents and birds, and their number one choice of prey is gophers. They can be of great value in all agricultural situations, but their population is dwindling due to lack of nesting sites.

Kestrels: Attach nesting boxes to tall poles or trees 10 to 20 feet above the ground, away from human activity. Install up to 1 per 5 acres to increase chances of nesting, but note that a pair may defend up to 250 acres. Adding a bit of nesting material (twigs, wood shavings) can help attract the birds. Monitor each box weekly and remove starling nests. Clean boxes each year.

Barn owls: To attract/keep birds on the farm, keep old wooden barns; they will not nest in metal barns. Nest boxes can be used in place of cavity trees or abandoned buildings. Owls may patrol up to 200 acres per nesting site.

Bats are the only night-flying predator that targets moths. Of the Intermountain West bat species, the big brown bat is the most common that is adaptable to farmland. An established colony feeds by the millions on larger insects. The little brown bat (locally abundant) also adapts to farmland, and feeds on flies (including mosquitoes), moths, mayflies, beetles, and leafhoppers. A single little brown bat can catch 600 mosquitoes per hour.

Bat houses should be installed against buildings where they stay warm at night. Bat houses can be purchased from many farm and garden supply catalogs. It may take several years for bats to find a newly installed house.

Fire Blight

Managing fire blight is a year-round effort. It is best to invest the energy in prevention and managing light infections than doing nothing and reacting to severe infections that may result in tree or orchard removal. When planting a new orchard, consider selecting more disease resistant cultivars (see table on next page).

Winter

The fire blight bacteria overwinter in cankers, and pruning out infested plant tissue will reduce the amount of inoculum in the orchard, thereby reducing future infections. Pruning should be done in winter and early spring when the weather is dry. Infected twigs are easy to identify because the leaves will remain attached well into winter. Limbs with bark that appears wet, off-color, or sunken indicate a canker. Cut the twig or branch at least 8 inches below the visible margin of the infection. Also remove all root suckers and rootstock sprouts because if they become infected, the entire tree is at risk. (Common dwarfing rootstocks such as M9 and M26 are highly susceptible to blight.) Tools do not need to be sterilized between cuts. Debris does not need to be burned or chipped.

Blight Susceptibility of Selected Rootstocks, Apples, and Pears

Variety	Rating	Variety	Rating
ROOTSTOCKS		Honeycrisp	HS
Bud.9	S	Jonagold	S
Bud.118	MR	Jonathan	HS
Geneva 11	MR	Liberty	S
Geneva 16	MR	Lodi	HS
M.7	MR	Macoun	S
M.9	S	McIntosh	S
M.26	S	Mutsu (Crispin)	HS
MM 106	MR	Northern Spy	S
MM 111	MR	Paulared	HS
APPLE		Red Delicious	MR
Braeburn	S	Rome Beauty	HS
Cortland	HS	Spartan	S
Earligold	S	Spigold	HS
Early McIntosh	MR	Winesap	S
Empire	S	**PEAR**	
Fuji	HS	Aurora	HS
Gala	HS	Bartlett	HS
Ginger Gold	HS	Bosc	HS
Golden Del.	S	D'Anjou	S
Granny Smith	HS	Harrow Delight	MR
Idared	HS	Moonglow	MR

MR = Moderately resistant; S = susceptible; HS = highly susceptible

Spring

A copper spray works by providing a surface barrier that prevents bacteria from colonizing. It can be applied from dormant to delayed dormant timing (between tight bud to green tip stages). It must be applied as a high-volume spray so that all exposed surfaces in the orchard are thoroughly wetted, including orchard support structures. Its effect is dependent on how and when it is applied, and the weather after application. Whether a grower uses copper or not will depend on weather, cost, amount of infection in the orchard, and personal experience.

Antibiotics are applied in spring during bloom, only when the predictive model, **Cougarblight**, recommends. Cougarblight uses daily temperatures to provide a risk rating for potential infections.

The Cougarblight model is based on several factors:

1. **Local blight history of the orchard:** The presence or absence of blight in the orchard or nearby will affect the risk potential for infection. Infection is most likely to occur if there was fire blight in the orchard or in neighboring orchards the previous year.

2. **Daily maximum temperature:** Although bacteria can start multiplying at 50°F, the most accelerated bacterial division occurs between 78 and 90°F. The model uses a 4-day accumulation of risk values related to each day's maximum temperature to determine risk potential. The 4-day tally may equate to LOW, CAUTION, HIGH, or EXTREME risk.

3. ***Moisture***: Even if flower stigmas are colonized with bacteria, infection will not occur without sufficient moisture to wash the bacteria into the floral cup. The Cougarblight model provides a risk of infection and it is up to the grower to decide on the presence of moisture. Wetting that triggers flower infection may come from 2 hours of rain, dew, or misting or light wetting from irrigation. Heavy rain or irrigation water that directly strikes the blossom does not seem to trigger infection, perhaps because the blossoms are actually washed free of bacterial colonies.

Antibiotics should only be used on open blossoms. They are not effective at any other time (for example on shoot blight or existing cankers). Streptomycin (Agri-Mycin) is the most effective fire blight antibiotic available, but in Utah County, Utah, fire blight bacteria have developed resistance, limiting its use.

Streptomycin is effective because it has slight systemic activity, lasts 3 to 4 days, and kills the fire blight bacteria. It can be applied up to 24 hours before or

after a wetting event. Adding the nonionic spreader-activator Regulaid will improve coverage and uptake of streptomycin. In areas of documented resistance, streptomycin can be used once per season, and it must be mixed with another antibiotic on that one use. So it should be saved for the "most important" spray where it will be the most effective. In areas where there is no resistance, it is recommended to use streptomycin only when necessary, and mix it with another antibiotic to avoid resistance.

Oxytetracycline is not as effective as strep because it works by slowing down the division of bacteria rather than killing it. As such, it works best if applied 12 to 24 hours before a wetting event to target the bacteria before it is washed into the floral cup. Oxytet lasts about 3 days.

Kasumin (kasugamycin) is a newer antibiotic. It has been extensively tested in Utah, the Pacific Northwest, and in Michigan, and found to be highly effective. It should not be used more than twice in a row.

It is important to realize that all trees can have late blooms during periods when temperatures are warmer, resulting in a great risk for infection. As long as forecasts predict a high risk and blooms are open, antibiotics may need to be reapplied for protection if there is 2+ hours of moisture.

Some organic growers are using of biologicals with their antibiotic spray program. Biologicals alone have not shown to be very effective in managing fire blight, but in areas of streptomycin resistance, biologicals can help oxytetracycline be more effective. For best effect, follow these guidelines when using biologicals:

- Increase water volume to 200 gal/acre. Trees must be wet for the biological to get started.
- Apply the material when flowers are about 15-30% open (early bloom). A second application can be made when flowers are 75-100% open.
- Apply in early morning when temperatures are in the low 60s. Below 50 °F, the biologicals are ineffective and will die. Biologicals need to colonize the flower before the fire blight bacteria have had a chance. A warm day after application is perfect. After successful colonization, it is OK if the weather turns cold.
- Do not mix other pesticides with biologicals.
- Continue to watch the Cougarblight model and follow with an antibiotic when risk levels are high and 2+ hours of moisture is expected. When following with streptomycin, wait 1 day after biological application, and with oxytetracycline, wait 2 days after biological application.
- Do not apply biologicals after fruit set.

Summer

The growth regulator Apogee (prohexadione calcium) can be used to manage shoot blight (but not blossom blight). Apogee does not affect the pathogen directly, and is not a substitute for streptomycin during bloom for blossom blight control. Apogee-treated shoots have hard cell walls, physically barring the spread and growth of fire blight, reducing build up during the summer. The decision to use Apogee is based on past blight history. Where infections are high and antibiotics and pruning are not proving effective, Apogee can help to lessen the spread within trees. The drawback is that the rate of Apogee that is required stops new growth and applications may slow development and result in reduced fruit size and return bloom.

Pruning new infections in summer is just as important as pruning old infections in winter. Early detection and removal slows the spread of fire blight in the tree. Young orchards are most sensitive and should be given high priority. If crews can catch blossom strikes just as they begin (i.e., the leaves/ flowers are just starting to turn color and wilt), the amount to remove should be double the length of the visibly damaged shoot tissue. If the infection is older, find the edge of the canker and then prune 12" beyond that. Prune only in dry weather. It is not necessary to disinfect pruning tools between cuts so long as proper cuts are made (below, and not through, cankers). Pruning debris can be left on the orchard floor to be mowed, so long as the weather is hot and dry.

Where infections are more severe and older wood is affected, it is often best to wait until winter to do a thorough pruning. Research has shown that heavy pruning of fire blight during the growing season can actually increase the spread within the tree.

Information on Apogee for fire blight

Cost	Rate	Timing	Notes
$40-60 per acre	18-36 oz per acre in 300 gal with Regulaid	late bloom or early petal fall	follow up 3-4 weeks later on very vigorous trees; takes almost 2 weeks for the first application to take effect

Replant Problems

Orchard trees replanted into soil previously cropped to the same tree type (apple after apple, peach after peach, etc.) often grow slower and more poorly than the same trees planted into virgin soils or soils previously planted to a different type of crop. Affected trees take 8 years or more to reach full cropping production.

As a result, the onset and rate of fruit production is slowed for those trees. In addition, total fruit production and crop returns over the life of the orchard planting are reduced. This could be due to:

1. Depletion of necessary soil nutrients by the preceding crop.
2. Production of phytotoxic residues by the previous crop root system or by breakdown of the previous crop roots after tree removal.
3. Build-up of soil populations of fungi, bacteria, and nematodes adapted to feeding on the roots of that particular type of fruit tree.

The third explanation seems to be the most likely because treatment of these soils with soil pesticides (nematicides, fungicides, broad-spectrum soil fumigants) has enhanced growth of new trees in old orchard soil. Narrow-spectrum treatments (nematicides, fungicides) often provide less enhancement of new growth than treatment with broad-spectrum soil fumigants (e.g., methyl bromide, chloropicrin). In addition, growth rates of the new trees in soils treated with soil fumigants typically diminish over the initial 3 years after planting to become equivalent to those of trees in non-treated soils. Thus, it is likely that the cause of the replant problem is a complex interaction of the soil nematodes, fungi, bacteria, and microfauna that slow root growth and function.

Replant problems take about 3 years to be re-established in soils treated with broad spectrum fumigants or in virgin soils used to replace old orchard soils within an orchard block being replanted. Rotation to another type of crop (e.g., alfalfa) requires about 8-10 years to return the soil to a state comparable to virgin soil for the initial crop.

Management

Several approaches have been used to address orchard replant problems. First is crop rotation: This usually requires a rotation of 8-10 years to a crop different than the original crop (e.g., peach to apple, peach to alfalfa, etc.).

Another is to replace old orchard soil with virgin soil or soil from a different crop. Dig a 3 ft x 3 ft x 3 ft deep hole and replace the soil in the hole with fresh soil. This labor intensive option is best for a single tree or a few trees within an existing old orchard block.

A third option is soil solarization: Homogenize the soil to very small, uniform soil units, provide sufficient soil moisture to encourage seed germination, and cover the prepared ground with one or two layers of transparent plastic mulch. Seal the edges of the mulch by burying them with soil. The sunlight will heat the soil beneath the clear plastic over time to temperatures as high as 140°F. The temperature threshold for control of soilborne pathogens is 99°F, and control is increased the longer temperatures remain above this point. The longer the plastic remains on the soil plots in the summer months, the deeper the heat will penetrate (it needs to treat as far down as 3 ft.). Once solarization is completed, the plastic mulch can be removed and trees planted into the treated soil, taking care not to pull untreated soil into the planting hole.

A fourth option is soil pasteurization through use of low pressure steam to raise soil temperature to 160°F for 3-4 hrs. However, field-friendly low-pressure

steam generation is rarely available to growers. The process does allow replanting within a day or two after treatment (when soil temperatures return to 70°F or below).

The last option is soil fumigation. This typically involves use of restricted use pesticides such as Telone products (combination nematicide, fungicide, bactericide), chloropicrin (broad-spectrum soil fumigant), or methyl bromide (broad-spectrum soil fumigant). Application of soil fumigants is becoming increasingly regulated because of the risk to the applicator, passers-by, and the environment. They need to be injected into the soil at 18 inches depth and the soil left undisturbed for at least a week. They also have minimum soil temperature thresholds for application (often 50°F or above).

Invasive Pests

Every state in the U.S. monitors for potential invasive pests through the Cooperative Agricultural Pest Survey (CAPS) Program. CAPS is funded by the U.S. Department of Agriculture (USDA) through its Animal and Plant Health Inspection Service (APHIS), which operates the Plant Protection and Quarantine Program (PPQ). The CAPS survey data collected each year are entered into a federal database (NAPIS or IPHIS) and used to determine pest distribution and population levels, the life-stages of specific target pests, first occurrences, and other pest-related phenomena of local interest.

Pest Tracker (pesttracker.org) is the public face of invasive pest detection surveys.

Orchard surveys target up to 10 pests, including European grapevine moth, light brown apple moth, plum pox virus, and Asiatic brown rot.
Although spotted wing drosophila and brown marmorated stink bug have both been found in the Intermountain West, they are still being carefully monitored in orchards. More information about both these pests can be found in Chapter 3: Insects.

All surveys and reports can be found on each state's CAPS website:

Utah: extension.usu.edu/planthealh/invasives

Colorado: ag.colorado.gov/plants

Idaho: State survey reports are not available online. Please contact the Division of Plant Industries, Idaho State Department of Agriculture for more information at:

2270 Old Penitentiary Road, Boise, ID 83712 Phone: 208-332-8627, Fax: 208-334-2283

Montana: agr.mt.gov/Pests

Members of the public can view maps generated with CAPS data by visiting USDA's Pest Tracker website at: pesttracker.org

Managing Crown and Root Suckers Around Fruit Trees

Many types of fruit trees produce suckers around the base of the tree. Crown suckers arise in the area immediately surrounding the tree trunk. Root suckers can arise from roots further away from the trunk. Suckers around trees are unsightly and they can harbor insect pests like woolly apple aphids and can be points of entry for diseases like fire blight. If suckers are profuse, they interfere with in-row weed management and can absorb systemic herbicides such as glyphosate. Some rootstocks used for fruit trees such as M.7 for apples and Mazzard for cherries are genetically predisposed to produce suckers. M.9 clone RN-29 is more inclined to sucker than other M.9 clones. In some cases, sucker growth is a symptom of partial incompatibility between the rootstock and scion. Suckers can also result from injury to the crown such as extreme cold or mechanical injury. Whatever the cause, managing suckers takes time and expense.

This young apple tree has profuse suckers around the crown of the tree. Photo by Teryl Roper.

Left unmanaged, the suckers will grow up into the lower parts of the tree.

Sucker management falls into two general categories: mechanical and chemical. Each approach has merit depending on the orchard situation.

Mechanical Control

When only a few suckers are present, they are often removed during dormant pruning. In severe cases, sickle bar style mowers or gas-powered hedge shears have been used to remove suckers. However, when suckers are mechanically removed multiple new shoots can arise from cutting a single sucker, making the problem worse. Mechanical control is also expensive and labor intensive and may have to be done more than once per year.

Related to mechanical control is control by heat. In a USU trial, burning suckers with a propane torch provided good control that lasted several weeks. This may be an effective approach for a few suckers here and there. Treating an entire block with a torch would require very slow travel speeds and would consume a substantial amount of propane. Care would also need to be taken to not damage irrigation tubing.

Chemical Control

Chemical control of suckers can be effective and is less labor intensive than mechanical control. Many acres can be treated in a day by a single operator. Chemical controls for suckers can be grouped into three categories: Plant growth regulators, herbicides, and desiccants.

Plant Growth Regulators

Commercial fruit growers have long used a synthetic auxin, Naphthalene Acetic Acid (NAA), to reduce the growth of suckers. This is the same plant growth regulator (PGR) that is used to thin fruit, but the timing, and concentration are very different. Because NAA will cause a thinning response, application must be delayed until a month after petal fall. This allows time for the fruit to set and become less sensitive to NAA. Nevertheless, application should be made at a low pressure (10-20 psi) using nozzles that produce large droplets to reduce drift. A specific formulation of NAA (Tre-Hold A-112™) is registered for this use. For apples a single annual application with a 0.5% to 1% solution of NAA should reduce the growth of root suckers.

Herbicides

Some specific contact herbicides are registered for sucker management for fruit trees. While these are registered for sucker suppression or control, they are still herbicides and can damage trees, especially young trees where the bark is green and not yet corky. Therefore, extra care must be taken during application to not treat tree trunks. Young trees should have trunk wraps installed before application of herbicide products. Contact herbicides have the added advantage of providing some control for weeds that may have emerged since spring herbicide applications.

General principles for application of herbicides for sucker management include spraying only when winds are calm, using low pressure, and large droplet size. Low drift nozzles are preferred. The use of off-center nozzles may lead to overspray on trunks. For these contact herbicides, good coverage of the foliage is essential. Thus, sufficient water must be sprayed to thoroughly wet the leaves. Control is best when the suckers are still young and succulent, and not woody.

Paraquat (Gramoxone™) is a caustic, non-systemic, post-emergent herbicide that burns green vegetation. Paraquat is rapidly absorbed by green plant tissues and reacts with photosynthesis to produce superoxides that kill the plant cells. Paraquat is highly toxic to humans and is a restricted use pesticide that can only be mixed and applied by certified pesticide applicators. It provides good burn down of suckers at the higher rates.

Glufosinate (Rely 280™, Cheetah™) is another contact herbicide that is registered for sucker management. It is the slowest acting of the herbicide products included in this fact sheet. It can take 20-25 days to reach the level of control provided by the other herbicides in 10-14 days.

Carfentrazone-ethyl (Aim EC™) is registered for sucker control in fruit trees. Aim must be applied using a hooded sprayer to minimize the opportunity for drift. Also, it must be mixed with an appropriate rate of a nonionic surfactant or crop oil concentrate. While Aim is effective at controlling suckers while they are green and non-woody, the opportunity for injury from drift makes this a less desirable choice.

Pyraflufen-ethyl (Venue™) is a contact herbicide for post-emergent control of a range of broadleaf weeds. It also has a supplemental label for control of suckers in fruit trees. It is fast acting and effective at the 4 fl. oz/a rate. Cherry suckers are more susceptible to Venue than apple suckers.

Use patterns for herbicides registered for control in tree fruits. Check product labels for specific use information.

Generic name Trade name	Rate/ acre	Appl. per yr	REI (hours)
paraquat gramoxone	2.5 to 4 pt	3	12
glufosinate rely, cheetah	48 to 56 fl oz	2	12
Carfentrazone-ethyl Aim	2 fl oz	---	12
Pyraflufen-ethyl Venue	3 to 4 fl oz	3	12

Desiccants

Recently we became aware of a material that is being used elsewhere for sucker control in tree fruits and nuts. Urea Ammonium Nitrate (UAN) is a liquid fertilizer that is a powerful desiccant. It is not registered as a pesticide. It can be purchased in co-op agronomy centers in the Intermountain West. When sprayed on suckers in the spring it desiccates the succulent foliage and stunts growth. Since it is 32% nitrogen, by weight, it also provides additional nitrogen when applied for sucker control.

In orchards, not all rootstocks are equally prone to sucker. We recommend avoiding planting apple trees on M.7 rootstocks. Also, when nursery trees are 'high-budded' so the root system can be planted slightly lower, this can reduce the amount of suckering. However, this approach can be overdone. Avoiding mechanically damaging rootstocks can also prevent suckering.

Apple trees with profuse suckering one week after treatment with UAN in Kaysville, Utah. The foliage has all been desiccated by the treatment. Photo by Samuel Johnson.

Note

References to chemicals in this publication are for your convenience and are not endorsements of particular products over other similar products. Plant growth regulators are classified as pesticides by the U.S. Environmental Protection Agency. You are responsible for using pesticides according to the manufacturer's current label directions. Follow directions exactly to protect people and the environment from pesticide exposure. Failure to do so violates the law.

This information is provided as an educational tool to inform growers what materials are legal to apply and what is effective. No implication is intended that Utah State University recommends the use of any materials.

Literature Cited

Johnson, S.L. 2020. Opportunities for Optimal Apple Production Management in Arid Conditions. Utah State University. MS Thesis.

Smith, T.J. and E Gutierrez. 2014. Evaluation of Venue, Gramoxone, Aim, and Rely Herbicides for Root and Crown Sucker Control in Apple and Cherry. Massachusetts Fruit Notes 79:1-4.

Tukey, R.B. and T.J. Raese. 1995. Chemical control of water sprouts and suckers. Washington State University, Extension Bulletin EB1593.

CHAPTER 3 INSECT AND MITE BIOLOGY AND MONITORING

Aphids – Green Apple Aphid

Aphis pomi

HOST: apple

BIOLOGY: Overwinter as eggs in protected areas on limbs and start hatching at half-inch green. Green apple aphids remain on apples all season.

SYMPTOMS/DAMAGE: Curled leaves; copious honeydew supports black, sooty mold; stunted shoots.

MONITORING: Look for shiny black eggs in early spring. If aphids are a problem later in the season, start after petal fall and select a random shoot on the major cultivar in the block and count the number of leaves that have one or more wingless aphids; repeat on 10-20 more shoots, and determine the average number of leaves/shoot that have aphids.

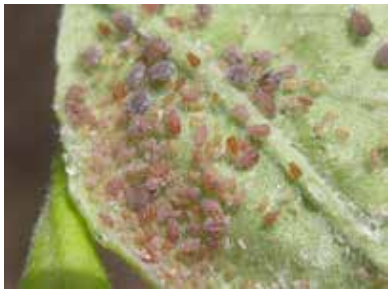
TREATMENT THRESHOLD: Delayed dormant oil will usually take care of this aphid. Otherwise, 4+ leaves/shoot infested with aphids during the season will require treatment.

MGMT CONSIDERATIONS: Numerous beneficial insects including lady beetle adults and larvae, lacewing larvae, and syrphid fly larvae help suppress aphid populations.

Aphids – Rosy Apple Aphid

Dysaphis plantaginea

HOST: apple



BIOLOGY: Overwinter as eggs in protected areas on limbs and start hatching at half-inch green. Migrate to alternate weed hosts during summer.

SYMPTOMS/DAMAGE: Curled leaves; honeydew; saliva of rosy apple aphid is toxic to fruit cells, resulting in deformed fruit.

MONITORING: Look for shiny black eggs in early spring. Starting at open cluster stage, examine at least 10 trees, spending 3 minutes/tree, and look for colonies.

TREATMENT THRESHOLD: Delayed dormant oil will usually take care of this aphid. Otherwise, an average of more than one colony per tree may result in fruit injury.

MGMT CONSIDERATIONS: Numerous beneficial insects including lady beetle adults and larvae, lacewing larvae, and syrphid fly larvae help suppress aphid populations.

Aphids – Woolly Apple Aphid

Eriosoma lanigerum

HOST: apple

BIOLOGY: Overwinter as nymphs primarily on the roots, but sometimes in cracks and crevices in the tree canopy. White, cottony colonies are visible by mid to late June. Their waxy covering makes them difficult to control.

SYMPTOMS/DAMAGE: Galls at feeding sites (twigs and roots); heavy feeding can reduce tree vigor; honeydew; sticky colonies are messy during harvest.

MONITORING: Start monitoring for colonies in mid-June by checking root suckers and edges of pruning cuts and wounds.

TREATMENT THRESHOLD: No threshold determined.

MGMT CONSIDERATIONS: Numerous beneficial insects including lady beetle adults and larvae, lacewing larvae, syrphid fly larvae, European earwig, and parasitoids (small wasps). If colonies are present, an insecticide treatment can be applied in early

to mid-July. If using spirotetramat (Ultor), apply at petal fall to allow time for translocation of the chemical within the tree.

Aphids – Green Peach Aphid

Myzus persicae

HOSTS: apricot, nectarine, peach

BIOLOGY: Overwinter as eggs at the base of buds in peach/nectarine trees. Migrate to alternate hosts during summer.

SYMPTOMS/DAMAGE: Curled leaves; honeydew; feeding on nectarine fruit results in deformities; reduced tree vigor; aborted fruit.

MONITORING: Beginning at petal fall, inspect the undersides of leaves for new colonies. For faster inspection, shake limbs over a cloth tray ("beating tray") to observe the dislodged insects.

TREATMENT THRESHOLD: Treat peaches with 2+ colonies/tree before shuck split or 6+ colonies/tree after shuck split; treat nectarines at 1 colony/tree at any time.

MGMT CONSIDERATIONS: Numerous beneficial insects including lady beetle, lacewing larvae, and syrphid fly larvae help suppress aphid populations.

Aphids – Black Cherry Aphid

Myzus cerasi

HOST: cherry

BIOLOGY: Overwinter as eggs on twigs and fruit spurs; hatch just before bloom. Migrate to mustard family weed hosts during summer.

SYMPTOMS/DAMAGE: Curled leaves; copious honeydew can cause severe stickiness on fruit.

MONITORING: Look for shiny black eggs in early spring at the base of buds.

TREATMENT THRESHOLD: No threshold determined.

MGMT CONSIDERATIONS: Delayed dormant oil will usually take care of this aphid. Numerous beneficial insects including lady beetle adults and larvae, lacewing larvae, and syrphid fly larvae help suppress aphid populations.

Apple Maggot

Rhagoletis pomonella

HOSTS: apple, hawthorn, plum

BIOLOGY: Adults lay eggs in host fruits in mid to late in summer; maggots drop to pupate in soil.

SYMPTOMS/DAMAGE: Knobby fruit with cone-shaped pits; egg-laying scars; narrow brown tunnels in flesh.

MONITORING: This fly is found in apples from Colorado Springs to Loveland, CO but has not been trapped in commercial orchards in Utah, Idaho, or Montana. It has been found infesting home garden plums in Utah. Its native host is river hawthorn. To monitor, hang red sticky sphere traps or Pherocon AM yellow sticky traps starting in early July at orchard borders.

TREATMENT THRESHOLD: According to Cornell University, treat when 5 flies per trap are caught.

MGMT CONSIDERATIONS: This pest is regulated by a quarantine to prevent its spread.

Brown Marmorated Stink Bug

Halyomorpha halys

HOSTS: all tree fruits, plus many vegetables, landscape ornamentals, and some row crops

BIOLOGY: Adults are shield-shaped, mottled brown, and about 5/8 inch long. They overwinter under rocks, logs, and leaves but may also enter homes, garages, and other sheltered buildings. Adults

become active in the spring to feed and mate. Females deposit clusters of 20 - 30 pale green eggs on the undersides of leaves. Newly hatched nymphs have yellow to red abdomens with black stripes and huddle around the egg mass. Nymphs darken with age and disperse from the egg mass.

SYMPTOMS/DAMAGE: Feeding causes necrotic (dark colored) lesions, pits, depressions, and cat-facing (deformities) on fruits; feeding in fruit flesh causes corky, discolored areas.

MONITORING: Pyramid or sticky panel traps with pheromone lure (Trécé Dual Lure), visual observations, beating trays, and sweep nets can detect the presence of BMSB. Traps are most effective when placed on orchard and field borders.

TREATMENT THRESHOLD: No threshold determined.

MGMT CONSIDERATIONS: Beginning in 2017, BMSB was found causing crop damage in peach, apple, squash, and corn in Utah. BMSB is present in fruit-producing counties of northern Utah. At least thirteen species of parasitoid wasps from the families Eupelmidae and Scelionidae are present in Utah. Treat with insecticides when active populations and initial crop damage are detected but avoid broad-spectrum compounds as they can harm parasitoid wasps.

Cat-facing Insects

Several species

HOSTS: all fruits

BIOLOGY: True bugs, such as stink bugs, lygus bug and boxelder bug, overwinter as adults and move to orchards when fruits become attractive and other foods (field crops or weeds) are not as abundant. Feed with piercing-sucking mouthparts.

SYMPTOMS/DAMAGE: Deep pits and sunken areas in fruit; distorted fruits; water-soaked gumming on peach fruit; brown spots in tissue of apples. Early-season feeding causes fruit distortion. Injury near harvest causes pits and sunken areas on fruits and lowers fruit quality and storability.

MONITORING: Use sweep nets in weedy areas or on orchard borders; inspect fruit for damage.

TREATMENT THRESHOLD: No threshold determined.

MGMT CONSIDERATIONS: True bugs use weeds as alternative hosts to feed, reproduce, and overwinter. Removing preferred hosts and managing weeds within and around the orchards help in reducing populations. Two species of parasitoids in the family Scelionidae have also been shown to help suppress stink bug populations.

Codling Moth

Cydia pomonella

HOSTS: apple, pear

BIOLOGY: Overwinter as diapausing larvae, and pupate in spring. Adult female moths lay eggs on and near apple/pear fruit, and larvae tunnel within fruit and feed on the seeds. Two-three generations/season.

SYMPTOMS/DAMAGE: Frass at entry/exit hole; tunneling in fruit flesh around seeds; early fruit drop.

MONITORING:

a) *non-mating disruption:* Follow USU Extension biofix model to predict timing of first egg hatch, or hang pheromone trap with standard (1×) codling moth lure at first pink or 100 degree days after March 1 to record date of first moth flight (called biofix, when first moth has been caught). Continue to monitor trap and determine weekly moth counts to monitor population throughout the season.

b) *mating disruption:* Follow USU Extension biofix model, or hang pheromone trap with CM-DA Combo lure at first pink or 100 degree days after March 1 in backyard tree or non-mating disrupted area close to orchard to determine biofix date. Continue checking trap weekly, and treat when threshold is reached.

TREATMENT THRESHOLD:

a) *non-mating disruption*: no threshold; usually treatment is needed throughout the season to protect fruit.

b) *mating disruption*: treat when 10 total moths, or 1 female moth, have been trapped using the CM-DA Combo lure. Restart threshold for each generation and after an insecticide treatment.

DEGREE DAY MODEL: upper threshold: 88°F; lower threshold: 50°F

Event (after biofix)	Degree Days
First Generation	
1% egg hatch	220
period of greatest egg hatch	340-640
100% egg hatch	920
Second Generation	
1% egg hatch	1100
period of greatest egg hatch	1320-1720
100% egg hatch	2100
Third Generation	
1% egg hatch	2160

MGMT CONSIDERATIONS: Proper timing of insecticides is important. Maintain sanitation by removing apple bins and removing/mowing fallen fruit.

European Earwig

Forficula auricularia

HOSTS: all fruit trees; cause damage to peach, apricot

BIOLOGY: European earwigs overwinter as adults, and females lay eggs in the soil in early spring. Populations become active in fruit trees by mid to late June. Wet, cool springs and summers favor this nocturnal insect.

SYMPTOMS/DAMAGE: Adults chew holes in fruit; enter split-pit peach fruits and feed on flesh near pits; produce small black dots of frass (excrement).

MONITORING: Corrugated cardboard "rolls" tied onto the tree trunk can indicate when earwigs start climbing into trees.

TREATMENT THRESHOLD: No threshold determined.

MGMT CONSIDERATIONS: Protect ripe, soft fruit from damage. Earwigs are also predators on other insects, so their presence at times other than when fruits are ripe can be beneficial.

European Fruit Lecanium

Parthenolecanium corni

HOSTS: all fruit trees but more commonly peach

BIOLOGY: The European fruit lecanium is a soft scale which means its body is attached to a waxy cover. Female adults are brown, spherical, and convex (humped). They overwinter as nymphs under the bark of twigs and branches.

SYMPTOMS/DAMAGE: Sticky honeydew and sooty mold; reduced growth; reduced fruit size.

MONITORING: Monitor for crawlers in early spring by inspecting twigs or by placing a double-sided sticky tape around them.

TREATMENT THRESHOLD: No threshold determined.

MGMT CONSIDERATIONS: Numerous beneficial insects including lady beetle adults and larvae, lacewing larvae, and parasitoid wasps. Apply a delayed dormant spray of oil when crawlers emerge. If needed, combine with insecticide to maximize effectiveness. Apply systemic insecticides in late spring when nymphs start feeding on trees.

Flatheaded Borers

Chrysobothris spp.

HOSTS: all fruit trees

BIOLOGY: Two species occur in the Intermountain West: Pacific and appletree flatheaded borers. Larvae overwinter inside the tree, and emerge as adult beetles in June-August (northern Utah). This insect is usually only a problem on stressed trees (drought, wounding, etc.) or when populations are high in an area. Young apple and peach trees have

been attacked under these conditions.

SYMPTOMS/DAMAGE: Oval-shaped exit holes; sawdust-like frass; loose, dead tree bark. The larvae can eventually girdle trunks which will kill young trees and heavily-attacked trees.

MONITORING: Watch for adult beetles in May-July.

TREATMENT THRESHOLD: No threshold determined.

MGMT CONSIDERATIONS: The key to management is to maintain healthy trees and remove sources of beetles, such as old orchards. Preventive trunk sprays may be necessary to kill larvae before they tunnel into trunks.

Greater Peachtree (Crown) Borer

Synanthedon exitiosa

HOSTS: apricot, nectarine, peach, plum

BIOLOGY: Adult clearwing moths begin activity in late June, and females lay their eggs on the base of tree trunks through September. Young or stressed trees can be killed.

SYMPTOMS/DAMAGE: Tree decline and dieback; oozing gummosis mixed with frass at the soil-line of the tree.

MONITORING: Look for holes near the soil line and oozing gum mixed with frass. To determine when adults emerge, hang pheromone traps starting in mid June or 400 degree days after March 1. Leave traps up and check weekly to monitor pest population throughout the season.

TREATMENT THRESHOLD: If peak trap catch is greater than 10/week, treatment may be needed, especially if you find an average of more than 1 empty pupal case per tree. For greater peachtree borer under mating disruption: average of 3 moths/trap.

DEGREE DAY MODEL: upper threshold: 87°F; lower threshold: 50°F

Event (after Jan.1)	Degree Days
adults begin flight (UT)	900-950
moth flight ends	2325-2525

MGMT CONSIDERATIONS: Remove grass, weeds, and suckers from around the base of trees and provide optimal watering. Mating disruption (1+ acres) or preventive trunk sprays covering the upper roots and 12-18" of lower trunk are the main control tactics.

Leaf Blister Mites

Eriophyes spp.

HOSTS: apple, pear

BIOLOGY: Pearleaf and appleleaf blister mites are microscopic worm-shaped mites in the eriophyid group. Adults overwinter under leaf bud scales and emerge with new leaf growth in the spring. They migrate to leaves and feed in colonies inside tiny blister-galls.

SYMPTOMS/DAMAGE: Newly formed leaf blisters are green and then turn brown as the leaves age; severe infestations can deform fruit and reduce tree vigor.

MONITORING: Watch leaves for blisters.

TREATMENT THRESHOLD: High populations can reduce photosynthesis and thus tree vigor. Lower populations can be tolerated.

MGMT CONSIDERATIONS: Cannot be treated in summer. Horticultural oil, sulfur, or carbaryl in fall or spring is most effective.

Leafhoppers

Several species

HOSTS: apple, cherry

BIOLOGY: White apple and rose leafhopper are the most common species. Nymphs begin feeding on leaves by petal fall. They are white and crawl slowly (rose leafhoppers have black spots). The adults

are wedge-shaped with wings meeting in a sharp peak over the back. There are two generations per year.

SYMPTOMS/DAMAGE: White stippling on leaves; frass (tar-like spots) on fruit; flying adults are a nuisance during picking; reduce tree vigor.

MONITORING: Look for nymphs at petal fall on undersides of leaves or shake branches over a cloth tray.

TREATMENT THRESHOLD: No fruit injury occurs even in heavy feeding, so treatment early in the season is done to prevent a nuisance population during picking. An average of 3 nymphs/leaf may require treatment, but trees can tolerate a much higher density.

MGMT CONSIDERATIONS: Nymphs are easier to control than adults.

Leafrollers

Several species

HOSTS: all fruit trees

BIOLOGY: Leafrollers (obliquebanded, OBLR; fruittree) are usually minor pests in the Intermountain West. OBLR larvae can damage tart cherries just before harvest if populations are high. Depending on the species, they overwinter as pupae or eggs and emerge in spring. Only the obliquebanded leafroller has more than one generation.

SYMPTOMS/DAMAGE: Rolled, chewed leaves; dimpling or scarring on fruit.

MONITORING: Look for rolled leaves at shoot terminals starting in late May; monitor adult populations with pheromone traps.

TREATMENT THRESHOLD: No threshold determined.

DEGREE DAY MODEL: For OBLR, lower threshold 43°F; upper threshold 85°F

MGMT CONSIDERATIONS: In apple and pear where OBLR injure fruit, suppress overwintering larvae in the spring (half-inch green to petal fall); insecticides applied for control of codling moth will often suppress OBLR later in the season. In tart cherry where OBLR larvae injure fruit just before harvest, select an insecticide that kills OBLR in the mid to late cherry fruit fly control program.

Event	Degree Days
Hang pheromone traps in orchards	600-700
First moths of 1st summer generation expected	1025-1175
Set biofix at 1st moth catch	0 (reset to zero)
1st generation egg hatch	400-920
2nd generation egg hatch	1590-2360

Peach Silver Mite, Plum Rust Mite & Apple Rust Mite

Aculus spp.

HOSTS: nectarine, peach, plum

BIOLOGY: Worm-shaped microscopic mites called eriophyid mites; related to blister and rust mites. They overwinter as females in buds, just beneath the outer scales; they crawl to new leaves after budbreak.

SYMPTOMS/DAMAGE: Heavy feeding causes

"silvering" of leaves, reduced fruit size, and premature fruit drop.

MONITORING: Because these mites are so small, they are difficult to see with a hand lens, which makes monitoring challenging. Starting in mid summer, check the leaves for the silvering symptoms.

TREATMENT THRESHOLD: No threshold determined.

MGMT CONSIDERATIONS: Moderate populations are a good food source for predatory mites, especially early in the season. Peach cultivars vary in susceptibility to the mite: Red Haven is a poor host while Elberta is a good host.

Peach Twig Borer

Anarsia lineatella

HOSTS: apricot, nectarine, peach

BIOLOGY: In spring, the brown larvae emerge from protected cells on the limbs of trees and tunnel into succulent shoot tips where they soon pupate to adults. Later in the season (after shoot growth hardens off), larvae enter soft fruit.

SYMPTOMS/DAMAGE: Infested twigs wilt and die back and small masses of gum exude from tunnel openings; larvae typically enter fruit near the stem end, especially in fruits with split pits; frass is present at larval entries into fruit.

MONITORING:

a) *non-mating disruption:* Hang pheromone trap with peach twig borer lure at 300 degree days after March 1 to record date of first moth flight (called biofix, when 2+ moths have been caught). Leave trap in orchard and check moth numbers weekly to monitor population throughout the season.

b) *mating disruption:* There are no special peach twig borer lures for monitoring orchards under mating disruption; follow "a" above.

TREATMENT THRESHOLD: Usually treatment is always needed throughout the season; no threshold has been determined for peach twig borer under conventional management or mating disruption.

DEGREE DAY MODEL: upper threshold: 88°F; lower threshold: 50°F

Event (after biofix)	Degree Days
5-28% egg hatch (1st gen)	300-400
5-28% egg hatch (2nd gen)	1200-1360

MGMT CONSIDERATIONS: Proper timing of insecticides is important.

Pear Fruit Sawfly

Hoplocampa brevis

HOST: pear

BIOLOGY: Larvae are boring insects that feed on pear fruitlets during spring. Mature larvae drop to the ground to pupate in the soil where they overwinter. Adults are small dark wasps with transparent wings and an orange head. This pest is not to be confused with another pest belonging to the same family (Tenthredinidae) and of a similar name, the pear sawfly, which feeds on the leaves of pear trees during summer.

SYMPTOMS/DAMAGE: Deformed and swollen fruitlets; exit hole near fruit calyx; premature fruit drop.

MONITORING: Start monitoring adult sawflies in March-April by checking buds and fruitlets.

TREATMENT THRESHOLD: No threshold determined.

MGMT CONSIDERATIONS: There are no products registered for pear fruit sawflies in Utah but dormant oil spray targeting other pests can control populations. Entomopathogenic fungi can also target larvae in the soil and reduce overwintering populations.

Pear Psylla

Cacopsylla pyri

HOST: pear

BIOLOGY: Overwinter as adults outside the orchard and move in to lay eggs on buds and twigs in early spring. The adults resemble small cicadas.

SYMPTOMS/DAMAGE: Honeydew; leaf scorching; leaf drop; black sooty mold on leaves and fruit. Pear psylla may also transmit a disease called "pear decline" that can slowly kill trees over a number of years.

MONITORING: Look for psylla adults early in the spring (starting 6 weeks before bloom) by tapping or shaking the branches over a light colored beating tray.

TREATMENT THRESHOLD: Early season, 0.5 nymphs/leaf; summer, 1.5 nymphs/leaf; examine 10 leaves per 5 randomly selected trees/block.

MGMT CONSIDERATIONS: Root stocks resistant to pear decline are available. Resistance to many insecticides has occurred in pear psylla populations, so switching insecticides across years can help prevent resistance in your orchard. The best control is achieved with a dormant spray to kill overwintered adults before new eggs are laid.

Pear or Cherry Slug (Pear Sawfly)

Caliroa cerasi

HOSTS: cherry, pear

BIOLOGY: Overwinter as pupae in the soil. Adults lay eggs on leaves in mid summer. The larvae have a slug-like appearance and feed on the upper surface of the leaf epidermis creating 'windowpanes.'

SYMPTOMS/DAMAGE: They cause a skeletonizing injury where membranous "windows" of leaf tissue remain in between leaf veins. Leaf feeding injury can proceed rapidly when populations are high.

MONITORING: Watch for sawfly larvae starting in mid to late July.

TREATMENT THRESHOLD: No threshold determined.

MGMT CONSIDERATIONS: The larvae are often suppressed by insecticides applied for other pests. Trees can tolerate low populations.

Plum Curculio

Conotrachelus nenuphar

HOSTS: apple, pear, nectarine, peach, apricot, cherry

BIOLOGY: The gray-brown weevils overwinter as adults under leaf litter and debris. Females insert eggs in green fruit in May-June. Larvae feed and develop inside the fruit until reaching maturity, then drop into the soil to pupate.

SYMPTOMS/DAMAGE: Crescent-shaped scar on fruit due to egg laying from females; galleries within fruit flesh; premature fruit drop; unmarketable fruit.

MONITORING: Visual inspection using beating sheets to detect adults in spring. Pyramid traps baited with benzaldehyde lures can also be set up by petal fall to monitor adult emergence. After petal fall, monitor for crescent-shaped wounds on fruits to detect immature activity.

TREATMENT THRESHOLD: Insecticide application is recommended when 0.1 adults per pyramid trap per day is detected.

MGMT CONSIDERATIONS: Apply insecticides at petal fall and repeat after 7 to 10 days during egg laying period. Removing infested fruits and alternate hosts around the orchards can reduce populations.

Root Borer – California prionus

Prionus californicus

HOSTS: peach, apricot, cherry

BIOLOGY: Larvae feed on roots and crowns of cherry and peach. Larvae can live for 3 years in the soil before emerging as adults around July in Northern Utah. They can be a problem in sandy soil and in new orchard sites.

SYMPTOMS/DAMAGE: General tree decline with canopy dieback or sudden loss of tree vigor. Feeding creates furrows in the roots and crown wood.

MONITORING: Ground bucket traps baited with prionic acid pheromone lures attract male *Prionus* beetles.

TREATMENT THRESHOLD: No threshold determined.

MGMT CONSIDERATIONS: There are no registered insecticides in Utah for this pest. Soil application of a systemic insecticide (neonicotinoids) may be an effective treatment in young trees with small root systems. Check the insecticide label to be sure the fruit crop is listed before use. Mass trapping with a pheromone lure can help to reduce *Prionus* populations. Avoid planting stone fruit trees into historically infested sites.

Root Borer – Ten-lined June Beetle

Polyphylla decemlineata

HOSTS: all fruit trees, but more common in cherry and peach

BIOLOGY: Larvae can stay 2 to 4 years in the ground, feeding on woody roots. Adults emerge in June-July and hide in weeds and grass surrounding the orchards.

SYMPTOMS/DAMAGE: General tree decline with few other above-ground symptoms. Extensive feeding throughout roots and within crown wood. Adults create notches on the edge of the leaves, causing little damage.

MONITORING: Declining trees in sandy soil, despite adequate care, can be pulled to check for grubs near the roots. Since adult males are attracted to light, they can be monitored with blacklight traps.

TREATMENT THRESHOLD: No threshold determined.

MGMT CONSIDERATIONS: Parasitoid wasps from the family Tiphiidae can infest the grubs. Entomopathogenic nematodes and fungi can be effective on June beetle larvae but require adequate soil moisture to be effective.

Root Weevils

Otiorhynchus spp.

HOSTS: all fruit trees

BIOLOGY: The adults are hard, rounded beetles with pronounced "snouts;" primarily active at night. Adults feed on foliage and the small, white legless larvae feed on roots and crowns.

SYMPTOMS/DAMAGE: Semi-circular notches at leaf edges; reduced tree vigor and increased drought stress.

MONITORING: Check for leaf damage in summer.

TREATMENT THRESHOLD: No threshold determined.

MGMT CONSIDERATIONS: The best timing for suppression is in the spring and early summer when leaf-notching injury first appears, and again in the late summer to early fall to target larvae before winter. Many insecticides can kill adults; entomopathogenic nematodes and fungi applied to the soil by the roots can kill larvae.

San Jose Scale

Quadraspidiotus perniciosus

HOSTS: apple, pear, cherry, peach, nectarine

BIOLOGY: San Jose scale is an armored scale that overwinters as a mix of nymphs and adults. Contrary to soft scales, armored scales do not secrete honeydew and are covered with a waxy cover that can be detached fron their body. Crawlers (newly hatched nymphs) emerge in late spring and a second generation emerges in late summer. They feed on sap from leaves, limbs, and fruits.

SYMPTOMS/DAMAGE: Feeding on apple and pear fruit appears as red halos with white centers. Heavy feeding reduces tree vigor and blemishes fruit.

MONITORING: Look for limbs encrusted with small, circular, black and gray armored scales. Monitor for crawlers by wrapping black tape around an infested limb and covering the tape with petroleum jelly; look for trapped crawlers. There are pheromone traps for male adults, but they have not been reliable in Utah.

TREATMENT THRESHOLD: Treat at crawler stage if any fruit in the orchard in the prior season had scale.

DEGREE DAY MODEL: upper threshold: 90°F; lower threshold: 51°F; crawlers begin hatching approximately 300-400 degree days after codling moth biofix; time to treat is at 600 degree days

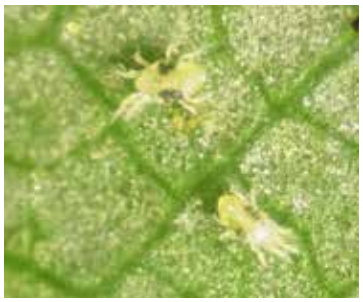
MGMT CONSIDERATIONS: Adults are difficult to kill. Dormant oil can kill a portion of overwintering nymphs, but crawlers hatched from overwintering adults will have to be treated when they emerge. Thus, a first application of dormant oil is recommended when the trees are fully dormant, and a second oil application should be performed as flower buds begin to swell and break. Contact insecticides may be added to the second dormant spray to increase efficacy on newly hatched crawlers. Apply treatment at high volume, as complete coverage of the tree is critical for effective management. If crawlers have settled, consider applying systemic insecticides (neonicotinoids).

Spider Mites

Several species

HOSTS: all fruit trees

BIOLOGY: Mites are very small arthropods that are more closely related to ticks than insects. European red mites overwinter as black eggs on tree limbs and, if abundant, can cause feeding injury early in the season. Two-spotted and McDaniel spider mites overwinter as adults on lower trunks and in groundcover, and may become a problem during hot, dry conditions in the mid and late summer when they reproduce rapidly (1-2 weeks to complete a generation).



SYMPTOMS/DAMAGE: Stippling on leaves due to removal of chlorophyll and sap; severe feeding causes "mite burn." Spider mites produce fine silk webbing that becomes apparent when populations are high.

MONITORING: Before budbreak, look for European red mite egg masses on tree bark and near buds. In late spring, watch for stippling damage on lowest interior leaves first. Shake limbs over cloth tray.

TREATMENT THRESHOLD: Start monitoring 5 weeks after bloom and treat if average number of mites per leaf is greater than 10 (apple and cherry) or 5 (pear).

MGMT CONSIDERATIONS: In addition to plant-feeding mites, there are predatory mites that feed on spider mites. Specifically, predatory mites from the family Phytoseiidae (phytoseiid mites) can provide effective biological control if they aren't harmed by pesticides. In Utah, *Galendromus occidentalis* is the most common species encountered in orchards. Low populations of spider mites can be ignored and are often kept in check by the predatory mites. Spider mite outbreaks often follow pesticide applications that upset the predator-prey balance. Resistance to chemicals is common, so miticides should not be used repeatedly. Applying insecticidal soap or horticultural mineral oil every 5-7 days until mite densities decline can be effective. Avoid applying soaps or oils during the hot part of the day as some leaf burn may result.

Spotted Wing Drosophila (SWD)

Drosophila suzukii

HOSTS: all fruits, especially soft fruits

BIOLOGY: Overwinter as adults and pupae; adults

lay eggs inside fruit and maggots feed on pulp. SWD adults have been trapped in Utah orchards, but no fruit injury has been detected.

Martin Hauser, CA Dept of Agriculture

SYMPTOMS/DAMAGE: Sunken fruit; holes in fruit.

MONITORING: SWD has been found in northern Utah in low numbers, in north-central Idaho in high numbers, and is established in northwestern Montana in Lake and Flathead Counties. Monitoring should be done using traps containing a cider vinegar or sugar-yeast bait. See the USU fact sheet, Spotted Wing Drosophila, for more detailed information on monitoring techniques.

TREATMENT THRESHOLD: None determined yet.

MGMT CONSIDERATIONS: Monitoring will help to determine if this pest has been introduced to your area.

Western Flower Thrips

Frankliniella occidentalis

HOSTS: all fruits

BIOLOGY: Overwinter as adults in protected areas on the ground and emerge in spring and feed on and lay eggs within, flower parts. Adults sometimes also feed on young fruit, but are not generally a pest on apples after bloom. They may feed on older nectarine fruit, causing russeting.

SYMPTOMS/DAMAGE: Nectarine: scarring, russeting, deformation; Apple: "pansy spot" most visible on light-skinned cultivars.

Thrips injury on Idared

MONITORING: Shake flower clusters vigorously into a cup or jar. Test 5 clusters on 5 trees per 10 acres. Yellow sticky traps hang to branches can help monitoring population and migration from weeds to fruit.

TREATMENT THRESHOLD: In light-skinned apple varieties, treat if there are more than 2 adults per cluster. In nectarine, treat if there is more than 1 adult per cluster.

MGMT CONSIDERATIONS: Minute pirate bugs, lacewings, and predatory mites from the family Phytoseiidae are important predators late in the season to help reduce populations the following spring. Ground cover and weed management can help reduce populations. Treat at petal fall for best control, after bees have been removed from the orchard.

Walnut Husk Fly

Rhagoletis completa

HOSTS: apricot, nectarine, peach

BIOLOGY: The walnut husk fly is a tephritid fruit fly like the apple maggot and western cherry fruit fly. The adults are about the size of a house fly and have patterned wings with an inverted "V" at the tip. It lays eggs in the husk of walnut after the husk has softened a bit. It will also lay its eggs in softening peach and nectarine fruits, especially where husk fly numbers are elevated due to the presence of non-treated walnut trees. Larvae (maggots) feed within fruits.

SYMPTOMS/DAMAGE: Small maggots inside peach/nectarine or apricot fruit; small brown tunnels in fruit.

MONITORING: Yellow sticky traps baited with ammonium carbonate. Place traps at 1600 degree days after

January 1 and check them once to twice per week Replace traps and refill ammonia baits once per month.

TREATMENT THRESHOLD: No threshold determined.

DEGREE DAY MODEL: lower threshold: 41°F

MGMT CONSIDERATIONS: Treat by 7-10 days after the first adult flies are caught when females start to oviposit (2480 degree days) or beginning in late July when eggs start to hatch (2700 degree days).

Western Cherry Fruit Fly

Rhagoletis indifferens

HOST: cherry

BIOLOGY: Western cherry fruit fly is a common pest of cherries. Every cherry can be infested by a maggot if populations are high. The dark banding pattern on the wings of the cherry fruit fly is a malformed letter "F" with the cross-bar originating from the upper vertical bar rather than the upright bar.

SYMPTOMS/DAMAGE: Small holes in fruit with maggots inside; collapsed fruit if injury is severe; larvae floating in tart cherry harvest tanks.

MONITORING: Yellow stick traps baited with ammonium carbonate. Place traps at 750-800 degree days after January 1 and change traps as needed.

TREATMENT THRESHOLD: No threshold determined.

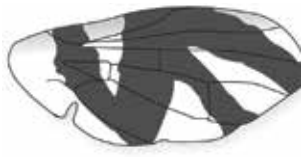
DEGREE DAY MODEL: lower threshold: 41°F

Event (after Jan.1)	Degree Days
First emergence of flies	950-970
3% of flies emerged, 1% of flies sexually mature	1060-1160

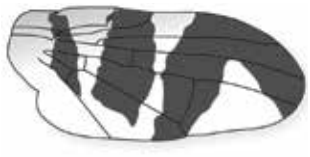
MGMT CONSIDERATIONS: To prevent egg-laying in fruits, treat by 5-7 days after the first flies are detected (190 degree days after first fly is caught), when fruits develop a salmon blush color, or when 1060 degree days have passed since January 1. Proper timing of insecticides is important.

Comparison of Fruit Fly Wings

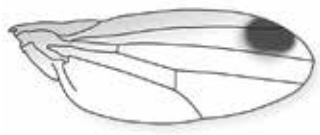
Apple Maggot



Walnut Husk Fly



Spotted Wing Drosophila



Cherry Fruit Fly

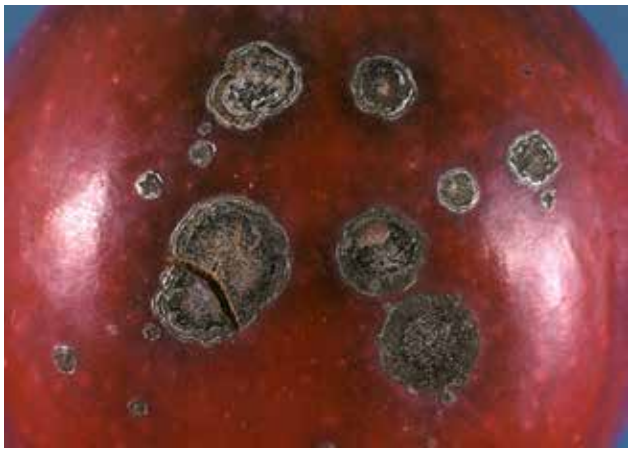
CHAPTER 4 DISEASE BIOLOGY AND MONITORING

Apple Scab

HOSTS: Apple, crabapple, hawthorn, pyracantha, mountain-ash

BIOLOGY: Apple scab is caused by the fungus *Venturia inaequalis*. It is an infrequent disease of apple in the Intermountain West, because it requires humid, cool weather during the spring months. The fungus overwinters as fruiting bodies within infected leaves and fruit on the orchard floor. The table at right shows the amount of moisture needed at various temperatures for infection to occur. After the first infection, later infections occur within 9 to 17 days, and these are the main means of disease spread during the summer months.

SYMPTOMS: The most obvious symptoms occur on the leaves and fruit. Leaf infections consist of velvety brown to olive green spots that look like dark mold on the leaf surface. Infected leaves become deformed over time. Fruit infections also begin as velvety brown to olive green spots that become brown, corky, and cracked. Late season infections may produce very small spots (known as pin-point scab) that may not become visible until the fruit is in storage.



Red Delicious apple with apple scab infection lesions. Note fruit crack running through one lesion.

MONITORING: Infections require different lengths of time of continuous leaf wetness for success. The effective wetness periods depend on temperature. At

Temperature-related wetness periods needed for apple scab infection

Temperature (F)	Minimum hours leaf wetness for infection period to occur.
48	12
50	11
52	9
54	8
55	8
57	7
59	7
61-75	6
77	8

61-75°F, only 6 hours are needed, while at 48°F, 12 hours are required. Post-infection (curative) fungicide sprays need to be applied within 24 - 96 hours. following infection in order to be effective.

MANAGEMENT: Some newer cultivars are more resistant to apple scab; the best of these at present include Liberty and Prima. Sanitation helps minimize future infections. This includes raking and burning leaves, disking (in clean cultivated orchards), or applying nitrogen (e.g., as urea) to accelerate the rotting process of the fallen leaves in areas where winter temperatures are mild and moisture is enough to at least partially rot the leaves. Often, however, these approaches are impractical in commercial orchards, and fungicide sprays are needed.

Correct timing of sprays is essential for good control. The period between the start of bud growth and when the young apples are 12 mm in diameter is the most critical. Protective materials are applied as soon as susceptible tissue is exposed in the spring, and every 7-10 days throughout the season if conditions warrant The post-infection approach requires accurate monitoring of orchard temperatures and the length of time the leaves remain wet.

Bacterial Canker

HOSTS: Sweet cherry

BIOLOGY: Bacterial canker can affect most stone fruits, but in the Intermountain West, sweet cherry is the primary host. The bacteria, *Pseudomonas syringae*, survive on most plant surfaces as an epiphyte. They enter the plant through wounds sustained from winter injury, or through buds in the fall. They may infect flowers when springs are cool and moist.

SYMPTOMS: The bacteria grow in and kill the phloem tissue, resulting in cankers. The affected bark oozes a sticky, amber gum, and becomes sunken and darker and the inner tissue is orange to brown, with narrow, reddish streaks that extend into healthy tissue above and below the canker. Often the wood has a fermented odor. The affected limb will eventually die, and the leaves will remain attached.

Bacterial canker affects sweet cherries in the Intermountain West. Infections may be common following a severe cold winter, and/or a cool, moist spring.

If blossom infection occurs, cankers subsequently form on twigs and spurs, and the dead flowers remain attached on fruit spurs. Leaf and fruit infections are rare in the Intermountain West.

MONITORING: One to two weeks after bloom, watch sweet cherry trees for dead flower clusters and twigs. These will be associated with amber ooze.

MANAGEMENT: Bacterial canker is a disease of cool, moist conditions. Some years will require more diligent action than others. Using a combination of sanitation, proper pruning, and fall copper sprays can help to mitigate the disease.

Cultural Management:

- Prune out affected twigs and branches,
- Rootstocks can affect susceptibility. Gisela 6 is most susceptible, followed by Krymsk 5, and Mazzard least susceptible.
- Other practices, such as weed control, maintaining a balanced soil pH, and pruning only in dry weather have all been shown to minimize disease.

Chemical Control:

- Apply a copper-based fungicide in fall during or soon after leaf drop.

Brown Rot

HOSTS: Peach, nectarine, plum

BIOLOGY: The brown rot fungus (*Monilinia fructicola* and related species) causes blossom blight, shoot

Brown rot is most commonly found on late peaches during seasons of late-summer monsoons. Infected fruit rapidly shrivels and forms a coating of gray-colored spores.

dieback, twig cankers, and fruit rot. The most common symptom in the Intermountain West is fruit rot. The fungus overwinters in mummified (infected) fruit hanging in the tree or on the ground. In spring and summer, spores form on the fruit and may infect flowers (not often seen) or ripening fruit. Ripening fruit must have a tiny lesion or opening from insect feeding, hail, wind damage, etc., for the spores to cause an infection. During seasons of late summer monsoonal rains, brown rot becomes more common on late-season peaches.

SYMPTOMS: If blossoms are affected, they will wilt, shrivel, and die. As they turn brown, they remain attached to the twig in a gummy mass. The first evidence of fruit rot will occur in mid to late summer after the fruit ripens. Small brown lesions increase rapidly in size and within a week, the entire fruit can be infected. The infection produces a soft rot (though the skin remains firm), and the fruit shrivels. During moist conditions, the surface of the fruit may become covered with grayish-tan powdery spore masses. The infected fruit may hang in the tree through winter, or drop to the ground.

MANAGEMENT: Sanitation is essential to prevent an epidemic during years that are favorable for disease development. Where brown rot has occurred in the past, fungicide sprays may be needed in successive years, applied when fruit has ripened and rain is forecasted.

Cultural Management:

- Remove all remaining fruit from the tree after the final picking to prevent overwintering mummies in the canopy, where they would be adjacent to susceptible blossoms in the spring.
- In spring, survey the orchard for blossoms that wilt, brown prematurely, and have gumming. Remove the associated twigs.
- Conduct summer pruning that will increase air circulation, promoting rapid drying, and increasing light and spray penetration.
- Avoid dumping rotten fruit in one location, which could become the starting point for disease and insect outbreaks in the following season.

Chemical Control:

- A fungicide cover spray after thinning, with one nozzle directed at the orchard floor, may help limit the production of spores from thinned fruits.
- Fungicides are recommended generally in a protective program and are applied to fruit prior to fungal infection. Infections of ripe peach fruit may take place within 6 hours during rainy periods at temperatures from 75 - 85°F.

Coryneum Blight (Shothole)

HOSTS: peach, nectarine, apricot, cherry and almond

BIOLOGY: Coryneum blight is caused by the fungus *Wilsonomyces carpophilus*. It is most common on apricot, peach, and nectarine. The fungus overwinters in infected buds and in small twig cankers. Infections can occur (via fungal spores) from spring to fall. Rainy

Coryneum blight leaf infections cause a shothole symptom.

Early-season fruit infections result in corky lesions (left). Late season infections may show up at harvest (right) or after several weeks in cold storage.

weather spreads spores from infected tissue to leaves and fruit by splashed and wind-blown rain. Spores require 4 hours of moisture to germinate, sometimes leading to rapid spread of the disease within a tree. (Movement from tree to tree usually slower.) Lesions develop very slowly at 45°F; their development is much faster at optimal temperatures of 70-80°F. In the fall, infections occur on leaf scars and spread to buds.

SYMPTOMS: Leaf infections first appear as small red spots which enlarge and become purple with a tan-white center. The spots then drop out of the leaf to leave a "shothole." Severe infections produce numerous holes and give the affected leaves a very tattered appearance. Shoot infections also appear as reddened spots.

Fruit infections begin as purple-red spots on the f skin as early as shuck-split and may occur as late as at harvest. Infections that occur on young fruit produce the largest and roughest, scab-like spots on the fruit skin. The spots coalesce and cause the skin to crack and ooze. Mid-season infections produce smaller red spots. Infections on fruit nearing harvest produce sunken, greyish lesions.

MONITORING: During spring pruning, remove twigs that have dead buds with a sunken, darkened area encircling them. During the growing season, check twigs and young leaves for small red spots. Check fruit for small purple-red spots.

MANAGEMENT: Fall applications of copper sprays or Bordeaux mixture at 50% leaf drop are effective in controlling this disease. Chlorothalonil sprays in fall and/or spring before shuck fall also work well.

Cytospora Canker

HOSTS: peach, nectarine, plum, apricot, cherry, and occasionally on apple

BIOLOGY: Cytospora canker is caused by *Leucostoma persoonii* or *L. cincta*. *L. persoonii* tends to be more common on peach, nectarine, plum, apricot, and low elevation cherry, especially in warmer climates. *L. cincta* is more common on apple and cherry in cooler growing areas (high elevation orchards), where infections occur through damaged fruit buds.

Typical cytospora canker infection on peach (top). Note the characteristic gum exudation and the flush cut pruning wound entry point.

Cytospora canker growth on sweet cherry (bottom). Note the zonate growth pattern in the bark tissue (arrow).

Leucostoma is a wound parasite – it needs an injury to the bark to enter the tree, such as frost injury, pruning wounds, borer damage, spray injury, or other wounding. About 30 days after initial infection, pimple-like fruiting bodies (pycnidia) form beneath the infected bark surface, creating a new crop of spores for release. The spores are spread by wind, rain, insects, birds, and on pruning implements to other trees.

Cankers can grow all year, but the greatest growth occurs in early spring before tree activity resumes. Trees that are vigorous can form callus tissue around the canker, creating a barrier that slows growth of the fungus.

SYMPTOMS: On stone fruit trees, copious yellow or amber gum on the bark indicates the presence of *Leucostoma*, while clear gum is not a disease, but rather injury (mechanical, low-temperature, or other) or borer activity.

Underneath the gumming, the tissue between the wood and bark interface is dead, and will be light to dark brown in color. Progression of the infection often occurs in spurts which are evident in alternating bands of darker and lighter colored tissue. Pimples appear beneath the bark as the spore-producing fruiting bodies (pycnidia) develop. The spores are released during and following extended wet periods.

As the canker progresses around the circumference of the branch or tree trunk, it girdles the structure and cuts off nutrient and water flow, resulting in dieback. This can occur very rapidly when hot, dry weather increase the tree's demand for water.

Symptoms in apples are similar but without the amber gumming. Infections result in a reddened color to the bark surface with reddish-brown discoloration of the tissue beneath. As in stone fruits, branch dieback occurs more quickly during the heat of the summer.

MONITORING: On stone fruit trees, examine trunk and branches for dark, oozing gum in the spring. On apple trees, look for bark with an unusual reddish tint. On all trees, blackish pimples (pycnidia) on the affected bark confirms evidence of cytospora canker.

MANAGEMENT: There currently are no effective chemical control options available for cytospora canker. Any affected limbs should be pruned out. Sometimes entire trees may need to be removed. Minimize winter injury by promoting early hardiness of trees in the fall. Avoid applying excess nitrogen fertilizer, late applications, and late summer pruning. Minimize risk of sunscald by using 50% (in water)white latex paint on the bark of young trees. Practice proper pruning techniques: don't leave stubs, don't make flush cuts, and don't leave flat cuts. Avoid pruning during wet weather periods.

Fire Blight

HOSTS: Apple and pear (plus some ornamentals in the Rose family, including quince, crabapple, hawthorn, ornamental pear)

BIOLOGY: Fire blight is a bacterial disease caused by *Erwinia amylovora*. Susceptibility to infection varies. For example, Bartlett and Bosc pears and Jonathan, Honeycrisp, Lodi, Rome Beauty, and Transparent apples are all highly susceptible to fire blight. The causal bacterium can develop resistance to agricultural antibiotics and complicate control programs. In the Intermountain West, this has only been documented in Utah County, UT.

The bacteria overwinter within infected twigs and branches in the orchard. In spring, the bacteria multiply and ooze out of the bark. They are then spread to open flowers by insects and rain-splash. The bacteria colonize the flower stigma and infection only occurs when at least 2 hours of moisture (light rain or dew) to wash the bacteria down into the floral cup. Infected tissue will be apparent from a few days to a week, depending on temperatures. New infections can sometimes occur in summer when bacteria is able to enter leaves or fruit through tiny wounds (caused by hail or insects).

Whether infections are through blossoms or leaves, the bacteria will continue to spread inside the plant tissue, killing flower shoots, twigs, and limbs (depending on tree variety). Spread slows in hot weather as well as at the end of the season.

Optimum temperatures for disease development are 70-81°F, with little growth below 50°F or above 95°F.

Fire blight infection on Bartlett pear branch shows the blackened, wilted shoot with "shepherd's crook" above the damaged blossom cluster.

SYMPTOMS: Infected blossoms on apple turn brown, and on pears, turn black. There is often bacterial ooze visible from the pedicel. Infected terminals (shoot ends) often develop a curled, drooping end, called a "shepherd's crook". The leaves will eventually dry up and hang on to the tree through most of the dormant season.

Fruit infections on both apple and pear begin with a firm brown rot that quickly includes the whole fruit. Droplets of ooze may be present on the fruit surface. Infected fruit gradually shrivel and can remain attached through the winter.

Cankers (slightly sunken areas of dead bark tissue) develop when the infection progress into woody tissue. The canker margins may crack as the bark dries out in late summer or fall. Small droplets of amber ooze are especially evident in spring. The infected tissue just under the bark will show streaks of reddish brown.

MONITORING: Be vigilant when weather conditions favor blight development during bloom. When temperatures rise above 65°F for several days, there is a greater chance of infection when moisture arrives. The Cougarblight model can predict infections.

In late spring, scout orchards for infected/wilted blossoms. Continue scouting for infections once per week until the weather turns hot.

During pruning in winter, look for dead twigs that still have leaves attached. These are old shoot infections.

MANAGEMENT: An effective management and control program for fire blight should include both cultural and chemical aspects.

Cultural Management:

- Reduce fire blight inoculum by removing other hosts such as pyracantha, hawthorn, cotoneaster, and wild crabapple growing near the orchard.
- Select moderately resistant cultivars, such as Red Delicious or Early McIntosh, or resistant rootstocks, such as Geneva or M.7. See page 15 for a list of varieties.
- Prune out limbs with blight during the dormant pruning season and regularly prune out strikes in spring and summer. Cut 8-12 inches below the reddish color that can be found in the cambial layer beneath the bark. If you can catch infections early (such as on blossoms or leaves), remove twice the length of visible dead tissue.

Except during dormant pruning, tools must be disinfected between cuts, or blight may be carried to other branches or trees throughout the orchard. Use household cleaning wipes that contain bleach.

Chemical Control:

- Apply a copper spray in early spring, just before buds swell. This treatment will slow the bacterial growth on plant surfaces. Do not use copper every year, as it can affect soil organisms or wash into groundwater. Do not apply sprays containing copper to Anjou pears; russet may result.
- Cougarblight is a forecasting model that predicts infection risk (see page 15 for an explanation). When infections are predicted, apply a suitable antibiotic. Blossom sprays are effective for 3-5 days because new blossoms open and need protection if conditions continue to favor disease development.

Oxytetracycline or Kasumin should be used in areas where streptomycin resistance has been reported.

Nematode Problems

BIOLOGY: Nematodes are worm-shaped, nearly microscopic organisms. There are many species of beneficial nematodes that help to improve nutrient cycling and feed on other soil microbes including plant pathogens and insects. There are a few plant parasitic nematodes (PPN) that affect fruit trees. They feed on plant cells using a spear-like structure called stylet to withdraw plant juices.

PLANT PARASITIC NEMATODES IMPORTANT IN FRUIT CROPS OF THE INTERMOUNTAIN WEST:
Eight plant parasitic nematode genera have been found in fruit orchard soils in soil surveys in Colorado (but no other states). These are: the root-lesion, dagger, spiral, root-knot, lance, citrus, ring, and stunt nematodes. The most important of these are the root-lesion and the dagger nematodes.

Root-Lesion Nematode (*Pratylenchus* spp.)
Root-lesion nematode can be a major cause of orchard replant failures. Lesion nematodes enter the root and burrow tunnels through the root cortex. Eggs are laid inside root tissues or in the soil. They hatch, and the juveniles then enter the roots and contribute to root injury. Root lesion nematodes are migratory and therefore are capable of repeatedly entering and exiting from root tissue.

They cause small brown lesions on the white lateral roots and kill fine feeder roots. The entire root system appears discolored when these lesions merge. Severely affected trees may lose all feeder roots. Ultimately, young replant trees will be stunted and chlorotic, and may die. The most common root-lesion nematode in fruits that causes damage in apple, peach, cherry, grapes and so many other crops is *P. vulnus*.

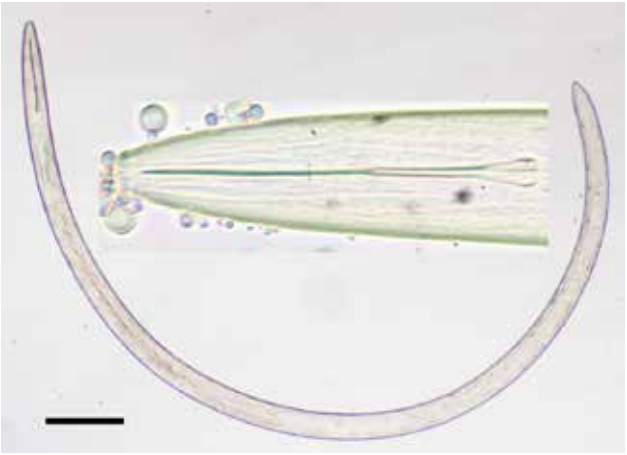
Dagger Nematode (*Xiphinema* spp.)
This is the largest of the plant parasitic nematodes found in our orchard soils. Up to 2-3 mm in length, it has a characteristic flanged bulb at the base of its stylet. This nematode is observed in all most all fruit orchards in Colorado irrespective of crop, location, soil type, etc.

Females lay eggs singly in the soil near plants. They may take 6-12 months to complete their life cycle from egg to adult. Dagger nematodes do not burrow into roots, but instead insert their long stylet deep into root tips where they feed on root tip cells. This feeding causes some necrosis and stunting and swelling of root tips.

Dagger nematode densities observed in most western Colorado apple orchards (18-152 nematodes/100 ml soil) are above the economic threshold level for apple (10-100 nematodes/100 ml soil). Economic threshold levels are not known for other fruit crops.

Eleven species of dagger nematodes are known to transmit 13 viruses, including Cherry Rasp Leaf Virus (CRLV) and tomato ringspot virus (TmRSV), which causes prunus stem pitting (PSP). Some other important fruit viruses transmitted by dagger nematode are grapevine fan leaf virus, grapevine yellow vein virus, tobacco ring spot virus, peach rosette mosaic virus, and three strains of TmRSV causing peach yellow bud mosaic, prune brown line, and Prunus stem pitting. The viruses are acquired within 24 hours of the initiation of feeding and are carried in the esophagus lumen for up to 12 months. Virus particles are transmitted by both adults and juveniles.

SYMPTOMS: Symptoms caused by most of the plant parasitic nematodes are difficult to distinguish from those caused by other soil related problems. Thus, identification based on symptoms is not easy. They include: non-uniform plant growth, mostly in patches and with poor plant establishment, giving an unhealthy appearance; chlorosis and stunting (resembling symptoms of some virus infections); stubby roots, bifurcated roots, root lesions, root galls (knots);



Dagger nematode adult. Inset photo shows its stylet with characteristic flanges on stylet basal bulb. Bar=100 um (applies only to the whole nematode).

Sweet cherry leaves with roughened tissue outgrowths on their undersurface, characteristic symptoms of infection with cherry rasp leaf virus.

Peach economic damage thresholds (number/100 ml soil) in clay to clay-loam soil of eight nematode genera found in orchard soils of Colorado.

Nematode (genus)	Threshold (no./100 ml soil)
Root Lesion (*Pratylenchus*)	500-1000
Dagger (*Xiphinema*)	50-100
Lance (*Hoplolaimus*)	40-150
Ring (*Criconemoides*)	250-600
Root Knot (*Meloidogyne*)	100
Stunt (*Tylenchorhynchus*)	150-300
Citrus (*Tylenchulus*)	10-100
Spiral (*Helicotylenchus*)	300-500

excessive root branching and proliferation ("hairy root" symptoms); and poor root health, growth, and establishment.

MONITORING: Nematode populations and species within soils of production blocks are monitored by collecting soil samples in a representative pattern (usually as a transect or a zigzag pattern) across the production block. Approximately 1 cup (~250 ml) of soil is collected from the top foot of soil for each sample and placed into a plastic bag for transport to the extraction location. A 100 ml sub-sample is taken from each sample and the nematodes contained are extracted by density centrifugation, elutriation, or wet sieving for enumeration and identification. Once identified and counted, the results are compared to the economic damage threshold for that species, crop, and soil type.

MANAGEMENT: Most of the time, management of nematodes must focus on reducing nematode numbers to levels below the damage threshold. However, management of nematodes is important as they are a predisposing factor to soilborne diseases and environmental stresses such as cold injury, frost, salt injury and/or micronutrient deficiency.

Organic amendments will increase the beneficial nematodes which will help to reduce the PPNs. Marigold, sudan grass and *Brassica* spp. can be used as green manure crops to control PPNs and boost free living nematode populations in the soil. Glucosinilate or isocthiocyanate content in many *Brassica* species is known to control many PPNs.

Soil solarization is very effective for control of many nematodes and other soilborne pathogens. For soil solarization: plow field to ensure looseness, ensure adequate moisture, cover with plastic, seal the plastic to make it air tight and maintain the seal for at least 45 days in June and July. Soil solarization combined with green manure crops should be more effective.

Host resistance: Many rootstocks are reported to have tolerance or resistance to PPNs. In grape, rootstock 9407-14 is resistant to many PPNs. Some Peach rootstocks are resistant to nematodes: Guardian is resistant to ring and root-knot nematodes, Nemagard is resistant to root-knot nematode, and Schwarzmann and Freedom rootstocks were rated as resistant against X. index.

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Peach Leaf Curl

HOSTS: Peach, nectarine

BIOLOGY: The fungus (*Taphrina deformans*) overwinters as resting spores on bud and bark surfaces. During cool weather in spring, splashing water from irrigation or rain moves spores onto newly emerging leaves. About 12.5 hours of moisture is needed for infection to occur at temperatures below 61°F. The greatest amount of infection occurs when rains last 2 or more days.

If spring temperatures remain above 70°F, symptoms may not appear from earlier infections. Once leaves have fully expanded and the weather becomes hot and dry, the fungus goes into dormancy.

Peach leaf curl may be a problem in times of cool, moist springs. Infections happen in early spring only. It is treated with a copper spray in the fall or early spring.

SYMPTOMS: Leaf symptoms first show up about 3 to 4 weeks after leaves start emerging. The affected areas are red, thickened, and puckered, causing the leaf to curl. The thickened areas then turn an olive yellow and velvety spores are produced on the surface by the leaf curl fungus.

MONITORING: Monitoring is not an effective IPM tool because once symptoms are visible, it is too late to take action that season.

MANAGEMENT: Peach leaf curl is easily controlled by applying a fungicide (copper, chlorothalonil, or others) at leaf fall and/or during the dormant season in spring. Fungicides should not be applied after symptoms are seen because by that time, new infections have ceased.

Powdery Mildew

HOSTS: Apple, peach, nectarine, cherry

BIOLOGY: Many different fungi cause powdery mildew, and they are usually specific to a host plant. Apple and cherry powdery mildews are the most common and economically important mildew diseases. Apple powdery mildew is caused by *Podosphaera leucotricha*, and can also cause problems on peach fruit. Cherry powdery mildew is caused by *Podosphaera clandestina*, and peaches and nectarines are damaged by the peach powdery mildew, *Sphaerotheca pannosa*. All of these powdery mildews behave similarly with early control needed to avoid fruit damage in orchards where they occur.

The *apple mildew* fungus overwinters as mycelium (thread-like, multicellular structures) on twigs and fruit buds. As the buds open in the spring, the mycelium grows out into the developing leaf tissues, causing early spring infections. Spores (conidia) are then released from these infected tissues to other leaves and fruit throughout the spring and summer. Cloudy, overcast conditions with 70 - 90°F temperatures favor disease development until shoot growth stops and temperatures increase.

Cherry powdery mildew overwinters as cleistothecia (resting spore structures) on orchard floor detritus and in bark cracks and crevices. In mid to late spring, after irrigation starts washing spores into the air, infections become visible on foliage closest to the ground or the trunk. Secondary infections eventually spread throughout the tree to leaves and fruit. Cooler temperatures and leaf senescence in the fall prompts the formation of cleistothecia on the undersides of leaves for overwintering.

Peach mildew overwinters as mycelium inside dormant rose buds and on inner bud scales of peach in milder climates. Primary infections on emerging shoots (mostly rose shoots) produce conidia (spores) that are carried by wind to newly emerging leaves and produce secondary infections on rose and peach. Early in the season, peach fruit is much more susceptible to infection than foliage. Foliar infections are more obvious in late summer.

"Rusty spot" of peach fruit is caused by the apple mildew fungus. Fruit is susceptible between shuck split and pit hardening.

SYMPTOMS: Infected leaves and shoots of apple and cherry are covered by a light grey or white powdery coating of spores and mycelium. They become curled, crinkled, and stunted. Leaves may bronze or drop prematurely.

Infections on the surface of apple and peach fruit damages the fruit skin cells (the fruit epidermis) and results in scarring of the fruit surface, known as russet.

Tart cherry fruit with infected stems tend to be more difficult to harvest by shaking because the fruit doesn't release as readily as non-infected fruit.

MONITORING: On apples, watch for shoot terminals with a whitish mycelial coating and terminal buds that are not tightly closed. These shoots should be removed during dormant pruning. As buds emerge in spring, look for dwarfed shoot growth or powdery infections on new foliage.

On cherries, examine leaves on suckers and spurs in the lowest portion of the crown for roundish mildew spots beginning in early bloom. Black Tartarian, Bing, Ranier, and Lapins sweet cherry and Montmorency tart cherry are highly susceptible to mildew.

Peach growers need to monitor shoots and fruit for development of white, thick, felt-like mycelial patches or less obvious, roundish, rusty-orange patches of mycelium on peach and nectarine fruit surfaces from bloom through pit hardening.

MANAGEMENT: Powdery mildew impacts can be minimized through cultural management and chemical control options. These will differ with the crop type and mildew type involved.

Cultural Management:

- Overwintering inoculum of apple powdery mildew can be reduced with attention to orchard sanitation. Judicious removal of flagged terminals during dormant pruning is the first step; scouting for and removing flagged spurs is a second.
- When planting new orchards, select cultivars that are resistant. Freedom, Liberty, Prima, Goldrush, Jonafree, MacFree and Red Delicious are resistant cultivars. Golden Delicious and JonaGold are moderately susceptible. Jonathan, Rome, Gala, Granny Smith, Fuji, Honeycrisp, and MacIntosh are all very susceptible. Anjou pear is susceptible while Bartlett pear is moderately resistant.
- Prune trees to allow for air circulation and keep water sprout growth from scaffolds to a minimum.

Chemical Control:

Spring and summer sprays of sulfur (when temperatures are below 80°F), certain DMI fungicides, and the combination of a strobilurin and carboximide fungicide can provide effective control of apple, cherry, and peach mildew. Avoid developing resistance to effective control chemistries by rotating modes of action for sprays applied throughout the season. Available modes of action groups are as follows:

Apple powdery mildew infection on apple shoot **(**top**)**. Note the white powdery layer, and infolding and twisting of leaves.

Jonathan apple fruit russeted by early season infection with apple powdery mildew (middle).

Peach fruit infected with peach powdery mildew (left) and apple powdery mildew on center and right fruits (bottom). Note the rusty orange mycelial patch on the peach fuzz in the center fruit and the russeted fruit skin in the right fruit.

- ***Multi-site contact activity:*** Potassium bicarbonate products (Kaligreen), sulfur products (flowables, wettable powders, micronized powders, dusts), and calcium polysulfide products. Sulfur products are phytotoxic when applied within 10 days of oil except in dormant sprays. Dormant sprays with lime-sulfur can kill overwintering cleistothecia with which they come in contact.
- ***Demethylase Inhibitor (DMI)*** products include myclobutanil (Rally), metconazole (Quash), tebuconizole (Tilt), triflumizole (Procure), etc. They provide good control, but have risk of developing resistance and cross-resistance with QoI fungicides.
- ***Quinone outside Inhibitors (QoI fungicides)*** include strobilurins such as Flint and Sovran. These provide good control, but have risk of developing resistance and cross-resistance with DMI fungicides.
- ***Succinate dehydrogenase inhibitors (SDHI fungicides)*** include carboximides like fluopyram
- ***Biocontrol*** products such as Serenade and Sonata are organic, but not as effective. They work by inhibiting germination and should be applied every 5 days.
- ***Oils*** include plant oil products (Captiva) and highly purified paraffinic oils (horticultural oil). They can be combined with other materials (except sulfurs or captan) to enhance efficacy. Horticultural oil applied on 14 day intervals at a 1% vol/vol rate provided excellent control of apple mildew in Colorado-based trials during the 1990's.
- ***Potassium salts*** of fatty acids (M-Pede) provide limited control at best.

Phytophthora Crown and Root Rot

BIOLOGY: *Phytophthora* crown and collar rot of fruit trees is a fungal disease that affects all species of pome and stone fruit. The disease frequently kills trees 5-7 years in age. It is caused by various species of *Phytophthora*, including *P. cactorum, P. cambivora, P. megasperma, P. dreschsleri*, and *P. syringae* that all require saturated soils to cause infection.
The fungus can be introduced into an orchard through infected planting stock, contaminated farm implements, or through contaminated irrigation water. Spores are released in water and infect tree roots and crown tissues. Initial infections result in cankers on the trunk between the soil line and the crown roots. The pathogen can also spread via root to root contact.

SYMPTOMS: The most evident symptoms are dead areas (cankers) on the base of the tree. These begin on the bark between the soil line and crown roots. The infected bark tissue darkens and becomes increasingly sunken and the canker expands slowly. Detection requires removal of the outer bark. The inner bark of affected area will be a cinnamon brown color.

Affected trees will have early fall color and leaf out late in spring. Fruit will be stunted and leaves will be abnormally small. Eventually, the canker will girdle the tree and kill it, seemingly overnight. Leaves remain attached to Phytophthora-killed trees.

MONITORING: Check orchards in mid-summer for trees with weak aerial growth, especially in orchard areas prone to poor soil drainage or low spots that may experience ponding. In late summer to early fall, check for trees that have early fall coloration. On suspect trees, check the trunk at and below the soil line for any canker development or presence. Tissue samples at the edge of the canker can be collected for an attempt to isolate the fungus and confirm the presence of *Phytophthora.*

Crown rot canker on apple. Note the narrowly rounded and sharply sunken upper edge of the canker.

MANAGEMENT: Best control is obtained through preventive cultural management practices.

Cultural Management:

- Select orchard sites with good drainage. Keep water away from tree trunks (no basins around the trunk, space trickle irrigation outlets away from the trunk). Plant trees on raised beds. Keep irrigation runs to 8 hours or less.
- Select resistant varieties and rootstocks or do not plant susceptible rootstocks where soil is poorly drained. For apple: East Malling (M) rootstocks M-9, M-26, M-7, and M-111 have intermediate resistance while Malling-Merton (MM) rootstocks MM-104 and MM-106 are susceptible. For cherry: Mahaleb rootstock is susceptible, while Mazzard, Stockton Morello, and Colt are less susceptible. For peach, nectarine, apricot, and plum trees, Nemaguard, Myrobalan plum, or Marianna 2624 are moderately resistant.
- Avoid deep planting; plant trees with the graft union several inches above the soil line. Scion varieties often are more susceptible to collar rot infection than are the rootstocks, and trees planted with graft unions at or below the soil line have increased potential for the scion to self-root and provide an entry for collar rot.

Other options:

- Bridge-graft over damaged tissue if less than 30-50% of the trunk circumference is affected, in-arch graft 1 yr-old whips of a resistant variety into the trunk well above the diseased area.
- Remove soil from around the base of infected trees and allow the infected area to dry out and stop further progression of the disease. Spray the lower trunk with a fixed copper fungicide (50% metallic copper), using 2-3 Tbs of fungicide/gal. of water. Refill the soil depression around the trunk with fresh soil in late autumn in order to prevent winter injury to the tree collar.
- Irrigation practices that keep the soil saturated for 36 or more hours should be avoided, especially when temperatures are 60-70°F.
- Finally, soil drenches of metalaxyl (Ridomil Gold EC) or a foliar sprays of phosetyl-Al (Aliette) can be helpful. Check on new registrations and rates for these systemic fungicides.

CHAPTER 5 ORGANIC ORCHARD MANAGEMENT

Growing fruit organically in the Intermountain West has many advantages over other growing regions. Our relatively dry and cold climate harbor fewer insect and pathogen pests, many of which can be controlled by organic means through strategic orchard design and management. However, weed and fire blight management can be more challenging in organically managed orchards. Following are considerations growers should take pertaining to growing fruit organically in the Intermountain West.

Organic Certification

In order to sell fruit using the organic label, orchards must be certified, unless their gross sales are less than $5,000 per year. The Organic Foods Protection Act of 1990 required the United States Department of Agriculture (USDA) to develop uniform national organic standards. From this legislation, arose the National Organic Program (NOP), which through a 15-member National Organic Standards Board (NOSB) developed regulatory codes that must be followed for selling any products labeled as organic. Since 2002, all organic farming and processing operations are certified by a USDA Accredited Certification Agency (ACA) to assure consumers that all NOP regulations are being followed.

The NOP maintains a list of ACAs on their website (www.ams.usda.gov/NOP). The choice of certifiers is often dictated by cost, experience with the crops being produced, and familiarity with the targeted marketing outlets. Organic producers with gross sales less than $5,000 per year **do not** need to be certified, but they do need to follow all NOP regulations in order to use the organic label.

The USDA defines organic as a labeling term that refers to an agricultural commodity produced in accordance with the NOP. In other words, the USDA views the term organic primarily as a marketing category. However, in order to access the organic market, the USDA specifically states that an organic production system must be managed to respond to site-specific conditions by integrating cultural, biological, and mechanical practices that foster the cycling of resources, promote ecological balance, and conserve biodiversity.

Accredited Certification Agencies should be able to provide a template for the Organic System Plan (OSP). Additionally, the National Sustainable Agriculture Information Service, (formerly ATTRA), has produced a guide to organic certification that includes templates for developing an OSP as well as several other related resources (attra.ncat.org/topics/organic-farming/).

Under NOP Section 205.202, "any field or farm parcel from which harvested crops are intended to be sold, labeled, or represented as "organic," must have had no prohibited substances, as listed in §205.105, applied to it for a period of three years immediately preceding harvest of the crop." This three-year period is referred to as the transition period. Orchards on land to which no prohibited substances have been applied for three years, can be certified immediately but in accordance with 7 CFR §205.204(a)(4), if planting stock is from an uncertified source it must be maintained under organic management for one year after planting before it can be "sold, labeled or represented as organically produced." During these transition periods, growers will likely assume greater operating expenses, without earning organic price premiums. Newly established orchards, however, will not have much of a crop to sell during this period so losses will be minimal compared to an established orchard transitioning from conventional to organic management.

Accredited Certification Agencies and Other Resources

- **Utah**: ag.utah.gov/plant-industry/organic-program
- **Colorado**: ag.colorado.gov/plants/organic
- **Idaho**: agri.idaho.gov/ag-inspections/organics/
- **Montana**: agr.mt.gov/Organic-Program
- National Organic Program: ams.usda.gov/about-ams/programs-offices/national-organic-program
- OMRI (Organic Materials Review Institute): omri.org
- Organic Farming Research Foundation: ofrf.org
- Organic Trade Association: ota.com
- Organic Crop Improvement Association: ocia.org

- Western Sustainable Agriculture Research and Education Program: western.sare.org

Organic Orchard Design

Orchard design and cultivar selection have a long-term impact on pest control and fruit quality. In organic orchards where pest control tools are limited, it's important that orchards be designed and planned to use the cultural (e.g. rootstock and scion selection) and organically approved pest management tools (e.g. mechanical or mulch-based weed control) to the grower's greatest advantage. Rootstocks and cultivars should be selected for vigor, hardiness and disease resistance to overcome the challenges of weed competition and limited organic controls for pests like fire blight, scab or woolly apple aphid (see Table 1). Drip or microsprinkler irrigation should be designed to avoid spraying the canopy and spreading disease as well as reduce watering unwanted vegetation. Additionally, irrigation should designed to allow for easy mechanical weed management. See Chapter 8 Orchard Floor and Weed Management for more details.

If an existing orchard is being used to establish new trees, attention should be paid to the potential for new trees to be stunted by replant disease. Replant disease has nonspecific causes that often differ from one site to another but are largely thought to be attributed to soil organisms including pathogens and parasitic nematodes (Hewavitharana, et al.). Multiple biotic and abiotic factors are involved in replant disease. Organic growers have limited options for control, which conventionally consists of soil fumigation, a practice not approved in organic production. Replant resistant rootstocks are available for apple (See Table 1), but not other tree fruits (Hewavitharana, et al.).

In addition to careful rootstock selection, avoiding original rows, or applying other organic approved soil treatments may help. Pre-planting cover crops of marigold flowers, certain oilseed rape cultivars, and Sudan grass hybrids, may provide partial control of replant disease in some orchards. Replacing soil from the planting hole with a mixture of fresh soil and compost may also be helpful. Other factors that may alleviate replant disease include allowing a fallow period before planting, soil pH adjustment, minimizing soil compaction, improving soil drainage, correcting nutri-

Cold Hardy Apple Rootstocks for Organic Production

Rootstock	Vigor	Fire Blight	Woolly Apple Aphid	Replant
G935	Moderate	Very Resistant	Susceptible	Tolerant
G30	High	Very Resistant	Susceptible	Tolerant
G210	High	Very Resistant	Resistant	Tolerant
G41	Low	Very Resistant	Resistant	Tolerant
G11	Low	Resistant	Susceptible	Moderately Tolerant
G16	Low	Resistant	Susceptible	Moderately Tolerant
G213	Low	Very Resistant	Very Resistant	Tolerant
M7	Moderate	Very Resistant	Susceptible	Susceptible
M26	Moderate	Susceptible	Susceptible	Susceptible
M106	High	Susceptible	Resistant	Susceptible
MM111	Low	Susceptible	Resistant	Susceptible
B9	Low	Moderate Resistance	Susceptible	Susceptible
B118	Moderate	Moderate Resistance	Susceptible	Moderately Tolerant

Table 1. Rootstock selection is an important cultural control for organic growers. Selecting rootstocks that are resistant to pests such as wooly apple aphid, fire blight and replant syndrome as well as vigorous to overcome weed competition can help growers be successful in the long-term. (Cornell Geneva Apple Rootstock Comparison Chart, Crassweller, et al. 2018, Dinniny, S. 2016)

ent deficiencies, and providing supplemental irrigation immediately after nursery trees are planted in the orchard. New research has shown some benefits to amending soil with brassica seed meal and Anaerobic Soil Disinfection (Browne, et al., Mazolla, et al.).

Additionally, encouraging beneficial insects and biodiversity in the orchard can improve long-term pest management. Edge habitats can be beneficial for wildlife biodiversity by providing habitat for beneficial insects. They also act as a tool in resistance management of key insect pests, such as codling moth, peach twig borer, or western cherry fruit fly as wild-type individuals from surrounding habitat migrate into your orchard and mate with the resident pest population. Having these two gene pools intermix will help delay the development of pesticide-resistant pests. The trade-off, however, is that such migration may interfere with the effectiveness of chemical controls if pests migrate after spraying has taken place. Ultimately growers should rotate chemicals, using products with different modes of action to avoid any pest, weed, pathogen or insect, developing resistance.

Specific Pest Management Concerns

Any pest management program needs to be a multifaceted plan of action. A well balanced "toolbox" for an organic pest management program may include careful cultivar selection, orchard management practices to discourage habitat and conditions for disease, beneficial insects, bat boxes, insect-specific bacteria or viruses, mating disruption, tangle foot, baits, traps, and less toxic organic pesticides. Which tool is employed will depend on the pest and the grower's threshold for damage.

Vertebrate pests such voles, pocket gophers and other rodents can become a serious problem in orchards during the winter where surrounding hedgerows, brambles, or fields provide an ideal rodent habitat. When snow cover deprives them of other food sources, they tend to gnaw on the lower branches and the crown of trees, which can cause damage or even death. Pocket gophers may feed on tree roots throughout the growing season. In organic orchards, management relies on trapping, protecting trees, and managing the orchard to reduce food and cover for these pests. Keeping vegetation short especially as fall approaches, protecting trees with guards and limiting the use of heavy mulch, in particular black plastic mulch, are integral to reducing rodent populations. Encouraging predators can also help. See Chapter 9 "Rodent Management," for more details on reducing habitat and excluding rodents from the orchard.

For insect pests, many organic biological and chemical sprays are available for primary fruit pests, but should be used in conjunction with other prevention measures and timed carefully with available models and degree day tracking. Other strategies for controlling insect pests like codling moth in orchards include pheromone disruption, sterile releases, reducing overwintering habitat, crop thinning, kaolin clay sprays and the encouragement of beneficial insects (Richter, et al. 2021). When possible use local resources for determining the best management approaches and timing for controls.

Similarly, managing pathogens should begin with selecting resistant cultivars and using good sanitation practices in the orchard including removing infected branches or trees, mowing leaves and pruned branches, avoiding overhead irrigation and disposing of infected fruit. Additionally dormant sprays using copper or sulfur may be effective against fruit pathogens including fire blight, scab and peach leaf curl (Smith et al. 2019). For very fire blight susceptible varieties, like many cider cultivars, antibiotics, currently not approved for organic certification, may be necessary. Growers should weigh the advantages of organic certification against fire blight management strategies if they choose to grow these cultivars. More information on the performance and fire blight susceptibility of cider cultivars grown in the Intermountain West can be found at agresearch.montana.edu/warc/research_current/apples/cider_cultivar_research.html.

Nutrition for Organic Orchards

As specified under the National Organic Program (NOP), "Organic producers must rely upon animal manures, compost (organic matter of animal and/or plant origin that has been decomposed by microorganisms), and cover crops to supply some, if not all, of the required nutrients for healthy crops." Under NOP regula-

tions, many non-synthetic fertilizers like fish emulsion, poultry manure and blood meal are permitted, but in many cases supplemental fertilizers are allowable ONLY after documenting a deficiency. Both soil and leaf samples can be used for documentation and growers will need to work with their accredited certifying agent to develop an acceptable nutrient program that prevents rather than corrects nutrient deficiencies.

When relying on organic fertility, growers should be aware of the differences between synthetic and organic fertilizers as well as organic soil amendments. Following are several nutrient amendment options available to increase the nutrient health of organic orchards, starting with naturally derived soil amendments, namely compost and cover crops. These soil amendments differ from both synthetic and organic fertilizers in the benefits they provide to soil health and the availability of the nutrients they contain. While nutrients supplied to trees is limited, these soil amendments also increase soil organic matter, balance pH levels, increase microbial activity, improve soil structure and tilth, improve drainage in clayey soils, improve water-holding capacity in sandy or gravelly soils, and help to suppress some root diseases. Organic fertilizers while often lower in nutrient content by volume then synthetic fertilizers contain additional naturally occurring nutrients including micronutrients. They also are higher in available nutrients than composts, but do not provide the previously mentioned added benefits of organic residuals.

Several additional regional resources exist for exploring enhancing soil fertility in organically managed orchards at the following links:

USU Fact Sheet Strategies for Managing Soil Fertility and Health in Organic Orchards (July 2018)
Washingon State University Organic Tree Fruit Soils & Nutrition
WSU Tree Fruit Soils & Nutrition

Cover Crops

Cover crops in orchards can be used both as a pre-plant tool in orchards needing renovation from previous uses or planted alongside trees as a tool to encourage beneficial insects, improve site aesthetics and provide long-term inputs of nutrients and organic matter to the orchard system. Pre-plant cover cropping can improve soil conditions, provide nutrients and organic matter. They can also be used alongside tilling to reduce weed competition before establishment. Nitrogen-fixing legume cover crops are often seeded along with one or more species of annual grass. Nutrient availability will depend upon the growing conditions, species used, seeding rates, and prior soil nutrient status. Typically, the cover crops are mowed/chopped and then incorporated into the soil prior to tree planting. When using as a pre-plant tool, care should be given to terminate cover crops, typically at flowering, to avoid reseeding of the crop, which can become a weed.

Organic growers can also maintain permanent covers in rows and/or alleys of bearing orchards to suppress weeds and protect soil. In choosing which system and plant species to use growers must weigh the trade-offs between competition and supply of nutrients, cover water use, the potential for increased pest habitat vs beneficial habitat and management of the cover (Rowley, et al). See Chapter 8 for more details about orchard floor and weed management.

Compost

Compost can be applied pre-plant to increase soil organic matter, but also post-plant as a mulch to increase soil water holding capacity and nutrient cycling. This can be particularly helpful in sandy or coarse soils.

Compost use in organic systems is regulated by the NOP to insure proper application and use of organic residuals to reduce risks to food safety. NOP regulation §205.203 specifies that: "Compost must be produced through a process that combines plant and animal materials with an initial C:N ratio of between 25:1 and 40:1. Producers using an in-vessel or static aerated pile system must maintain the composting materials at a temperature between 131°F and 170°F for at least 3 days. Producers using a windrow system must maintain the composting materials at similar temperature for 15 days, during which time, the materials must be turned a minimum of five times." Animal manures may also be used in organic orchards, but they must be incorporated into the soil at least 90 days prior to harvest.

Most commercial compost suppliers will provide a nutrient content analysis report to help calculate application rates for their composts as formulated. Growers should also verify that the compost supplier is following all of the current NOP regulations, and that the accredited certifying agency will approve that compost for organic production. Biosolids are not approved for use in organic production (7CFR§205.105).

In addition to following these guidelines, growers should obtain composts or feedstocks for compost from trusted sources to insure they do not apply an amendment that has been contaminated with residual herbicides such as aminopyralid, clopyralid, aminocyclopyralid or picloram as the presence of these substances can compromise organic certification. Applying compost contaminated with these herbicides or any other substance prohibited by 7CFR§205.105 will void certification for 36 months after application. If in doubt, growers can have the compost tested. If the compost is free of prohibited substances a record of testing should be kept on file.

In the case of residual herbicides which are expensive to test for, growers can perform a bioassay by planting a fast growing, herbicide sensitive annual like peas in soil amended with the compost in question and again in potting soil (control). Plants grown in contaminated soil will emerge with cupped, curled or fringed leaves and appear stunted compared to the control. This compost should not be used. Residual herbicides can remain in soil and compost for years, especially in the Intermountain West's dry cold climate.

For more information on using compost in orchards including benefits, testing and calculating application rates visit the WSU web page, Tree Fruit Compost Considerations.

Fertilizers

Any material, including fertilizers, that is used in a certified organic system must be approved under NOP regulations by your certifier. Growers must also demonstrate deficiency before applying foliar fertilizers. If deficiencies are evident based on visual symptoms or foliar test results, growers should consider other factors contributing to nutrient uptake including water and irrigation management, soil compaction and health.

Many companies now make custom organic fertilizer blends. These products tend to be more expensive than purchasing the materials in bulk and blending them on-site prior to application. There are also numerous companies making liquid nutrients for foliar applications. These can be useful for correcting deficiencies, making maintenance applications for return bloom (e.g., boron and zinc) and improving fruit quality (e.g., calcium).

Applying nutrients to leaves in a spray solution can provide the plant with nutrients such as calcium and zinc that are taken up poorly by the root system, as well as to help correct immediate nutrient deficiencies. Under NOP regulations many of these products are only allowed if there is a documented nutrient deficiency. Growers should contact their certifier to learn how to best document deficiencies, but soil and leaf analyses as well as visual symptoms will likely need to be documented.

Organic sources of foliar nitrogen are derived mostly as a by-product of seafood processing, and come in the form of fish emulsions, fish powders, and fish oils. Rates will depend upon the specific product. Several companies make chelated foliar fertilizer products that are compliant with the NOP. However, there are few replicated trials comparing different organically allowed foliar fertilizer products in orchards. Solubor is a good source of foliar boron, and has proven to be an effective material for increasing leaf boron levels in orchards.

In most Intermountain West soil types, it is recommended that growers apply at least two "spring tonic" sprays that contain boron, zinc, iron and nitrogen in order to stimulate fruit set and flower bud initiation. Also recommended are two to three applications of Epsom salt (for magnesium) at 15 lb/100 gallons of spray, starting at petal fall and continuing for several cover sprays.

Additionally, repeated calcium sprays from the end of shoot growth to harvest have been shown to help improve fruit storage duration, particularly in Honey

Crisp. Calcium chloride is typically used as a calcium source, but other formulations may also be acceptable under NOP regulations. The above foliar fertilizer recommendations are based upon trials in non-organic orchards, and it is not known whether recommendations for organic systems would be different.

Microbial Stimulants

Numerous microbial-based products are marketed with claims that they stimulate soil biological activity. While these products may be acceptable under NOP regulations, there is little independent scientific confirmation of the manufacturers' claims. Well-managed organic orchards that include regular organic matter inputs (e.g., cover crops, manures, mulches, composts) typically already have relatively high soil organism biomass and activity, and additional microbial "stimulation" should not be necessary and is unlikely to be cost-effective.

Organic Fertilizers Supplying NPK

Fertilizer	Comments	Pros and Cons
Alfalfa meal (pellets)	Increases organic matter in soil and offers nutrients and a high availability of trace minerals.	*pro:* Available at feed stores *con:* May contain seeds
Corn gluten meal	Also marketed as a pre-emergent weed control for annual grasses in bluegrass lawns.	*pro:* High N *con:* Inhibits germination
Bat guano	Bat guano (feces) harvested from caves is powdered. It can have either high N or high P depending on how it is processed.	*pro:* Stimulates soil microbes *con:* Cost
Blood meal	Blood meal, made from dried slaughterhouse waste, is one of the highest non-synthetic sources of nitrogen.	*pro:* Available at feed stores *con:* Can burn plants if over-applied; expensive
Bone meal	Steam processed and widely available at feed stores and in garden centers. Soil PH above 7 may limit phosphorus plant availability.	*pro:* High plant-available source of phosphorus *con:* Cost
Fish meal	Ground and heat-dried fish by-products.	*pro:* N and P source *con:* Heat processed
Fish bone meal	Made from fish bones that are cooked and ground.	*pro:* High P
Fish emulsion	Soluble, liquid fertilizers that have been heat and acid processed from fish by-products.	*pro:* Adds nitrogen and micronutrients *con:* Foul smelling

See Ch. 11, *Nutrition*, for additional information on micronutrient sprays, timing and rates.

CHAPTER 6 PESTICIDE TABLES

Generic Options for Common Insecticides

Common Name	Brand Name and Current Manufacturer	Other Brand Names and Manufacturers	
abamectin	Agri-Mek SC (Syngenta)	ABBA 0.15 EC (Makhteshim) Abacus (Rotam) Abamex (Nufarm)	Epi-Mek 0.15 EC (Syngenta) Reaper 0.15 EC (Loveland)
carbaryl	Sevin 4F (Tessenderlo)	Carbaryl 4L (Loveland)	Sevin SL (Bayer)
chlorantraniliprole	Altacor (United Phosphorus)	Shenzi 700WG (United Phosphorus) Evenex 400SC (Albaugh) Trinalor (Makhteshim) Turazi (Loveland)	Osaria (Atticus)
chlorothalonil	Bravo (Makhteshim Agan)	Echo 720 (Sipcam Agro)	
beta-cyfluthrin	Baythroid XL (Bayer)	Sultrus (Helena)	Tombstone (Loveland)
bifenazate	Acramite (Arysta)	Bizate (Loveland)	Enervate (Atticus)
esfenvalerate	Asana XL (Valent)	S-FenvaloStar (LG Life)	Zyrate (Rotam)
imidacloprid	Admire Pro (Bayer)	Alias 2F, 4F (Makhteshim) Dominion 2L (Control Sol. Inc.) Imidacloprid 4F (Makhteshim) Macho 2 FL (Albaugh) Montana 2F (Rotam N.A.) Nuprid 2 SC, 4.6F, 4F Max (Nufarm)	Omni 2F, 4F (Helena) Prey 1.6F (Loveland) Sherpa (Loveland) Widow (Loveland) Wrangler (Loveland)
lambda-cyhalothrin	Warrior II (Syngenta)	Drexel L-C (Drexel) Grizzly Too, Z (Winfield) Lambda T, T2 (Helena) Lambda-Cy 1 EC (Willowood USA) LambdaStar (LG Life)	Lamcap (Syngenta) Paradigm (Makhteshim) Province (Tenkoz) Silencer 1 EC (Makhteshim)
permethrin	Pounce 25 WP (FMC)	Ambush (Amvac) Arctic 3.2 EC (Winfield) Astro (FMC) Fastac CS (BASF)	Mustang (FMC) Perm-Up 3.2 EC (United Phosphorus) Permastar AG (LG Life) Tengard SFR (United Phosphorus)
triflumizole	Procure (MacDermid)	Trionic 4SC (United Phosphorus)	

This list of generic products is not all-inclusive. Those included are not an endorsement by the authors, and those not included is not intentional.

Restricted Entry and Pre-Harvest Intervals

Formulation Name (Active Ingredient Name)	Type	REI (hrs)	PHI (days)						
			apple	pear	cherry	peach	nectar-ine	apricot	plum
Abamex (abamectin)	I	12	28	28	21	21	21	21	21
Abound (azoxystrobin)	F	4	---	---	0	0	0	0	0
Acramite 50WS (bifenazate)	I	12	7	7	3	3	3	3	3
Actara (thiamethoxam)	I	12	14 or 35	14 or 35	14	14	14	14	14
Actigard 50WG (acibenzolar-S-methyl)	F	12	0 or 60	0 or 60	---	---	---	---	---
Admire Pro (imidacloprid)	I	12	7 or 21	7 or 21	7 or 21	0 or 21	0 or 21	0 or 21	7 or 21
Agri-Flex (thiamethoxam/ abamectin)	I	12	35	35	---	---	---	---	---
Agri-Mycin 50 (streptomycin)	F	12	50	30	---	---	---	---	---
Aim EC (carfentrazone)	H	12	3	3	3	3	3	3	3
Akari 5 SC (fenpyroximate)	I	12	NL[a]	NL[a]	NL[a]	NL[a]	NL[a]	NL[a]	NL[a]
Aliette WDG (aluminum tris)	F	24	14[f]	14[f]	NL[af]	NL[af]	NL[af]	NL[af]	NL[af]
Alion (indaziflam)	H	12	14	14	14	14	14	14	14
Altacor (chlorantraniliprole)	I	4	5	5	10	10	10	10	10
Amine 4, Saber (2,4-D amine)	H	48	14	14	40	40	40	40	40
Aprovia (benzovindiflupyr)	F	12	30	30	---	---	---	---	---
Asana XL (esfenvalerate)	I	12	21	28	14	14	14	14	14
Assail 30SG (acetamiprid)	I	12	7	7	7	7	7	7	7
Avaunt (indoxacarb)	I	12	14	28	14	14	14	14	14
Aza-Direct (azadirachtin)	I	4	0	0	0	0	0	0	0
AzaGuard (azadirachtin)	I	4	0	0	0	0	0	0	0
Azatin O (azadirachtin)	I	4	0	0	0	0	0	0	0
Badge X2 (coppers)	F	48	0	0	0	0	0	0	0
Baythroid XL (beta-cyfluthrin)	I	12	7	7	7	7	7	7	7
Belay (clothianidin)	I	12	7	7	---	21	---	---	---
Beleaf 50 SG (flonicamid)	I	12	21	21	14	14	14	14	14
Besiege (lambda-cyhalothrin/ chlorantraniliprole)	I	24	21	21	14	14	14	14	14
Bexar (tolfenpyrad)	I	12	14[df]	14[df]	14[df]	14[df]	14[df]	14[df]	14[df]
BlightBan A506 (*Pseudomonas fluorescens*)	F	4	0[df]	0[df]	0[df]	0[df]	0[df]	0[df]	---
Blossom Protect (*Aureobasidium pullulans*)	F	4	0[b]	0[b]	NL[b]	NL[b]	NL[b]	NL[b]	NL[b]
BotaniGard ES (*Beauveria bassiana* strain GHA)	I	4	0	0	0	0	0	0	0
Bravo Ultrex/Weather Stik (chlorothalonil)	F	12	---	---	NL[c]	NL[c]	NL[c]	NL[c]	NL[c]
Brigade 2EC (bifenthrin)	I	12	14	14	---	14	---	---	---
Cabrio EG (pyraclostrobin)	F	12	0	---	0	---	---	---	---
Captan 80 WDG (captan)	F	24	0	---	0	0	0	0	0
Captiva Prime (canola oil/garlic oil)	I	4	0	0	0	0	0	0	0

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Restricted Entry and Pre-Harvest Intervals, continued

Formulation Name (Active Ingredient Name)	Type	REI (hrs)	PHI (days)						
			apple	pear	cherry	peach	nectar-ine	apricot	plum
Carbaryl 4L (carbaryl)	I	12	3	3	3	3	3	3	3
Casoron 4G (dichlobenil)	H	12	0	0	0	---	---	---	---
Centaur WDG (buprofezin)	I	12	14[f]	14[f]	14[f]	14[f]	14[f]	14[f]	14[f]
Cevya (mefentrifluconazole)	F	12	0	0	NL	NL	NL	NL	NL
Champ Formula 2, Champ WG (copper hydroxide)	F	48	NL[b]	NL[b]	NL[b]	21	21	NL[b]	NL[b]
Chateau SW (flumioxazin)	H	12	60	60	60	60	60	60	60
C-O-C-S WDG (copper oxychloride)	F	48	0[f]	0[f]	0[f]	0[f]	0[f]	0[f]	0[f]
Cormoran (acetamiprid/ novaluron)	I	12	14[f]	12[f]	8[f]	8[f]	8[f]	8[f]	8[f]
CS 2005 (copper sulfate pentahydrate)	F	48	0	0	0	21	21	0	0
Cueva (copper octanoate)	F	4	0	0	0	0	0	0	0
Cuprofix Ultra 40 (copper sulfate)	F	48	NL	NL	NL	21	21	NL	NL
Cyd-X (*Cydia pomonella* granulosis virus)	I	4	0	0	---	---	---	---	0
Danitol 2.4 EC (fenpropathrin)	I	24	14	14	3	3	3	3	3
Delegate WG (spinetoram)	I	4	7	7	1	1	1	1	1
Diazinon AG600 (diazinon)	I	4 days	21	21	21	21	21	21	21
Dimethoate 4EC (dimethoate)	I	10 or 14 days	---	28	21	---	---	---	---
Dimilin 2L (diflubenzuron)	I	12	---	14	---	14	14	14	14
Dipel DF (*Bacillus thuringiensis*)	I	4	0	0	0	0	0	0	0
Eagle 20EW (myclobutanil)	F	24	14	0[a]	0	0	0	0	0
Elevate 50WDG (fenhexamid)	F	12	---	0	0	0	0	0	0
Endigo ZC (lambda-cyhalothrin/ thiamethoxam)	I	24	35	35	14	14	14	14	14
Entrapment FV (xanthan gum)	I	4	NL[df]	NL[df]	NL[df]	NL[df]	NL[df]	NL[df]	NL[df]
Entrust (spinosad)	I	4	7	7	7	1	1	14	7
Envidor 2 SC (spirodiclofen)	I	12	7	7	7	7	7	7	7
Esteem 35 WP (pyriproxyfen)	I	12	45	45	14	14	14	14	14
Excalia (inpyrfluxam)	F	12	NL[b]	---	---	---	---	---	---
Exirel (cyantraniliprole)	I	12	3	3	3	3	3	3	3
Flint (trifloxystrobin)	F	12	14	14	---	---	---	---	---
Fontelis (penthiopyrad)	F	12	28	28	0	0	0	0	0
Fosphite (salts of phosphorous acid)	F	4	0	0	0	0	0	0	0
Fusilade DX (fluazifop-P)	H	12	360[a]	360[a]	14	14	14	14	14
Gallery 75 (isoxaben)	H	12	NL[a]	NL[a]	NL[a]	NL[a]	NL[a]	NL[a]	NL[a]
Gatten (flutianil)	F	12	14[f]	---	3[f]	---	---	---	---
GF-120 NF (spinosad)	I	4	0	0	0	0	0	0	0

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Restricted Entry and Pre-Harvest Intervals, continued

Formulation Name (Active Ingredient Name)	Type	REI (hrs)	PHI (days)						
			apple	pear	cherry	peach	nectar-ine	apricot	plum
Gladiator (zeta-cypermethrin/ abamectin)	I	12	28	28	21	21	21	21	21
Glyphosate (glyphosate)	H	12	1	1	17	17	17	17	17
Goal 2XL (oxyfluorfen)	H	24	NL[b]	NL[b]	NL[b]	NL[b]	NL[b]	NL[b]	NL
Gramoxone SL (paraquat)	H	48	NL	NL	28	14	28	28	28
Grandevo WDG (*Chromobacterium subtsugae*)	I	4	0	0	0	0	0	0	0
Harbour (streptomycin sulfate)	F	12	50[f]	30[f]	---	---	---	---	---
Horticultural Oil	I	0	0	0	0	0	0	0	0
Hulk (florpyrauxifen-benzyl)	H	12	60	60	60	60	60	60	60
Imidan 70-W (phosmet)	I	7 days cherry-3 days	7	7	7 (tarts only)	14	14	14	7
Indar 2F (fenbuconazole)	F	12	14	---	0	0	0	0	0
Inspire Super (difenoconazole/ cyprodinil)	F	12	14	14	2 (tarts only)	2	2	2	2
Intrepid 2F (methoxyfenozide)	I	4	14	14	7	7	7	7	7
Kaligreen (potassium bicarbonate)	F	4	1	1	1	1	1	1	1
Karmex DF (diuron)	H	12	NL	NL	---	8 mo.	---	---	---
Kasumin 2L (kasugamycin)	F	12	90	90	30	---	---	---	---
Kendo 22.8 CS (lambda-cyhalothrin)	I	24	21	21	14	14	14	14	14
Kenja 400 SC (isofetamid)	F	12	20	20	1	1	1	1	1
Kerb 50-W (pronamide)	H	24	NL	NL	NL	NL	NL	NL	NL
Kocide (copper hydroxide)	F	48	0	0	0	0	0	0	0
Lannate LV, Lannate SP (methomyl)	I	2-4 days	14	---	---	4	---	---	---
Leverage 360 (beta-cyfluthrin/ imidacloprid)	I	12	7	7	7	7	7	7	7
Luna Experience (tebuconazole/ fluopyram)	F	12	---	---	0	0	0	0	0
Luna Sensation (fluopyram/ trifloxystrobin)	F	12	14	14	1	1	1	1	1
Luna Tranquility (fluopyram/ pyrimethanil)	F	12	72	72	---	---	---	---	---
Magister SC (fenazaquin)	I	12	7	7	3	3	3	3	3
Malathion 57 EC (malathion)	I	12-24	---	---	3	7	7	6	---
Matrix SG (rimsulfuron)	H	4	7	7	14	14	14	14	14
Mastercop (copper sulfate pentahydrate)	F	48	NL	NL	NL	NL	NL	NL	NL
Merivon Xemium (fluxapyroxad/ pyraclostrobin)	F	12	0	0	0	0	0	0	0
Microthiol Disperss (sulfur)	F	24	0	0	0	0	0	0	0

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Restricted Entry and Pre-Harvest Intervals, continued

Formulation Name (Active Ingredient Name)	Type	REI (hrs)	PHI (days)						
			apple	pear	cherry	peach	nectar-ine	apricot	plum
Milstop SP (potassium bicarbonate)	F	1	0	0	0	0	NL[a]	0	0
Minecto Pro (abamectin/ cyantraniliprole)	I	12	28	28	21	21	21	21	21
M-Pede (potassium salts of fatty acids)	I	12	0	0	0 (tarts only)	0	0	0	0
Mustang Maxx (zeta-cypermethrin)	I	12	14	14	3	14	14	14	14
Mycoshield (oxytetracycline)	F	12	60	60	---	21	21	---	---
Nealta (cyflumetofen)	I	12	7	7	7	7	7	7	7
NemaSeek (*Heterorhabditis bacteriophora*)	I	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Nexter (pyridaben)	I	12	25	7	300 (post-harvest only)	7	7	300 (post-harvest only)	7
Nu-Cop 50 DF (copper hydroxide)	F	48	NL[f]	NL[f]	NL[f]	21[f]	21[f]	NL[f]	NL[f]
Onager (hexythiazox)	I	12	28	28	7	7	7	7	7
OSO 5%SC (polyoxin D zinc)	F	4	0	0	0	0	0	0	0
Ph-D (polyoxin D zinc salt)	F	4	0	0	0	0	0	0	0
Phostrol (salts of phosphorous acid)	F	4	0	0	NL	NL	NL	NL	NL
Poast (sethoxydim)	H	12	14	14	25	25	25	25	365[a]
Pounce 25 WP (permethrin)	I	12	NL[bf]	NL[bf]	3[f]	14[f]	14[f]	---	---
Previsto (copper hydroxide)	F	48	---	---	NL	NL	NL	NL	NL
Princep 4L (simazine)	H	12	150	21	21 (tarts only)	21	21	21	---
Pristine (boscalid/pyraclostrobin)	F	12	0	0	0	0	0	0	0
Proclaim (emamectin benzoate)	I	12-48	14	14	7	---	---	---	---
Procure 480SC (triflumizole)	F	12	14	14	1	---	---	---	---
PropiMax EC (propiconazole)	F	12	---	---	10	10	10	10	10
Prowl 3.3 EC (pendimethalin)	H	24	NL[a]	NL[a]	NL[a]	NL[a]	NL[a]	NL[a]	NL[a]
Pyganic (pyrethrins)	I	12	0	0	0	0	0	0	0
Quadris Top (difenoconazole/ azoxystrobin)	F	12	---	---	0	0	0	0	0
Quash (metconazole)	F	12	---	---	14	14	14	14	14
Quilt Xcel (propiconazole/ azoxystrobin)	F	12	---	---	0	0	0	0	0
Quintec (quinoxyfen)	F	12	---	---	7	7	7	7	7
Rally 40WSP (myclobutanil)	F	24	14	---	0	0	0	0	0
Regalia CG (*Reynoutria sachalinensis*)	F	4	0	0	0	0	0	0	0
Reglone 2L (diquat)	H	24	NL[a]	NL[a]	NL[a]	NL[a]	NL[a]	NL[a]	NL[a]
Rely (glufosinate)	H	12	14	14	14	14	14	14	14
Relision (glufosinate/indaziflam)	H	12	14	14	14	14	14	14	14

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Restricted Entry and Pre-Harvest Intervals, continued

Formulation Name (Active Ingredient Name)	Type	REI (hrs)	PHI (days)						
			apple	pear	cherry	peach	nectar-ine	apricot	plum
Rhyme (flutriafol)	F	12	14	14	7	7	7	7	7
Ridomil Gold SL (mefenoxam)	F	48	NL	---	0	0	0	0	0
Rimon 0.83EC (novaluron)	I	12	14	---	8	8	8	8	8
Rovral (iprodione)	F	48	---	---	NL[b]	NL[b]	NL[b]	NL[b]	NL[b]
Savey 50 DF (hexythiazox)	I	12	28	28	28	28	28	28	28
Scala SC (pyrimethanil)	F	12	72	72	---	30	30	30	30
Scythe 4.2E (pelargonic acid)	H	12	NL	NL	NL	NL	NL	NL	NL
Scorpion 35SL (dinotefuran)	I	12	0	0	0	3 or 21	3 or 21	0	0
Serenade ASO, Serenade Opti (*Bacillus subtilis*)	F	4	0	0	0	0	0	0	0
Sinbar WDG (terbacil)	H	12	60[df]	---	NL[adf]	60[df]	---	NL[adf]	NL[adf]
Sivanto prime (flupyradifurone)	I	4	14	14	14	14	14	14	14
Snapshot 2.5TG (isoxaben/ trifluralin)	H	12	NL[a]	NL[a]	NL[a]	NL[a]	NL[a]	NL[a]	NL[a]
Solicam DF (norflurazon)	H	12	60[df]	60[df]	60[df]	60[df]	60[df]	60[df]	60[df]
Sonata (*Bacillus pumilis*)	F	4	0	0	0	0	0	0	0
Sovran (kresoxim-methyl)	F	12	30	30	---	---	---	---	---
Stinger (clopyralid)	H	12	30	---	30	30	30	30	30
Success (spinosad)	I	4	7	7	7	1	1	14	7
Sulfur	F	0	0	0	0	0	0	0	0
Surflan AS (oryzalin)	H	24	NL	NL	NL	NL	NL	NL	NL
Surround WP (kaolin clay)	I	4	0	0	0	0	0	0	0
Swagger (bifenthrin/imidacloprid)	I	12	---	14	---	---	---	---	---
Tersus (pyrethrins)	I	12	0	0	0	0	0	0	0
Tetris SG (rimsulfuron)	H	4	7	7	14	14	14	14	14
Theia (*Bacillus subtilis* strain AFS032321)	F	4	0	0	0	0	0	0	0
Tilt (propiconazole)	F	24	---	---	0	0	0	0	0
Tombstone (cyfluthrin)	I	12	7	7	7	7	7	7	7
Topguard EQ (flutriafol)	F	12	NL[e]	NL[e]	7[e]	7[e]	7[e]	7[e]	7[e]
Topsin M WSB (thiophanate-methyl)	F	48	1	1	1	1	1	1	1
Torino (cyflufenamid)	F	4	14	14	6	---	---	---	---
Transform WG (sulfoxaflor)	I	24	7	7	7	7	7	7	7
Trionic 4SC (triflumizole)	F	12	14	14	1	---	---	---	---
Ultor/Movento (spirotetramat)	I	24	7	7	7	7	7	7	7
Vangard WG (cyprodinil)	F	12	0	0	2 (tarts only)	2	2	2	2
Vendex 50WP (fenbutatin-oxide)	I	48	14	14	14	14	14	---	14
Venerate XC (*Burkholderia* spp.)	I	4	0	0	0	0	0	0	0
Venom (dinotefuran)	I	12	---	---	---	21	21	---	---
Verdepryn (cyclaniliprole)	I	4	7	7	7	7	7	7	7

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Formulation Name (Active Ingredient Name)	Type	REI (hrs)	PHI (days)						
			apple	pear	cherry	peach	nectar-ine	apricot	plum
Versys Inscalis (afidopyropen)	I	12	7	7	7	7	7	7	7
Virosoft CP4 (*Cydia pomanella* granulosis virus)	I	4	NL	NL	NL	NL	NL	NL	NL
Vivando (metrafenone)	F	12	---	---	7	7	7	7	---
Voliam Flexi (chlorantraniliprole/ thiamethoxam)	I	12	35	35	14	14	14	14	14
Voliam Xpress (lambda-cyhalothrin /chlorantraniliprole)	I	24	21[dfe]	21[dfe]	14[dfe]	14[dfe]	14[dfe]	14[dfe]	14[dfe]
Vydate L (oxamyl)	I	48	14	14	NL[a]	NL[a]	---	---	---
Warrior II (lambda-cyhalothrin)	I	24	21	21	14	14	14	14	14
XenTari (*Bacillus thuringiensis)*	I	4	0	0	0	0	0	0	0
Zeal (etoxazole)	I	12	14	14	7	7	7	7	7
Ziram 76DF (ziram)	F	48	14	14	30	30	30	30	---
Zivalgo (isocycloseram)	I	12	14	14	14	14	14	14	14

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Protecting Pollinators and Beneficials From Pesticides

- Take advantage of the delayed dormant timing, when bees are not active, for many insect pests.
- Choose the least toxic insecticide possible.
- Do not spray trees in bloom.
- Apply insecticides in late evening, night, or early morning while bees are not actively foraging.
- Even if trees are not in bloom, plenty of plants are blooming on the orchard floor or border. Evening applications are generally less hazardous to bees than early morning applications. Bees and many beneficial insects can be considered to be active when temperatures are above 52°F.
- Before making a pesticide application, notify the beekeeper or your county bee inspector t of the application, the type of pesticide, and the area of application.
- Select herbicide formulations that are the least harmful to bees for roadside and other weed control operations. Tests have shown that at maximum dosage, 2,4-D, alkanolamine salts and isopropyl esters, and herbicides that have a more oily formulation, are more toxic than other forms.
- Spraying in late afternoon or evening will also lessen the hazard, since bees will not visit the blooms after they become curled.
- Blossom-thinning sprays have not been hazardous to bees in orchards. However, Sevin used as a fruit thinner 15 to 25 days past full bloom of apples is highly hazardous if cover crop blooms become contaminated.
- Learn about the beekeeper's problems with the poisoning of bees and enter into mutually advantageous agreements with him or her to best produce bee-pollinated crops.

Pesticide Toxicity to Pollinators and Beneficials

Formulation Name (Active Ingredient Name)	honey-bees	lady beetles	parasitoid wasps	predatory mites	syrphid flies	lace-wings
Abamex (abamectin)	++++	++++	+++	++	++++	++++
Abound (azoxystrobin)	++	---	---	---	++++	---
Acramite 50WS (bifenazate)	+++	++	---	---	++	+
Actara (thiamethoxam)	++++	---	+++	---	---	+++
Actigard 50WG (acibenzolar-S-methyl)	+	---	---	---	---	---
Admire Pro (imidacloprid)	++++	+++	++++	---	+++	+++
Agri-Flex (thiamethoxam/abamectin)	++++	++++	---	+	+++	+++
Agri-Mycin 50 (streptomycin)	+	---	---	---	---	---
Akari 5 SC (fenpyroximate)	+	++	++	++++	++	++
Aliette WDG (aluminum tris)	---	---	---	---	++++	---
Altacor (chlorantraniliprole)	+	++	++	++	++	++
Aprovia (benzovindiflupyr)	+	---	---	---	---	---
Asana XL (esfenvalerate)	++++	+++	++++	++++	+++	+++
Assail 30SG (acetamiprid)	+++	+++	+++	++	++	++
Avaunt (indoxacarb)	++++	++	++	+	++	++
Aza-Direct (azadirachtin)	+	---	---	---	++++	+++
AzaGuard (azadirachtin)	+	+	+	+	++++	+++
Azatin O (azadirachtin)	---	---	---	---	---	++
Badge X2 (copper oxychloride/hydroxide)	---	---	---	---	++++	++++
Baythroid XL (beta-cyfluthrin)	++++	+++	++++	++++	++	++++
Belay (clothianidin)	++++	+++	++++	++	++++	++++
Beleaf 50 SG (flonicamid)	+	---	---	++	---	---
Besiege (chlorantraniliprole/lambda-cy)	++++	++++	++++	+++	++	++++
Bexar (tolfenpyrad)	++	---	---	---	---	---
Bravo Ultrex/Weather Stik (chlorothalonil)	+	---	---	---	---	---
Brigade 2EC (bifenthrin)	++++	++++	++++	++++	++++	++++
BotaniGard ES (*Beauveria Bassiana* Strain GHA)	++	---	---	---	---	---
Cabrio EG (pyraclostrobin)	+	---	---	---	---	---
Captan 80 WDG (captan)	++	---	---	++	---	++
Captiva Prime (canola oil/garlic oil)	+	++	+	++	++	++
Centaur WDG (buprofezin)	++	++	++	++	+++	+++
Champ Formula 2,WG (copper hydroxide)	++	---	---	---	---	---
C-O-C-S WDG (copper oxychloride)	++	---	---	---	---	---
Cormoran (novaluron/acetamiprid)	+++	++++	+++	++++	++++	+++
CS 2005 (copper sulfate pentahydrate)	++++	---	++++	++	++++	---
Cyd-X (CM granulosis virus)	+	+	+	+	+	+
Danitol 2.4 EC (fenpropathrin)	++++	++++	++++	++++	++++	++++
Delegate WG (spinetoram)	+++	+++	++	+++	+++	+++
Diazinon AG600 (diazinon)	++++	++++	++++	+++	++++	++++
Dimethoate 4EC (dimethoate)	++++	++++	+++	+++	---	++++

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Pesticide Toxicity to Pollinators and Beneficials, continued

Formulation Name (Active Ingredient Name)	honey-bees	lady beetles	parasitoid wasps	predatory mites	syrphid flies	lace-wings
Dimilin 2L (diflubenzuron)	+	++	++++	---	---	++++
Dipel DF (*Bacillus thuringiensis*)	+	++	++	++	++	++
Eagle 20EW (myclobutanil)	+++	+	---	++	---	---
Elevate 50 WDG (fenhexamid)	+	---	+++	+++	---	---
Endigo ZC (thiamethoxam/lambda-cyhalothrin)	++++	+++	++++	++++	+++	++++
Entrapment FV (xanthan gum)	+	+	---	+	---	---
Entrust (spinosad)	+++	+++	++	+++	+++	+++
Envidor 2 SC (spirodiclofen)	+++	++	---	++	---	+
Esteem 35 WP (pyriproxyfen)	+	++	++	++	++	++
Exirel (cyantraniliprole)	+++	++	++	++	++	++
Flint (trifloxystrobin)	+	---	---	+	---	---
Fontelis (penthiopyrad)	+	---	---	---	---	+
Gatten (flutianil)	+	+	---	---	+	+
GF-120 NF (spinosad)	++++	---	---	++	---	---
Gladiator (avamectin/zeta-cypermethrin)	++++	+++	++++	++++	++	++++
Goal 2XL (oxyfluorfen)	---	---	---	+++	---	---
Gramoxone SL (paraquat)	---	---	---	++++	---	---
Grandevo WDG (*Chromobacterium subtsugae*)	+++	+	+	+	---	---
Harbour (streptomycin sulphate)	+	---	---	---	---	---
Horticultural oil	++	+	---	---	---	+
Imidan 70-W (phosmet)	++++	++++	++++	++++	++++	++++
Indar 2F (fenbuconazole)	+	---	---	---	---	---
Inspire Super (difenoconazole/cyprodinil)	+	---	---	---	---	---
Intrepid 2F (methoxyfenozide)	++	++	++	++	++	++
Kanemite 15 SC (acequinocyl)	+	+	---	++	---	---
Kasumin 2L (kasugamycin)	+	---	---	---	---	---
Kocide (copper hydroxide)	+	---	---	---	---	---
Lannate LV, Lannate SP (methomyl)	++++	++++	++++	++++	++++	++++
Leverage 360 (imidacloprid/cyfluthrin)	++++	++++	++++	++++	+++	++++
Luna Experience (fluopyram/tebuconazole)	+	---	---	---	---	---
Luna Sensation (fluopyram/trifloxystrobin)	+	---	---	---	---	---
Magister SC (fenazaquin)	++++	---	---	++++	---	---
Malathion 57 EC (malathion)	++++	++++	++++	+++	++++	++++
Microthiol Disperss (sulfur)	+	++	++++	+++	+++	+++
Minecto Pro (abamectin/cyantraniliprole)	++++	---	+++	+++	++	---
M-Pede (potassium salts of fatty acids)	+	---	---	---	---	++
Mustang Maxx (zeta-cypermethrin)	++++	++++	++++	+++	++	++++
Mycoshield (oxytetracycline calcium)	+	---	---	---	---	---
Nealta (cyflumetofen)	+	+	---	+	---	+

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Pesticide Toxicity to Pollinators and Beneficials, continued

Formulation Name (Active Ingredient Name)	honey-bees	lady beetles	parasitoid wasps	predatory mites	syrphid flies	lace-wings
NemaSeek (*Heterorhabditis bacteriophora*)	+	+	+	+	---	---
Nexter (pyridaben)	++++	+++	---	++++	+++	+++
Nu-Cop 50 DF (copper hydroxide)	++	---	---	---	---	---
Onager (hexythiazox)	+++	++	++	++	++	++
OSO 5%SC (polyoxin D zinc salt)	+	---	---	---	+++	+++
Pounce 25 WP (permethrin)	++++	++++	++++	++++	++++	++++
Previsto (copper Hydroxide)	+	---	---	---	---	---
Pristine (boscalid/pyraclostrobin)	+	---	---	---	---	---
Proclaim (emamectin benzoate)	++++	+	---	---	---	+
Procure 480SC (triflumizole)	+	---	---	---	---	---
PropiMax EC (propiconazole)	+	---	---	---	---	---
Pyganic (pyrethrins)	++++	+++	+++	++	+++	+++
Quash (metconazole)	+	---	---	---	---	---
Quintec (quinoxyfen)	+	---	---	---	---	---
Quadris Top (azoxystrobin/difenoconazole)	+	---	---	---	++++	---
Rely (glufosinate)	---	---	---	++++	---	---
Relsion (glufosinate/indaziflam)	---	---	---	++++	---	---
Rimon 0.83EC (novaluron)	++	++++	++	+++	+++	++++
Rovral (iprodione)	+	---	---	---	---	---
Savey 50 DF (hexythiazox)	+++	++	++	+++	++	++
Sivanto prime (flupyradifurone)	+	+	---	---	++	++
Sonata (*bacillus pumilis*)	+	---	---	---	---	---
Sovran (kresoxim-methyl)	+++	---	---	---	---	++++
Success (spinosad)	+++	+++	+++	+++	+++	+++
Sulfur	+	---	---	++	---	++
Surround WP (kaolin clay)	+	+++	---	+++	---	---
Swagger (imidacloprid/bifenthrin)	++++	++++	+++	++	++++	++++
Tersus (pyrethrins)	++++	++	---	+	---	---
Theia (*Bacillus subtilis* strain AFS032321)	---	---	---	---	---	---
Tombstone (cyfluthrin)	++++	+++	++++	++++	++	++++
Topsin M WSB (thiophanate-methyl)	---	+++	++++	++++	---	++++
Torino (cyflufenamid)	+++	---	---	---	+++	+++
Transform WG (sulfoxaflor)	++++	++	---	++	---	++
Trionic 4SC (triflumizole)	---	---	---	---	---	---
Ultor/Movento (spirotetramat)	+++	++	++	++	++	++
Vendex 50WP (fenbutatin-oxide)	++	++	++	+++	---	+++
Venerate XC (*Burkholderia* spp. strain)	+	+	---	---	---	+
Venom (dinotefuran)	++++	++++	++++	---	---	---
Verdepryn (cyclaniliprole)	++++	+++	++	++	++	+++
Versys Inscalis (afidopyropen)	+	++	---	++	---	++
Virosoft CP4 (CM granulosis virus)	+	+	---	+	+	++

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Pesticide Toxicity to Pollinators and Beneficials, continued

Formulation Name (Active Ingredient Name)	honey-bees	lady beetles	parasitoid wasps	predatory mites	syrphid flies	lace-wings
Voliam Flexi (thiamethoxam/ chlorantraniliprole)	++++	+++	++	++	+++	+++
Voliam Xpress (lambda-cyhalothrin/ chlorantraniliprole)	++++	++++	+++	++++	++++	++++
Vydate L (oxamyl)	++++	+++	++++	++++	---	++
Warrior II (lambda-cyhalothrin)	++++	++++	++++	++++	++++	++++
XenTari (*Bacillus thuringiensis)*	++	++	---	++	---	++
Zeal (etoxazole)	++	+++	---	+++	++	++
Zivalgo (isocycloseram)	++++	---	---	---	++++	++++

Insecticide Classes

Main Group and *Primary Site of Action*	Chemical Sub-group or primary Active Ingredient	Example Active Ingredients
1: Acetylcholinesterase inhibitors *Nerve action*	1A - Carbamates	carbaryl, methomyl, oxamyl
	1B - Organophosphates	diazinon, dimethoate, malathion, phosmet
3: Sodium channel modulators *Nerve action*	3A - Pyrethroids, Pyrethrins	esfenvalerate, beta-cyfluthrin, fenpropathrin, gamma-cyhalothrin, lambda-cyhalothrin, permethrin, pyrethrin
4: Nicotinic acetylcholine receptor agonists *Nerve action*	4A - Neonicotinoids	acetamiprid, clothianidin, imidacloprid, thiamethoxam
	4C - Sulfoxaflor	sulfoxaflor
	4D - Flupyradifurone	flupyradifurone
5: Nicotinic acetylcholine receptor activators *Nerve action*	5 - Spinosyns	spinetoram, spinosad
6: Chloride channel activators *Nerve and muscle action*	6 - Avermectins, Milbemycins	abamectin, emamectin benzoate
7: Juvenile hormone mimics *Growth regulation*	7C - Pyriproxyfen	pyriproxyfen
9: Selective homopteran feeding blockers	9C - Flonicamid	flonicamid
10: Mite growth inhibitors *Growth regulation*	10A - Hexythiazox	hexythiazox
	10B - Etoxazole	etoxazole
11: Microbial disrupters of insect midgut *Membranes*	11 - *Bacillus thuringiensis*	*Bacillus thuringiensis*
12: Inhibitors of mitochondrial ATP synthase *Energy metabolism*	12B - Organotin miticides	fenbutatin-oxide
15: Inhibitors of chitin biosynthesis, type 0 *Growth regulation*	15 - Benzoylureas	diflubenzuron, novaluron
16: Inhibitors of chitin biosynthesis, type 1 *Growth regulation*	16 - Buprofezin	buprofezin
18: Ecdysone receptor agonists *Growth regulation*	18 - Diacylhydrazines	methoxyfenozide
20: Mitochondrial complex III electron transport inhibitors *Energy metabolism*	20 - Acequinocyl, Bifenazate	acequinocyl, bifenazate
21: Mitochondrial complex I electron transport inhibitors *Energy metabolism*	21 - METI acaricides and insecticides	pyridaben, tolfenpyrad
22: Voltage-dependent sodium channel blockers *Nerve action*	22 - Indoxacarb	indoxacarb
23: Inhibitors of acetyl CoA carboxylase *Lipid synthesis, growth regulation*	23 - Tetronic and Tetramic acid derivatives	spirodiclofen, spirotetramat
25: Mitochondrial complex II electron transport inhibitors	25A - Beta-ketonitrile derivatives	cyflumetofen
28: Ryanodine receptor modulators *Nerve and muscle action*	28 - Diamides	chlorantraniliprole, cyantraniliprole, cyclaniliprole
30: GABA-gated chloride channel allosteric modulators *GABA channels*	30 - Meta-diamides, Isoxazolines	broflanilide, cyproflanilide, fluxametamide, isocycloseram

Fungicide Classes

Main Group and *Primary Site of Action*	Chemical Sub-group or primary Active Ingredient	Example Active Ingredients
1: MBC - fungicides (Methyl Benzimidazole Carbamates) *Mitosis*	Benzimidazoles, Thiophanates	thiophanate-methyl
3: DMI-fungicides (DeMethylation Inhibitors) *Sterol biosynthesis*	DMI-fungicides	difenoconazole, fenbuconazole, flutriafol, metconazole, myclobutanil, propiconazole, tebuconazole, triflumizole
4: PA – fungicides (Phenyl Amides) *RNA polymerase*	PA - fungicides (Phenyl Amides)	mefenoxam
7: SDHI (Succinate dehydrogenase inhibitors) *Respiration*	Carboxamides	boscalid, fluopyram, fluxapyroxad
9: AP - fungicides (Anilino-Pyrimidines) *Methionine biosynthesis*	AP - fungicides (Anilino-Pyrimidines)	cyprodinil, penthiopyrad
11: QoI-fungicides (Quinone outside Inhibitors) *Respiration*	QoI-fungicides (Quinone outside Inhibitors)	azoxystrobin, pyraclostrobin, trifloxystrobin
	Oximino-acetates	kresoxim-methyl
13: Azanaphthanlenes *Signal transduction*	Quinolines	quinoxyfen
17: Keto Reductase Inhibitors *Sterol biosynthesis*	Hydroxyanilides	polyoxin
19: Polyoxins *Chitin synthase*	Peptidyl Pyrimidine Nucleosides	fenhexamid
24: Hexopyranosyl antibiotic *Protein synthesis*	Hexopyranosyl Antibiotic	kasugamycin
25: Glucopyranosyl antibiotic *Protein synthesis*	Glucopyranosyl Antibiotic	streptomycin
33: Phosphonates *Unknown*	Phosphonates	salts of phosphorous acid, aluminum tris
41: Tetracycline antibiotic *Protein synthesis*	Tetracycline Antibiotic	oxytetracycline
50: Aryl-phenyl-ketones *Cytoskeleton and motor protein*	Benzophenone	metrafenone
BM02: Microbial *Many types*	Biologicals	*Bacillus* spp.
M: Multi-site contact activity *Contact*	M1 - Inorganic	copper hydroxide, fixed copper
	M2 - Inorganic	sulfur
	M3 - Dithiocarbamates and Relatives	ziram
	M4 - Phthalimides	captan
	M5 - Chloronitriles (Phthalonitriles)	chlorothalonil
P01: Benzo-thiadiazole *Induced systemic resistance*	Benzo-thiadiazole	acibenzolar-S-methyl
P05: Plant-based *Induced systemic resistance*	---	*Reynoutria sachalinensis*

Spray Incompatibilities and Phytotoxicity Risk

Aliette plus products containing **copper** should never be mixed. If Aliette is to be applied after or before copper containing compounds, the pH of the Aliette spray should be raised to 6.0 or above to avoid phytotoxicity from solubilized copper.

Altacor is not compatible with **lime**.

Captan + **Oil** may cause injury to leaves or fruit when combined in the same spray or applied within 7 - 10 days of an oil spray, particularly after a frost or during slow drying conditions.

Fixed copper is not compatible with **Topsin.**

Lime is not compatible with **Altacor, Aza-Direct, AzaGuard, Azatin, Captan, dimethoate**, **Imidan, Lannate, malathion, pyrethroids,** or **Topsin.**

Oil is not compatible with **Captan, sulfur,** or **Surround.**

Sulfur is not compatible with **Bt, oil, or insecticidal soap (M-Pede)**.

Surround is not compatible with **oil** or fungicides that are **sterol inhibitors.**

Chemicals with a Risk of Phytotoxicity

Abound (azoxystrobin) is highly phytotoxic to certain apple varieties.

Calcium chloride, **calcium nitrate** - These materials can russet apple, mark pear fruit, and burn leaves following application depending upon concentration, temperature, and number of applications.

Captan + **Sulfur** is phytotoxic to apples.

Copper products

Imidan is phytotoxic to sweet cherry.

M-Pede – may be phytotoxic if applied in hot temperatures.

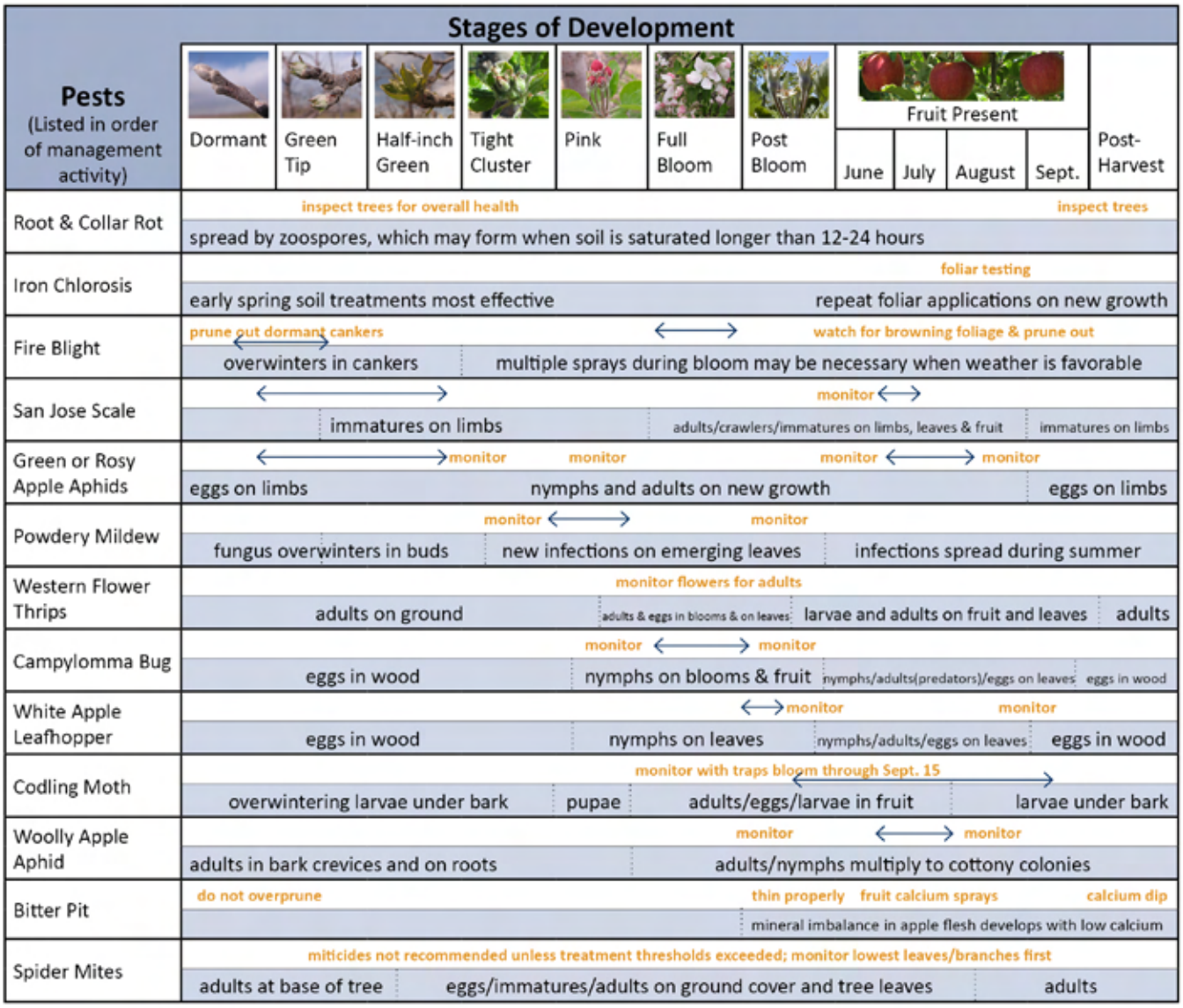
H**orticultural oil** - can cause injury if applied when temperatures read 85°F within 4 hours of application. Injury may also occur at temperatures under 40°F.

Topguard - do not use with adjuvant or 3 days within adjuvant spray.

CHAPTER 7 PEST MANAGEMENT PESTICIDE RECOMMENDATIONS

APPLE Pest Management Recommendations

Pest Phenology Calendar



Arrows (⟷) indicate intervals during which a recommended spray treatment occurs, if pest is present.
Note: The indicated monitoring times should serve as guidelines for when to monitor and manage pests, if the pest has been a problem in the past. Monitoring helps to identify whether the targeted pest is present in the orchard at damaging levels before a pesticide is used.

APPLE Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff.	MOA	Comments
GREEN TIP TO HALF-INCH GREEN (Delayed Dormant)				
Aphids (Green apple and Rosy apple aphid eggs)	*Conventional*:			2% horticultural oil plus insecticide is more effective at killing overwintering eggs. **Diazinon:** max 2 applications/yr. Supply may not be available. **Esteem 35:** max 2 applications/yr. **Beleaf:** max 3 applications/yr.
	Beleaf 50 SG (flonicamid) + 2% oil	3	29	
	Diazinon AG600[R] (diazinon) + 2% oil	4	1	
	Reduced Risk/Organic:			
	Esteem 35 WP (pyriproxyfen) + 2% oil	3-4	7	
	Horticultural oil[O] (many brands)	3	NC	
	Pest Biology: • aphids overwinter as eggs on limbs	*Scouting/Threshold:* • look for dark colored eggs under buds and in cracks and crevices		*Cultural*: • avoid applying excess nitrogen fertilizer; causes excess shoot growth that attracts aphids
Crown Rot *(Phytophthora)*	*Conventional*:			**Ridomil Gold SL:** apply in early spring and/or after harvest for best results. Use as a soil drench around trunk.
	Ridomil Gold SL (mefenoxam)	3	4	
	Pest Biology: • *Phytophthora* girdles the cambium, causing wilt, limb dieback, and tree death in wet, poorly drained soils	*Scouting/Threshold:* • watch for trees that have delayed bud break or that develop fall leaf color early (Aug. - early Sept.)		*Cultural*: • remove dead/dying tree(s); do not replant in the same site without improving drainage; avoid excessive irrigation
Brown Mite (eggs) *(these pests rarely need treatment)*	*Conventional*:			2% horticultural oil plus insecticide is more effective at killing overwintering eggs. **Gladiator:** max 38 oz/acre/yr.
	Gladiator[R] (zeta-cypermethrin/avermectin)	4	3/6	
	Reduced Risk/Organic:			
	Captiva Prime[O] (canola oil/garlic oil)	2-3	NC	
	Horticultural oil[O] (many brands)	4	NC	
	Pest Biology: • overwinter as eggs in cracks and crevices on bark	*Scouting/Threshold:* • look for red eggs on the bark of scaffolds and twigs		*Cultural*: • none

Eff = Efficacy, 4 is most efficacious, and 1, least. Information collected from a variety of sources.
MOA = Mode of Action
[R] = restricted use pesticide
[O] = OMRI approved organic pesticide
NC = not classified
--- = efficacy unknown
Number shown after pesticide name is number of days product lasts (only applies to certain pests).

APPLE Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff.	MOA	Comments
GREEN TIP TO HALF-INCH GREEN (Delayed Dormant) (continued)				
Fire Blight	*Conventional*:			**Badge X2, Champ Formula 2, Champ WG, C-O-C-S, Kocide, Mastercop, Previsto:** using copper on yellow varieties may cause discoloration. The addition of 1 to 3 lb of hydrated lime per pound of copper may reduce crop injury. Max 1 application/year.
	Champ Formula 2, Kocide (copper hydroxide)	3	M1	
	Reduced Risk/Organic:			
	Badge X2[O] (copper oxychloride/copper hydroxide)	3	M1	
	Champ WG[O] (copper hydroxide)	3	M1	
	C-O-C-S WDG (copper oxychloride)	2	M1	
	Cueva[O] (copper octanoate)	3	M1	
	Mastercop[O] (copper sulfate pentahydrate)	---	M1	
	Previsto[O] (copper hydroxide)	---	M1	

Pest Biology:
- bacteria overwinter in cankers in the orchard; cankers start to ooze bacteria when temperatures warm to 55-60 F

Scouting/Threshold:
- as temperatures warm, look for oozing cankers, which will indicate that the disease has become active

Cultural:
- prune limbs infected with cankers 8-10" below visible canker margins in late winter or early spring, before weather warms

San Jose Scale	*Conventional:*			Use Horticultural oil plus one of the other listed products
	Asana XL[R] (esfenvalerate)	3	3	
	Diazinon AG600[R] (diazinon)	4	1	**Centaur:** max 1 application/yr.
	Gladiator[R] (zeta-cypermethrin/avermectin)	---	3/6	
	Reduced Risk/Organic:			**Diazinon:** max 2 applications/yr. Supply may not be available.
	Centaur WDG (buprofezin)	4	16	
	Esteem 35 WP (pyriproxyfen)	3-4	7	**Esteem 35:** max 2 applications/yr.
	Horticultural oil[O] (many brands)	4	NC	
	Venerate XC[O] (*Burkholderia* spp.)	2	NC	**Gladiator:** max 38 oz/acre/yr.

Pest Biology:
- overwinter as black-capped immatures on limbs; crawlers hatch in late spring

Scouting/Threshold:
- scale on fruit in previous year indicates need for control
- examine limbs for clusters of gray-white "spots" to determine infestation
- delayed dormant timing kills many overwintering nymphs, but not all

Cultural:
- prune out heavily infested limbs

FIRST PINK				
Apple Scab *(this pest rarely needs treatment in commercial orchards)*	*Conventional:*			**Captan:** do not use with oils, lime, or alkaline materials.
	Aprovia (benzovindiflupyr)	4	7	
	Captan 80 WDG (captan)	3-4	M4	**Excalia**: do not apply after petal fall; apple only. Max 2 applications/yr.
	Dithane M45 (mancozeb)	3	M3	
	Excalia 2.84 SC (inpyrfluxam)	4	7	
	Indar 2F (fenbuconazole)	3	3	

Eff = Efficacy, 4 is most efficacious, and 1, least. Information collected from a variety of sources. **MOA** = Mode of Action [R] = restricted use pesticide [O] = OMRI approved organic pesticide **NC** = not classified **---** = efficacy unknown

Number shown after pesticide name is number of days product lasts (only applies to certain pests).

APPLE Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff.	MOA	Comments
FIRST PINK (continued)				
Apple Scab (continued)	*Conventional (continued):*			**Flint, Indar, Pristine, Procure, Ziram:** max 4 applications/yr. **Luna:** max 21 oz/acre/yr. **Scala:** max 40 oz/acre/yr. **Sovran**: drift may harm some cherry varieties. Max 4 applications/yr.
	Inspire Super (difenoconazole/cyprodinil)	3	3/9	
	Luna Sensation (fluopyram/trifloxystrobin)	3-4	7/11	
	Merivon Xemium (fluxapyroxad/pyraclostrobin)	3-4	7/11	
	Pristine (boscalid/pyraclostrobin)	3	7/11	
	Procure 480SC (triflumizole)	4	3	
	Eagle 20EW, Rally 40WSP (myclobutanil)	3-4	3	
	Scala SC (pyrimethanil)	3-4	9	
	Sovran (kresoxim-methyl)	3	11	
	Vangard WG (cyprodinil)	4	9	
	Ziram 76DF (ziram)	3-4	M3	
	Reduced Risk/Organic:			
	Flint (trifloxystrobin)	3-4	11	
	Fontelis (penthiopyrad)	3	7	
	Sulfur (many brands)	3	M2	

Pest Biology:
- this fungus overwinters on leaves and fruit; infections start at budbreak with rain

Scouting/Threshold:
- if scab was present the prior year, begin looking for lesions on early developing cultivars first

Cultural:
- practice good sanitation in fall with flail mowing of fruit

Powdery Mildew	*Conventional:*			Do not apply more than 2 sequential applications of one MOA. Protect susceptible varieties: Gala, Idared, Jonagold, Jonathan, and Rome. McIntosh, Golden, and Red Delicious are mildly affected. **Aprovia, Indar, Luna, Pristine:** max 4 applications/yr. **Excalia**: do not apply after petal fall; apple only. Max 2 applications/yr. **Merivon Xemium:** max 4 applications/yr. **Sovran**: drift may harm some cherry varieties. Max 4 applications/yr.
	Aprovia (benzovindiflupyr) (10)	3	7	
	Cabrio EG (pryaclostrobin) (10-14)	---	11	
	Cevya (mefentrifluconazole) (10)	3	3	
	Excalia (inpyrfluxam) (10-14)	3-4	7	
	Indar 2F (fenbuconazole) (10)	4	3	
	Inspire Super (difenoconazole/cyprodinil) (10-14)	4	3/9	
	Luna Sensation (fluopyram/trifloxystrobin) (10-14)	3-4	7/11	
	Merivon Xemium (fluxapyroxad/pyraclostrobin) (10-14)	4	7/11	
	Pristine (boscalid/pyraclostrobin) (10-14)	3	7/11	
	Procure 480SC (triflumizole) (14)	4	3	
	Rally 40WSP (myclobutanil) (10-14)	4	3	
	Rhyme (flutriafol) (10)	4	3	
	Sovran (kresoxim-methyl) (7-10)	3	11	
	Topsin M WSB (thiophanate-methyl) (10-14)	2-3	1	
	Torino (cyflufenamid) (14)	4	U6	
	Trionic 4SC (triflumizole) (14-12)	---	3	

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APPLE Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff.	MOA	Comments
FIRST PINK (continued)				
Powdery Mildew (continued)	*Reduced Risk/Organic:*			**Torino:** max 6.8 oz/acre/yr.
	Flint (trifloxystrobin) (10-14)	4	11	
	Fontelis (penthiopyrad) (7-14)	3	7	**Biologicals:** (Serenade, etc.) and **oils** must be applied before infection; they act as a protectant.
	Kaligreen[O], MilStop SP[O] (potassium bicarbonate) (5-7)	3	NC	
	Microthiol Disperss[O] (sulfur) (7)	3	M2	
	Ph-D, OSO 5% SC (polyoxin D zinc salt) (10-14)	3	19	
	Sulfur (many brands) (7)	4	M2	
	Regalia CG[O] (*Reynoutria sachalinensis*) (7)	---	P5	
	Serenade ASO[O] (*Bacillus subtilis*) (7)	2	BM2	
	Serenade Opti[O] (*Bacillus subtilis*) (7)	2	BM2	
	Sonata[O] (*Bacillus pumilis*) (7)	2	44	
	Theia[O] (*Bacillus subtilis*) (7)	---	BM2	

Pest Biology:
- the fungus overwinters on twigs and in buds and infects newly emerging leaves, which then serve as inoculum for later infections

Scouting/Threshold:
- if powdery mildew was severe the previous year, start applications at open cluster and continue every 7 to 14 days 2-3 times or as needed
- infections may continue through the summer in humid conditions

Cultural:
- overwinters on twigs and buds and infects emerging leaves

Pest	Brand (ingredient) - (residual days)	Eff.	MOA	Comments
PINK TO PETAL FALL				
Campylomma	*Conventional:*			One application at pink stage is more effective than at petal fall.
	Actara (thiamethoxam) (14)	3-4	4	
	Reduced Risk/Organic:			**Assail:** apply at night or while bees are not working in blooms.
	Assail 30SG, 70 WP (acetamiprid) (7-14)	3-4	4	

Pest Biology:
- adults are beneficial predators; nymphs may feed on developing fruit, causing corky bumps
- nymphs look similar to aphids, but are faster moving and do not have cornicles (tailpipes)

Scouting/Threshold:
- shake flower clusters into a cup or onto a tray to look for light green nymphs
- alternatively, use a beating stick to dislodge nymphs onto a tray; treat when you find 1 nymph/sample on Golden Delicious and 4 per sample for Red Delicious

Cultural:
- none

Pest	Brand (ingredient) - (residual days)	Eff.	MOA	Comments
Western Flower Thrips *(May be a problem on yellow, pink, and green varieties.)*	*Reduced Risk/Organic:*			**Delegate WG:** max 28 oz/acre/yr.
	Delegate WG (spinetoram)	4	5	
	Entrust[O] (spinosad)	4	5	**Entrust:** max 4 applications/yr.
	Grandevo WDG[O] (*Chromobacterium subtsugae*)	2-3	NC	
	Success (spinosad)	4	5	

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APPLE Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff.	MOA	Comments
PINK TO PETAL FALL (continued)				
Western Flower Thrips (continued)				
Pest Biology: • overwinter as adults in the ground and move to trees during bloom • females insert eggs into young fruitlet, resulting in "pansy spot"	*Scouting/Threshold:* • shake flower clusters into cup; check 5 clusters on each of 5 trees in each 10 acre block • treat when more than 2 adults are found per cluster			*Cultural*: • minute pirate bug and green lacewings are important predators
BLOOM				
Codling Moth	*Reduced Risk/Organic:*			Install **mating disruption** just before first moth flight (biofix), around full bloom of Red Delicious.
	Checkmate CM-O Puffer[O] (mating disruption)	4	NC	
	Isomate-CM Flex[O] (mating disruption)	4	NC	
Pest Biology: • moths start emerging from pupation around first bloom of Red Delicious, mate, and lay eggs on leaves and fruit	*Scouting/Threshold:* • after mating disruption is hung, install monitoring traps using Trece CM-DA Combo lure. Trap threshold for treatment is 10 moths (cumulative capture) • supplemental insecticides may be necessary; monitoring with traps is critical.			*Cultural*: • none
Fire Blight	*Conventional:*			**Actigard:** mix with antibiotic to improve efficacy. See label for info on painting existing cankers.
	Actigard 50WG (acibenzolar-S-methyl) (one application)	2	NC	
	Agri-Mycin 50 (streptomycin) (3-4)	3-4	25	**Agri-Mycin 50:** where there is resistance, use only once per year mixed with oxytetracycline. If using Regulaid, use 4-6 oz plus 1 pt Regulaid in 100 gal volume.
	Kasumin 2L (kasugamycin) (3-4)	4	24	
	Mycoshield (oxytetracycline) (2-3)	3-4	41	
	Reduced Risk/Organic:			**Biologicals:** products must be on flowers before infection. Apply at 10, 40, 70 and 90% open flowers.
	BlightBan A506 (*Pseudomonas fluorescens*) (3-5)	2	NC	
	Blossom Protect[O] (*Aureobasidium pullulans*) (3-5)	3	NC	**Cueva:** a soluble copper that is less phytotoxic; may cause russeting in some varieties.
	Cueva[O] (copper octanoate) (3-4)	2	M1	
	Mastercop[O] (copper sulfate pentahydrate) (5-7)	---	M1	**Kasumin 2L:** do not alternate–row spray. Alternate products after 2 applications.
	Previsto[O] (copper hydroxide)			
	Serenade Opti[O] (*Bacillus subtilis*) (2-7)	2	BM2	**Mastercop:** using on yellow varieties may cause discoloration. The addition of 1 to 3 lb of hydrated lime per pound of copper may reduce crop injury. Max 1 application/year.
	Theia[O] (*Bacillus subtilis* strain)	2	BM2	

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APPLE Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff.	MOA	Comments
BLOOM (continued)				
Fire Blight (continued)				
Pest Biology: • when rain occurs and average temperatures are >60° F, bacteria may be spread to open flowers	*Scouting/Threshold:* • check the Cougarblight model for treatment recommendations			*Cultural*: • another option is to not spray, but watch for dead terminals 7-14 days after bloom, and prune out immediately
PETAL FALL				
Aphids (Green Apple and Rosy Apple Aphids)	*Conventional:*			**Actara, Admire Pro:** do not apply when bees are active. **Agri-Flex:** max 2 applications/yr. Must be mixed with oil; can russet light-skinned fruit varieties. **Beleaf:** max 3 applications/yr. **Besiege:** max 31 oz/acre/yr. **Cormoran:** max 95 oz/acre/yr. **Esteem:** max 2 applications/yr. **Lannate:** do not use on early Macintosh and Wealthy varieties. **Leverage:** max 2.8 oz/acre/yr. **Nexter:** max 1 application/yr. **Ultor, Movento:** must be tank-mixed with a spray adjuvant/additive. **Sivanto:** max 28 oz/acre/yr. **Voliam Flexi:** max 4 applications/yr.
	Actara (thiamethoxam)	3	4	
	Admire Pro foliar (imidacloprid)	4	4	
	Agri-Flex[R] (thiamethoxam/abamectin)	4	4/6	
	Belay (clothianidin)	4	4	
	Beleaf 50 SG (flonicamid)	3	29	
	Besiege[R] (lambda-cyhalothrin/ chlorantraniliprole)	4	3/28	
	Cormoran (acetamiprid/novaluron)	4	4/15	
	Lannate LV[R], Lannate SP[R] (methomyl)	2-3	1	
	Leverage 360[R] (beta-cyfluthrin/imidacloprid)	4	3/4	
	Nexter (pyridaben)	4	21	
	Voliam Flexi (thiamethoxam/chlorantraniliprole)	3	4/28	
	Reduced Risk/Organic:			
	Assail 30SG, 70 WP (acetamiprid)	3-4	4	
	Aza-Direct[O] (azadirachtin)	2	UN	
	Captiva Prime[O] (canola oil/garlic oil)	2-3	NC	
	Esteem 35 WP (pyriproxyfen)	3-4	7	
	Grandevo WDG[O] (*Chromobacterium subtsugae*)	---	NC	
	Horticultural oil[O] (many brands)	2-3	NC	
	M-Pede[O] (potassium salts of fatty acids)	2-3	28	
	Sivanto prime (flupyradifurone)	4	4	
	Ultor, Movento (spirotetramat)	4	23	
	Versys Inscalis (afidopyropen)	4	9	
Pest Biology: • aphids begin hatching at pink stage, and colonies start to build • aphid "stem mothers" give birth to live young	*Scouting/Threshold:* • severe infestations of rosy apple aphid may result in deformed fruit; watch fruit for damage throughout the year			*Cultural*: • many beneficial insects help suppress aphids, so avoid insecticides unless necessary • avoid excessive nitrogen fertilizer as lush growth is attractive to aphids

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APPLE Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff.	MOA	Comments
PETAL FALL (continued)				
Borer (Shothole, Flatheaded) *(minor pests in Intermountain West)*	*Conventional:*			Only spray if absolutely necessary. Pyrethroids are harmful to beneficials.
	Endigo ZC[R] (lambda-cyhalothrin/thiamethoxam)	3	3/4	
	Voliam Xpress[R] (lambda-cyhalothrin/ chlorantraniliprole)	3	3/28	
	Warrior II[R] (lambda-cyhalothrin)	3	3	

Pest Biology:
- flatheaded and shothole borers attack trunks and limbs of trees under stress
- prevent infestations in at-risk trees (young, stressed, or in decline) when adults are active from spring - mid summer

Scouting/Threshold:
- treatments only necessary when borer populations are known to be high in an area
- look for sawdust-like frass, loose peeling bark, and exit holes

Cultural:
- maintain tree health to prevent infestation
- prune out dead/dying limbs immediately and remove debris

Brown Mite *(these pests rarely need treatment in commercial orchards)*	*Conventional:*			**Envidor, Nexter, Savey:** max 1 application/yr.
	Envidor 2 SC (spirodiclofen)	4	23	
	Gladiator[R] (zeta-cypermethrin/avermectin)	4	3/6	**Gladiator:** max 38 oz/acre/yr.
	Nexter (pyridaben)	3	21	
	Onager (hexythiazox)	4	10	**Onager:** max 1 application/yr; works best own eggs.
	Savey 50 DF (hexythiazox)	4	10	
	Vydate L[R] (oxamyl)	4	1	**Vydate:** max 4 applications/yr.
	Reduced Risk/Organic:			
	Horticultural oil[O] (many brands)	2-3	NC	**Zeal:** works best on eggs and nymphs; max 1 application/yr.
	Zeal (etoxazole)	3-4	10	

Pest Biology:
- mites become active in spring, and thrive in cool conditions; brown mites rest on twigs at day

Scouting/Threshold:
- these mites occur sporadically; look for small reddish or brown dots on lower leaf surface or shake branch over paper

Cultural:
- prevent tree water stress

Crown Rot *(Phytophthora)*	*Conventional*:			**Aliette, Fosphite, Phostrol:** apply as foliar spray as a protectant; will not "cure" already infected trees.
	Aliette WDG (aluminum tris)	2	33	
	Reduced Risk/Organic:			Repeat 2-4 times per as necessary (every 60 days).
	Fosphite (salts of phosphorous acid)	2	33	
	Oxiphos, Rampart (phosphites)	3	33	Do not apply to dormant trees.
	Phostrol (phosphorous acid)	2	33	

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APPLE Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff.	MOA	Comments
PETAL FALL (continued)				
Crown Rot (continued)				
Pest Biology: • *Phytophthora* girdles the cambium, causing wilt, limb dieback, and tree death in wet, poorly drained soils	*Scouting/Threshold:* • watch for trees that have delayed bud break or that develop purple leaf color early (Aug. - early Sept.)			*Cultural*: • remove dead/dying tree(s); do not replant in the same site without improving drainage; avoid excessive irrigation
Fruitworm (Speckled Green Fruitworm) **and/or Obliquebanded Leafroller** *(Fruitworms rarely need treatment. Leafrollers are sporadic on apple and rarely need treatment)*	*Conventional*:			**Altacor:** max 9 oz/acre/yr. **Besiege:** max 31 oz/acre/yr. **Bt products:** must be applied when larvae are less than 1/2 inch. **Danitol:** max 2 applications/yr. **Delegate WG:** max 28 oz/acre/yr. **Entrust, Success:** max 3 applications/yr. Toxic to bees for 3 hours after application. **Gladiator:** max 38 oz/acre/yr. **Imidan:** max 22 lb/acre/yr. **Leverage:** max 2.8 oz/acre/yr. **Verdepryn:** max 3 applications/yr. **Voliam:** max 16 oz/acre/yr.
	Besiege[R] (lambda-cyhalothrin/ chlorantraniliprole) (14-21)	4	3/28	
	Danitol 2.4 EC[R] (fenpropathrin) (14)	4	3	
	Gladiator[R] (zeta-cypermethrin/avermectin) (21)	4	3/6	
	Imidan 70-W (phosmet) (14-21)	2-3	1	
	Leverage 360[R] (beta-cyfluthrin/imidacloprid) (14)	3-4	3/4	
	Proclaim[R] (emamectin benzoate) (14)	4	6	
	Voliam Flexi (thiamethoxam/chlorantraniliprole) (14-17)	4	4/28	
	Reduced Risk/Organic:			
	Altacor (chlorantraniliprole)	4	28	
	Aza-Direct[O] (azadirachtin)	3	UN	
	Dipel DF[O], XenTari[O] (*Bacillus thuringiensis* sub. *kurstaki*)	3-4	11	
	Delegate WG (spinetoram)	4	5	
	Entrust[O], Success (spinosad)	3	5	
	Exirel (cyantraniliprole)	3-4	28	
	Grandevo WDG[O] (*Chromobacterium subtsugae*)	---	NC	
	Intrepid 2F (methoxyfenozide)	4	18	
	Verdepryn (cyclaniliprole)	---	28	
Fruitworm Pest Biology: • spring larvae will damage blooms and leaves; summer larvae will eat the fruit directly	*Fruitworm Scouting/Threshold:* • examine fruit clusters, take action at 10 larvae per 100 clusters			*Fruitworm Cultural*: • none
Leafroller Pest Biology: • fruittree leafrollers overwinter as eggs; obliquebanded overwinter as immatures in protected sites	*Leafroller Scouting/Threshold:* • look for white honeycomb egg masses on limbs; use beating tray to sample for newly hatched larvae • if using mating disruption for codling moth, leafroller damage may increase to lack of insecticide sprays, so monitor carefully			*Leafroller Cultural*: • often controlled with codling moth sprays

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APPLE Pest Management Recommendations

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PETAL FALL (continued)				
Lygus Bug	*Conventional*:			**Beleaf:** max 3 applications/yr.
	Beleaf 50 SG (flonicamid)	4	29	
	Danitol 2.4 EC[R] (fenpropathrin)	3	3	**Danitol:** max 2 applications/yr; not for BMSB.
	Endigo ZC[R] (lambda-cyhalothrin/thiamethoxam)	4	3/4	
	Gladiator[R] (zeta-cypermethrin/avermectin)	4	3/6	**Gladiator:** max 38 oz/acre/yr.
	Kendo 22.8 CS[R] (lambda-cyhalothrin)	---	3	
	Leverage 360[R] (beta-cyfluthrin/imidacloprid)	3	3/4	**Tombstone:** max 2.8 oz/acre/yr.
	Mustang Maxx[R] (zeta-cypermethrin)	3	3	
	Tombstone[R] (cyfluthrin)	3	3	
	Pest Biology: • often overwinter in alfalfa or other field crops and migrate to nearby fruit trees when other crops are harvested			*Scouting/Threshold:* • large numbers of bugs can cause significant cat-facing damage • look for adults in weeds and borders with sweep nets • feeding injury under warm, wet conditions can lead to fire blight infections
	Cultural: • remove weed host plants • do not mow nearby weeds or cover crops when fruit is present; insects will move to the trees			
White Apple Leafhopper	*Conventional:*			**Actara:** highly toxic to bees.
	Actara (thiamethoxam)	4	4	
	Agri-Mek SC[R] (abamectin)	4	6	**Agri-Mek:** max 8.5 oz/acre per year.
	Besiege[R] (lambda-cyhalothrin/ chlorantraniliprole)	4	3/28	
	Cormoran (acetamiprid/novaluron)	4	4/15	**Assail:** use with oil. Max 4 applications/yr.
	Danitol 2.4 EC[R] (fenpropathrin)	3	3	
	Endigo ZC[R] (lambda-cyhalothrin/thiamethoxam)	3-4	3/4	**Besiege:** max 31 oz/acre/yr.
	Kendo 22.8 CS[R] (lambda-cyhalothrin)	---	4	
	Leverage 360[R] (beta-cyfluthrin/imidacloprid)	3	3/4	**Centaur WDG:** max 1 application/yr.
	Carbaryl 4L (carbaryl)	4	1	
	Voliam Flexi (thiamethoxam/chlorantraniliprole)	4	4/28	**Cormoran:** max 95 oz/acre/yr.
	Reduced Risk/Organic:			**Danitol, Leverage, Surround WP:** max 2 applications/yr.
	Assail 30SG, 70 WP (acetamiprid)	3	4	
	Avaunt (indoxacarb)	3-4	22	**Exirel:** max 0.4 lb/acre/yr
	Aza-Direct[O] (azadirachtin)	2	UN	
	Centaur WDG (buprofezin)	3	16	**Sivanto:** max 28 oz/acre/yr.
	Exirel (cyantraniliprole)	4	28	
	M-Pede[O] (potassium salts of fatty acids)	2-3	28	**Verdepryn:** max 3 applications/yr.
	Sivanto prime (flupyradifurone)	4	4	
	Surround WP[O] (kaolin clay)	1	NC	
	Verdepryn (cyclaniliprole)	---	28	

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APPLE Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff.	MOA	Comments
PETAL FALL (continued)				
White Apple Leafhopper (continued)				
Pest Biology: • eggs hatch at tight cluster stage, peaking during bloom • best to manage nymphs early in the year, as adults are difficult to control	*Scouting/Threshold:* • monitor with beating tray; if population exceeds one nymph per terminal, treat before older nymphs (with long wing pads) are present			*Cultural*: • none
Woolly Apple Aphid and/or San Jose Scale	*Reduced Risk/Organic:* Ultor, Movento (spirotetramat)	4	23	**Ultor, Movento:** must be tank-mixed with a spray adjuvant/additive.
WAA Pest Biology: • overwinters primarily on roots, and colonies start forming on suckers or low in the tree by June; some overwinter in tree canopy	*WAA Scouting/Threshold:* • look for white cottony colonies in bark cracks and crevices and suckers			*WAA Cultural*: • many beneficial insects help suppress aphids, so avoid insecticides unless necessary
SJS Pest Biology: • the immature crawler stage is active in late spring/early summer, but Ultor must be applied earlier	*SJS Scouting/Threshold:* • check limbs and twigs for overwintering population size			*SJS Cultural*: • none
FRUIT PRESENT				
Aphids (Green Apple and Rosy Apple Aphids)	*See Petal Fall*			

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APPLE Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff.	MOA	Comments
FRUIT PRESENT (continued)				
Apple Maggot *(This fly occurs wherever native black hawthorn grows in Idaho, Utah. It has not caused economic damage in commercial orchards in the Intermountain West.)*	*Conventional:*			**Admire Pro:** do not apply when bees are active. **Altacor:** max 9 oz/acre/yr. **Avaunt:** for use in low to moderate pressure situations, use with mating disruption. **Baythroid, Leverage, Tombstone:** max 2.8 oz/acre/yr. **Belay:** max 6.4 oz/acre/yr. **Besiege:** max 31 oz/acre/yr. **Carbaryl 4L:** do not apply during bloom or when weeds are blooming on orchard floor. **Delegate WG:** max 28 oz/acre/yr. **Gladiator:** max 38 oz/acre/yr. **Imidan:** max 22 lb/acre/yr.
	Admire Pro (imidacloprid) (10)	3	4	
	Asana XL[R] (esfenvalerate) (14)	2	3	
	Baythroid XL[R] (beta-cyfluthrin) (14)	3-4	3	
	Belay (clothianidin) (14)	3	4	
	Besiege[R] (lambda-cyhalothrin/ chlorantraniliprole) (10)	3	3/28	
	Gladiator[R] (zeta-cypermethrin/avermectin) (14)	3	3/6	
	Imidan 70-W (phosmet) (14)	3	1	
	Leverage 360[R] (beta-cyfluthrin/imidacloprid) (14)	4	3/4	
	Mustang Maxx[R] (zeta-cypermethrin) (7)	3-4	3	
	Carbaryl 4L (carbaryl) (14)	3	1	
	Tombstone[R] (cyfluthrin) (14)	3	3	
	Voliam Xpress[R] (lambda-cyhalothrin/ chlorantraniliprole) (10)	4	3/28	
	Warrior II[R] (lambda-cyhalothrin) (5)	3	3	
	Reduced Risk/Organic:			
	Altacor (chlorantraniliprole) (14)	2	28	
	Assail 30SG, 70 WP (acetamiprid) (14)	3	4	
	Avaunt (indoxacarb) (10)	3-4	22	
	Delegate WG (spinetoram) (14)	3	5	
	Entrust[O] (spinosad) (10)	2	5	
	GF-120 NF[O] (spinosad + bait) (7-10)	2-4	5	
	Surround[O] (kaolin) (5-7)	2	NC	

Pest Biology:
- overwinter as pupae; flies emerge late June through September
- females lay eggs under fruit skin and maggots feed on flesh; larger, softer fruits are more susceptible

Scouting/Threshold:
- hang yellow sticky traps starting in early July, focusing on the southern border, or borders next to abandoned orchards
- according to Cornell University, treat when 5 flies per trap are caught

Cultural:
- hawthorn is preferred host; remove nearby trees if apples become infested

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FRUIT PRESENT (continued)				
Codling Moth	*Conventional:*			Keep fruit protected through September 15.
	Asana XL[R] (esfenvalerate) (14)	3	3	
	Belay (clothianidin) (10-14)	2-3	4	
	Besiege[R] (lambda-cyhalothrin/ chlorantraniliprole) (14-17)	4	3/28	**Altacor:** max 9 oz/acre/yr.
	Cormoran (acetamiprid/novaluron) (14)	3-4	4/15	**Assail:** use with oil.
	Danitol 2.4 EC[R] (fenpropathrin) (14)	3	3	
	Endigo ZC[R] (lambda-cyhalothrin/thiamethoxam) (14)	3-4	3/4	**Bt products:** must be applied when larvae are less than 1/2 inch.
	Imidan 70-W (phosmet) (21)	3-4	1	
	Leverage 360[R] (beta-cyfluthrin/imidacloprid) (14)	3	3/4	**Besiege:** max 31 oz/acre/yr.
	Minecto Pro[R] (abamectin/cyantraniliprole) (21)	3-4	6/28	**Cormoran:** max 95 oz/acre/yr.
	Carbaryl 4L (carbaryl) (14)	3	1	
	Voliam Flexi (thiamethoxam/chlorantraniliprole) (14-21)	4	4/28	**Danitol:** max 2 applications/yr.
	Voliam Xpress[R] (lambda-cyhalothrin/ chlorantraniliprole) (14-21)	4	3/28	**Delegate WG:** max 28 oz/acre/yr.
	Warrior II[R] (lambda-cyhalothrin) (14)	3	3	**Esteem:** max 2 applications/yr; use with oil.
	Reduced Risk/Organic:			
	Altacor (chlorantraniliprole) (14-17)	4	28	**Horticultural oil:** can be effective as one application just before egg hatch of each generation to smother eggs.
	Assail 30SG, 70 WP (acetamiprid) (14)	3-4	4	
	Avaunt (indoxacarb) (14)	2-3	22	
	Dipel DF[O], XenTari[O] (*Bacillus thuringiensis* sub. *kurstaki*) (7)	3-4	11	**Minecto Pro:** max 24 oz/acre/yr.
	Cyd-X[O], Virosoft CP4[O] (*Cydia pomonella* granulosis virus) (7)	2	NC	**Leverage 360:** max 2.8 oz/acre/yr.
	Delegate WG (spinetoram) (14)	3-4	5	
	Entrust[O] (spinosad) (7)	2-3	5	**Carbaryl 4L:** do not apply during bloom or when weeds are blooming on orchard floor.
	Exirel (cyantraniliprole) (14-17)	4	28	
	Grandevo WDG[O] (*Chromobacterium subtsugae*) (7)	2-3	NC	
	Horticultural oil[O] (many brands) (one application to eggs)	1-2	NC	**Zivalgo:** max 3 applications/yr.
	Success (spinosad) (7)	3-4	5	
	Verdepryn (cyclaniliprole) (14-17)	---	28	
	Zivalgo (isocycloseram) (15)	3-4	30	

Pest Biology:
- codling moth overwinters as resting larvae and pupate in spring; emerge as adults at approx. 100 GDD

Scouting/Threshold:
- hang pheromone traps to determine biofix (first male flight) in your area
- start sprays 10 days after petal fall or 220 degree-days after first adult moth activity (biofix)

Cultural:
- trunk banding / fruit bagging
- remove fruit bins from orchards where larvae can overwinter

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APPLE Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff.	MOA	Comments
FRUIT PRESENT (continued)				
Grasshoppers	*Conventioal:*			**Dimilin:** max 2 applications/yr. For non-crop areas only (borders, fence rows, roadsides, etc.) **EcoBran:** this is a bait; reapply after rain.
	Dimilin 2L[R] (iflubenzuron)	---	15	
	EcoBran (carbaryl)	---	1A	
San Jose Scale	*Conventional:*			**Assail:** max 4 applications/yr. **Belay:** max 0.2 lb/acre/yr. **Centaur WDG:** max 1 application/yr. **Cormoran:** max 95 oz/acre/yr. **Diazinon:** max 2 applications/yr. Supply may not be available. **Esteem:** max 2 applications/yr. **Leverage:** max 2.8 oz/acre/yr. **Sivanto:** max 28 oz/acre/yr. **Transform:** max 8.5 oz/acre/yr.
	Admire Pro (imidaclorpid)	2-3	4	
	Belay (clothianidin)	2	4	
	Cormoran (acetamiprid/novaluron)	3	4/15	
	Diazinon AG600[R] (diazinon)	3	1	
	Kendo 22.8 CS[R] (lambda-cyhalothrin)	2	3	
	Leverage 360[R] (beta-cyfluthrin/imidacloprid)	2	3/4	
	Transform WG (sulfoxaflor)	3	4	
	Reduced Risk/Organic:			
	Assail 30SG, 70 WP (acetamiprid)	3	4	
	Centaur WDG (buprofezin)	2	16	
	Entrapment FV[O] (xanthan gum)	---	NC	
	Esteem 35 WP (pyriproxyfen) + 1% hort. oil[O] (many brands)	4	7	
	Sivanto Prime (flupyradifurone)	3-4	4	
	Venerate XC[O] (*Burkholderia* spp.)	2	NC	

Pest Biology:
- overwinter as eggs in the soil, and hatch in spring; transition from nymph to adult takes 5 molts

Scouting/Threshold:
- apply bait in spring along roads, ditches, fences, and weedy areas; adults are more difficult to treat

Cultural:
- for more information, see Chapter 2, Grasshoppers.

Pest Biology:
- the immature crawler stage is active in late spring/early summer

Scouting/Threshold:
- place double-sided tape around infested limbs and monitor for activity of crawlers across tape
- apply 1 to 2 applications during crawler stage

Cultural:
- none

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APPLE Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff.	MOA	Comments
FRUIT PRESENT (continued)				
Spider Mites	*Conventional:*			**Akari 5 SC:** non-bearing trees only.
	Abamex[R] (abamectin)	2-3	6	
	Akari 5 SC (fenpyroximate)	3-4	21	**Agri-Flex:** apply before a threshold of 5 spider mites per leaf is reached. Using with oil can russet light-skinned varieties. Max 2 applications/yr.
	Agri-Flex[R] (thiamethoxam/abamectin)	4	4/6	
	Envidor 2 SC (spirodiclofen)	4	23	
	Nealta (cyflumetofen)	4	25	
	Nexter (pyridaben)	2-3	21	
	Onager (hexythiazox)	4	10	**Acramite, Envidor, Nexter, Onager, Savey, Vydate:** max 1 application/yr.
	Savey 50 DF (hexythiazox)	4	10	
	Vendex 50WP[R] (fenbutatin-oxide)	4	12	
	Vydate L[R] (oxamyl)	4	1	**Abamex:** max 2 applications/yr.
	Reduced Risk/Organic:			
	Acramite 50WS (bifenazate)	4	20	**Nealta:** max 2 applications/yr. Apply at first sign of mites.
	Entrapment FV[O] (xanthan gum)	---	NC	
	Horticultural Oil[O] (many brands)	---	NC	**Zeal:** max 1 application/yr. Apply at first sign of mites.
	M-Pede[O] (potassium salts of fatty acids)	2-3	28	
	Zeal (etoxazole)	3-4	10	**Zivalgo:** max 3 applications/yr. Do not apply during bloom or when weeds are blooming on orchard floor.
	Zivalgo (isocycloseram)	4	30	

Pest Biology:
- most likely to become a problem during hot, dry conditions in July to September when mites reproduce rapidly

Scouting/Threshold:
- look for "burning" or russeting of leaves and small mites on undersides of lowest, interior leaves first; treat only if "leaf burn" is evident

Cultural:
- predatory mites commonly suppress spider mites, so avoid insecticide unless necessary, especially pyrethroids in spring

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APPLE Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff.	MOA	Comments
FRUIT PRESENT (continued)				
Stink Bugs, including Brown Marmorated Stink Bug *(BMSB is not yet an economic pest in the Intermountain West)*	*Conventional*:			See fruit guide website for specific BMSB sprays.
	Asana XL[R] (esfenvalerate) (14)	2	3	
	Baythroid XL (beta-cyfluthrin) (14)	3-4	3	**Baythroid, Leverage, Tombstone:** max 2.8 oz/acre/yr.
	Belay (clothianidin) (14)	2	4	
	Beleaf 50 SG (flonicamid) (14)	3	29	**Beleaf:** max 3 applications/yr.
	Danitol 2.4 EC[R] (fenpropathrin) (14)	2	3	
	Endigo ZC[R] (lambda-cyhalothrin/thiamethoxam) (14)	4	3/4	**Danitol:** max 2 applications/yr; not for BMSB.
	Gladiator[R] (zeta-cypermethrin/avermectin) (14)	3	3/6	
	Lannate LV[R] (methomyl) (7)	4	1	**Gladiator:** max 38 oz/acre/yr.
	Leverage 360[R] (beta-cyfluthrin/imidacloprid) (14)	3	3/4	
	Tombstone[R] (cyfluthrin) (14)	3	3	**Lannate:** do not use on Early Macintosh and Wealthy varieties.
	Transform WG (sulfoxaflor) (14)	---	4	
	Voliam Xpress[R] (lambda-cyhalothrin/ chlorantraniliprole) (10)	3	3/28	**Transform:** max 8.5 oz/acre/yr.
	Warrior II[R] (lambda-cyhalothrin) (5)	4	3	**Voliam Xpress:** max 31 oz/acre/ yr.

Pest Biology:
- migrate to nearby fruit trees when host field crops are harvested or weeds mowed

Scouting/Threshold:
- look for adults in weeds and borders with sweep nets

Cultural:
- do not mow nearby weeds or cover crops when fruit is present

White Apple Leafhopper	*Conventional:*			**Actara:** highly toxic to bees.
	Actara (thiamethoxam)	4	4	
	Abamex[R] (abamectin)	4	6	**Abamex:** max 8.5 oz/acre/year.
	Admire Pro (imidacloprid)	4	4	
	Avaunt (indoxacarb)	3-4	22	**Assail:** max 4 applications/yr.
	Beleaf 50 SG (flonicamid)	4	4	
	Cormoran (acetamiprid/novaluron)	4	4/15	**Belay:** max 0.2 lb/acre/yr.
	Danitol 2.4 EC[R] (fenpropathrin)	3	3	
	Endigo ZC[R] (lambda-cyhalothrin/thiamethoxam)	3-4	3/4	**Centaur WDG, Leverage 360:** max 1 application/yr.
	Kendo 22.8 CS[R] (lambda-cyhalothrin)	---	3	
	Leverage 360[R] (beta-cyfluthrin/imidacloprid)	4	3/4	**Cormoran:** max 95 oz/acre/yr.
	Transform WG (sulfoxaflor)	---	4	
	Verdepryn (cyclaniliprole)	---	28	**Danitol:** max 2 applications/yr.
	Voliam Flexi (thiamethoxam/chlorantraniliprole)	4	4/28	**Transform:** max 8.5 oz/acre/yr.

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APPLE Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff.	MOA	Comments
FRUIT PRESENT (continued)				
White Apple Leafhopper (continued)	*Reduced Risk/Organic:*			**Verdepryn:** max 3 applications/yr.
	Assail 30SG, 70 WP (acetamiprid)	3	4	
	Aza-Direct[O] (azadirachtin)	2	UN	**Voliam Flexi:** max 16 oz/acre/year.
	Captiva Prime[O] (canola oil/garlic oil)	2-3	NC	
	Centaur WDG (buprofezin)	3	16	
	Entrapment FV[O] (xanthan gum)	---	NC	
	M-Pede[O] (potassium salts of fatty acids)	2-3	28	

Pest Biology:
- best to manage nymphs early in year, as adults are difficult to control; a second generation occurs in July-Aug

Scouting/Threshold:
- monitor with beating tray; if population exceeds one nymph per terminal, treat before older nymphs (with long wing pads) are present

Cultural:
- none

Woolly Apple Aphid	*Conventional:*			**Assail:** repeat applications may be required for woolly apple aphid control.
	Beleaf 50 SG (flonicamid)	2-3	29	
	Cormoran (acetamiprid/novaluron)	---	4/15	**Beleaf:** max 3 applications/yr.
	Diazinon AG600[R] (diazinon)	4	1	
	Transform WG (sulfoxaflor)	---	4	**Cormoran:** max 95 oz/acre/yr.
	Reduced Risk/Organic:			
	Assail 30SG, 70 WP (acetamiprid)	2-3	4	**Diazinon:** highly toxic to bees. Max 2 applications/yr. Supply may be limited.
	Aza-Direct[O] (azadirachtin)	---	UN	
	Entrapment FV[O] (xanthan gum)	---	NC	
	Horticultural oil[O] (many brands)	2-3	NC	**Transform:** max 8.5 oz/acre/yr.
	M-Pede[O] (potassium salts of fatty acids)	2-3	28	

Pest Biology:
- colonies start forming on suckers or low in the tree by June

Scouting/Threshold:
- look for white cottony colonies in bark cracks and crevices and suckers

Cultural:
- many beneficial insects help suppress aphids, so avoid insecticides unless necessary

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APPLE Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff.	MOA	Comments
POST-HARVEST (EARLY FALL)				
Pearleaf Blister Mite and Rust Mites *(these pests rarely need treatment in commercial orchards)*	*Conventional:*			**Abamex:** max 2 applications/yr. **Acramite, Nexter:** max 1 application/yr. **Sevin 4F:** do not apply when weeds are blooming on orchard floor.
	Abamex[R] (abamectin)	4	6	
	Nexter (pyridaben)	4	21	
	Sevin 4F (carbaryl)	3	1	
	Reduced Risk/Organic:			
	Acramite 50WS (bifenazate)	4	UN	
	Captiva Prime[O] (canola oil/garlic oil)	2-3	NC	
	M-Pede[O] (potassium salts of fatty acids)	2-3	28	
	Sulfur (many brands)	3-4	M2	

Pest Biology:
- blister mites live in blisters on leaves throughout the summer
- adults move to bud scales to overwinter

Scouting/Threshold:
- look for russeting of fruit and leaves
- treat before leaves drop and mites move to buds to spend the winter

Cultural:
- none

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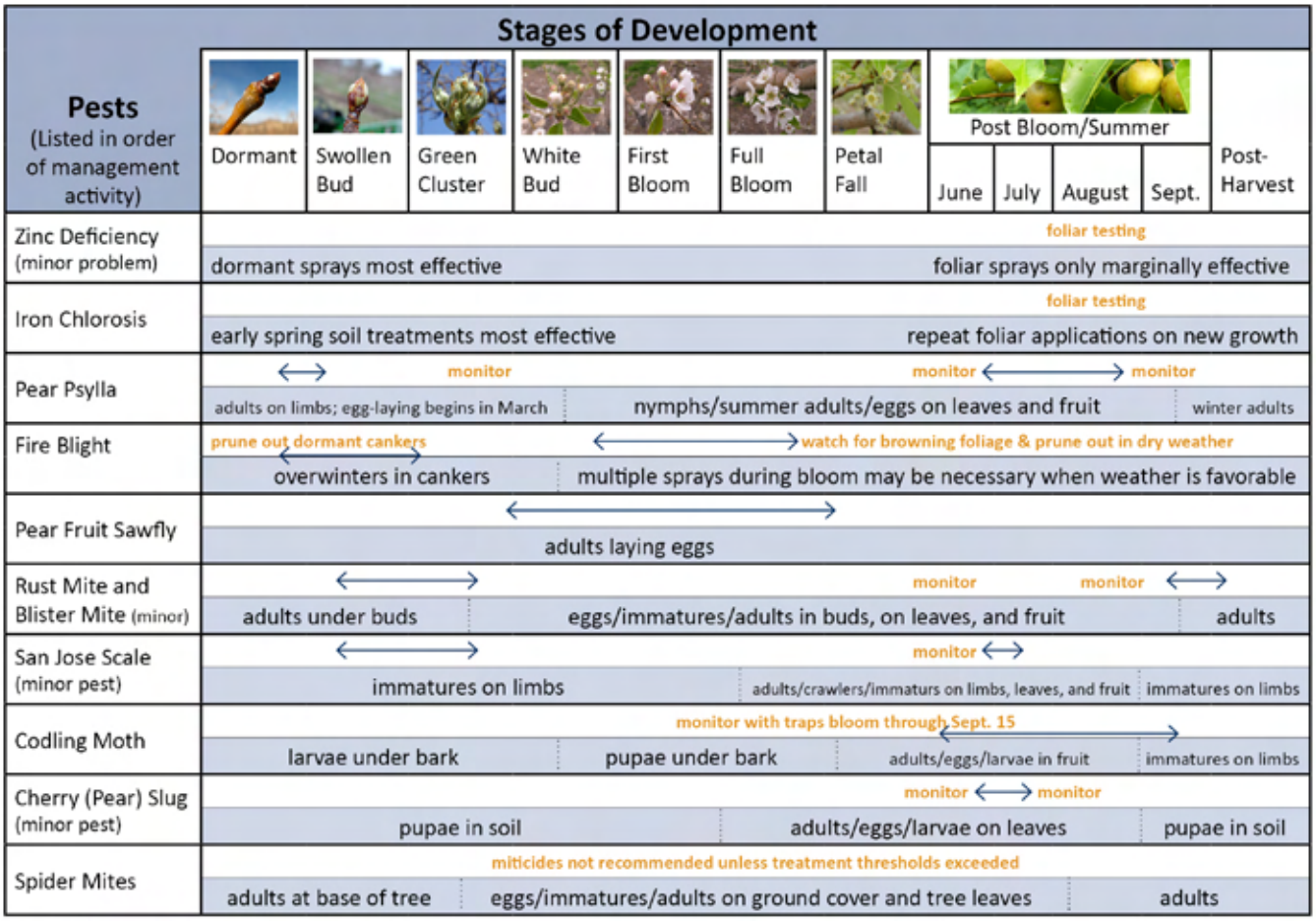
PEAR Pest Management Recommendations

Pest Phenology Calendar



Arrows (⟷) indicate intervals during which a recommended spray treatment occurs, if pest is present.
Note: The indicated monitoring times should serve as guidelines for when to monitor and manage pests, if the pest has been a problem in the past. Monitoring helps to identify whether the targeted pest is present in the orchard at damaging levels before a pesticide is used.

PEAR Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff.	MOA	Comments
DORMANT				
Fire Blight	*Conventional*:			**C-O-C-S:** max 1 application/yr.
	Champ Formula 2, Kocide (copper hydroxide)	3	M1	
	Reduced Risk/Organic:			
	Badge X2[o] (copper oxychloride/copper hydroxide)	3	M1	
	Champ WG[o] (copper hydroxide)	3	M1	
	C-O-C-S WDG (copper oxychloride)	2	M1	
	Cueva[o] (copper octanoate)	3	M1	
	Previsto[o] (copper hydroxide)	2-3	M1	
	Pest Biology: • bacteria overwinter in cankers in the orchard; cankers start to ooze bacteria when temperatures warm			*Scouting/Threshold:* • spray trees just before bud break *Cultural*: • during dry weather, prune dormant limbs infected with cankers 12" below visible canker margins
Pear Psylla	Horticultural oil[o] (many brands) + one of the following:			**Assail, Delegate WG:** max 4 applications/yr; use with adjuvant. **Pounce:** only allowed before bloom or after harvest. **Esteem, Gladiator:** max 2 applications/yr. **Sivanto:** max 28 oz/acre/yr.
	Conventional:			
	Asana XL[R] (esfenvalerate)	3	3	
	Pounce 25 WP[R] (permethrin)	3	3	
	Gladiator[R] (zeta-cypermethrin/avermectin)	4	3/6	
	Warrior II[R] (lambda-cyhalothrin)	3	3	
	Reduced Risk/Organic:			
	Assail 30SG, 70 WP (acetamiprid)	4	4	
	Delegate WG (spinetoram)	4	5	
	Esteem 35 WP (pyriproxyfen)	3-4	7	
	Grandevo WDG[o] (*Chromobacterium subtsugae*)	---	NC	
	Sivanto Prime (flupyradifurone)	---	4	
	Pest Biology: • overwinter as adults outside the orchard and fly into pear trees about 6 weeks before bloom (March) to lay eggs • egg-laying continues for several weeks			*Scouting/Threshold:* • treat at dormant stage or up to tight cluster timing if adults are detected in spring • treat again 1-2 weeks later in large populations *Cultural*: • can be active over a long time period, so one spray may not be adequate

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PEAR Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff.	MOA	Comments
DELAYED DORMANT (Swollen Bud to Tight Cluster)				
Pearleaf Blister Mite and Rust Mites *(these pests rarely need treatment)*	*Conventional:*			**Nexter:** use when populations are low. Do not apply during bloom or when weeds on orchard floor are blooming. Max 1 application/yr. **Carbaryl 4L:** do not apply during bloom or when weeds are blooming on orchard floor.
	Nexter (pyridaben)	4	21	
	Carbaryl 4L (carbaryl)	3	1	
	Reduced Risk/Organic:			
	Captiva Prime[O] (canola oil/garlic oil)	2-3	NC	
	Horticultural oil[O] (many brands)	4	NC	
San Jose Scale	Horticultural oil[O] (many brands) + one of the following:	4	NC	**Centaur:** max 1 application/yr. **Diazinon:** max 2 applications/yr. Supply may not be available. **Esteem 35:** max 2 applications/yr.
	Conventional:			
	Diazinon AG600[R] (diazinon)	4	1	
	Reduced Risk/Organic:			
	Centaur WDG (buprofezin)	4	16	
	Esteem 35 WP (pyriproxyfen)	3-4	7	
	Venerate XC[O] (*Burkholderia* spp.)	2	NC	
PRE-BLOOM (White Bud - Full White)				
Pear Fruit Sawfly	*Conventional:*			Apply pre-bloom or at petal-fall to target adults without harming bees **Baythroid, Tombstone:** max 2.8 oz/acre/yr. **Danitol:** max 2 applications/yr. **Diazinon:** max 2 applications/yr. Supply may not be available
	Baythroid XL[R] (beta-cyfluthrin)	3	3	
	Danitol 2.4 EC[R] (fenpropathrin)	3	3	
	Diazinon AG600[R] (diazinon)	4	1	
	Mustang Maxx[R] (zeta-cypermethrin)	3	3	
	Tombstone[R] (cyfluthrin)	3	3	
	Warrior II[R] (lambda-cyhalothrin)	3	3	
	Reduced Risk/Organic:			
	Exirel (cyantraniliprole)	4	28	
	Tersus (pyrethrins)	2-3	3	

Pest Biology:
- overwinter as adults under bud scales and migrate to leaves at bud break

Scouting/Threshold:
- treat if damage is severe the prior season; bud break is optimal treatment timing

Cultural:
- none

Pest Biology:
- overwinter as black-capped immatures on limbs; crawlers hatch in late spring

Scouting/Threshold:
- scale on fruit in previous year indicates need for control
- examine limbs for clusters of gray-white "spots" to determine infestation
- delayed dormant timing kills many overwintering nymphs, but not all

Cultural:
- prune out heavily infested limbs

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PEAR Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff.	MOA	Comments
PRE-BLOOM (White Bud - Full White) (continued)				
Pear Fruit Sawfly (continued)				
Pest Biology: • overwinter as larvae underground and adults emerge in spring • females lay a single egg inside of flowers	*Scouting/Threshold:* • feeding damage on fruit in previous year indicates need for control • look for adults on flowers through bloom			*Cultural*: • thinning may reduce need for control if crop load is high • autumn plowing and discing between tree rows can kill larvae in the soil
Powdery Mildew	*Conventional:*			**Biologicals:** (Serenade, etc.) and **oils** must be applied before infection; they act as a protectant.
	Aprovia (benzovindiflupyr) (7)	3	7	
	Cevya (mefentrifluconazole) (10)	3-4	3	
	Inspire Super (difenoconazole/cyprodinil) (10-14)	3	3/9	**Aprovia, Flint, Merivon, Pristine, Procure, Topsin:** max 4 applications/yr.
	Luna Sensation (fluopyram/trifloxystrobin) (10-14)	3-4	7/11	
	Luna Tranquility (fluopyram/pyrimethanil) (14)	4	7/9	**Cevya:** max 15 oz/acre/yr.
	Merivon Xemium (fluxapyroxad/pyraclostrobin) (10-14)	4	7/11	**Fontelis:** max 61 oz/acre/yr.
	Ph-D (polyoxin D zinc salt) (7-10)	3	19	
	Procure 480SC (triflumizole) (7-14)	4	3	**Sovran**: drift may harm some cherry varieties. Max 4 applications/yr.
	Pristine (boscalid/pyraclostrobin) (10-14)	4	7/11	
	Sovran (kresoxim-methyl) (7-10)	3	11	**Torino:** max 6.8 oz/acre/yr.
	Topsin M WSB (thiophanate-methyl) (10-14)	3	1	
	Torino (cyflufenamid) (14)	3	U6	
	Trionic 4SC (triflumizole) (10-14)	4	3	
	Reduced Risk/Organic:			
	Flint (trifloxystrobin) (10-14)	4	11	
	Fontelis (penthiopyrad) (7-14)	3	7	
	Kaligreen[O], MilStop SP[O] (potassium bicarbonate) (5-7)	3	NC	
	Regalia CG[O] (*Reynoutria sachalinensis*) (7)	2	P5	
	Serenade Opti[O] (*Bacillus subtilis*) (7)	2	BM2	
	Sonata[O] (*Bacillus pumilis*) (7)	2	44	
	Sulfur[O] (many brands) (7)	4	M2	
Pest Biology: • fungus overwinters in and on terminal buds	*Scouting/Threshold:* • watch terminals at open cluster stage for new infections • repeat applications as necessary every 7-14 days; new infections may continue in humid conditions			*Cultural*: • some cultivars are more resistant

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PEAR Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff.	MOA	Comments
BLOOM				
Codling Moth	*Reduced Risk/Organic*			Install **mating disruption** just before first moth flight (biofix), around full bloom.
	Checkmate Puffer CM-O[o] (mating disruption)	4	NC	
	Isomate-CM Flex[o] (mating disruption)	4	NC	

Pest Biology:
- moths start emerging from pupation around first bloom of Red Delicious, mate, and lay eggs on leaves and fruit

Scouting/Threshold:
- after mating disruption is hung, install monitoring traps using Trece CM-DA Combo lure; trap threshold for treatment is 10 moths (cumulative capture)
- Supplemental insecticides may be necessary; monitoring with traps is critical.

Cultural:
- none

Fire Blight	*Conventional:*			**Actigard:** mix with antibiotic to improve efficacy. See label for info on painting existing cankers. **Agri-Mycin:** where there is resistance, use only once per year mixed with oxytetracycline. If using Regulaid, use 4-6 oz plus 1 pt Regulaid in 100 gal volume. **Biologicals:** products must be on flowers before infection. Apply at 10, 40, 70 and 90% open flowers. **Blossom Protect:** keep agitated. Works best with Buffer Protect adjuvant. **Kasumin 2L:** max 4 applications; do not alternate–row spray.
	Actigard 50WG (acibenzolar-S-methyl)	2	NC	
	Agri-Mycin 50, Harbour (streptomycin)	4	25	
	Cuprofix Ultra 40 Disperss (basic copper sulfate)	2-3	M1	
	Kasumin 2L (kasugamycin)	3-4	24	
	Mycoshield (oxytetracycline)	2-3	41	
	Reduced Risk/Organic:			
	BlightBan[o] A506 (*Pseudomonas fluorescens*)	2	NC	
	Blossom Protect[o] (*Aureobasidium pullulans*)	3	NC	
	Cueva[o] (copper octanoate)	2	M1	
	Mastercop[o] (copper sulfate pentahydrate)	---	M1	
	Previsto[o] (copper hydroxide)	2-3	M1	
	Serenade Opti[o] (*Bacillus subtilis*)	2	BM2	
	Theia[o] (*Bacillus subtilis* strain AFS032321)	2	BM2	

Pest Biology:
- when rain occurs and average temperatures >60°F, bacteria may be spread to open flowers

Scouting/Threshold:
- look for oozing cankers in early spring
- repeat every 5 days during bloom when CougarBlight model predicts infection

Cultural:
- none

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PEAR Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff.	MOA	Comments
PETAL FALL				
Crown Rot *(Phytophthora)* *(this disease is rarely a problem on pears)*	*Reduced Risk:*			**Aliette, Fosphite, Phostrol:** apply as foliar spray as a protectant; will not "cure" already infected trees. Repeat 2-4 times per year as necessary (every 60 days). Do not apply to dormant trees.
	Aliette WDG (aluminum tris)	2	33	
	Fosphite (salts of phosphrous acid)	2	33	
	Phostrol (phosphorous acid)	2	33	
Oblique-banded Leafrollers *(leafrollers are sporadic in pear and rarely need treatment)*	*Conventional:*			**Altacor:** max 9 oz/acre/yr. **Bt products:** must be applied when larvae are less than 1/2 inch. **Entrust:** max 3 applications/yr. **Esteem 35:** max 2 applications/yr. **Leverage 360:** max 2.8 oz/acre/yr. **Voliam Flexi:** max 16 oz/acre/yr.
	Leverage 360[R] (beta-cyfluthrin/imidacloprid)	3	3/4	
	Proclaim[R] (emamectin benzoate)	3	6	
	Voliam Flexi (thiamethoxam/chlorantraniliprole)	4	4/28	
	Voliam Xpress[R] (lambda-cyhalothrin/ chlorantraniliprole)	3	3/28	
	Reduced Risk/Organic:			
	Altacor (chlorantraniliprole)	4	28	
	Aza-Direct[O] (azadirachtin)	2-3	UN	
	Dipel DF[O], XenTari[O] (*Bacillus thuringiensis* sub. *kurstaki*)	3-4	11	
	Delegate WG (spinetoram)	4	5	
	Entrust[O] (spinosad)	3	5	
	Esteem 35 WP (pyriproxyfen)	3	7	
	Exirel (cyantraniliprole)	4	28	
	Intrepid 2F (methoxyfenozide)	3-4	18	
	Success (spinosad)	3-4	5	

Pest Biology:
- *Phytophthora* causes root rot and crown rot (death of cambium) in wet, poorly drained conditions

Scouting/Threshold:
- watch for trees that are slow to leaf out, have slow growth, or die back

Cultural:
- remove dead/dying tree(s) and do not replant in the same site without improving drainage
- avoid excessive irrigation

Pest Biology:
- fruit tree leafrollers overwinter as eggs; obliquebanded leafrollers overwinter as young larvae in protected sites

Scouting/Threshold:
- check fruit spurs for honeycomb egg masses and/ or larvae; use beating tray to sample for larvae
- if using mating disruption for codling moth, leafroller damage may increase due to reduced sprays, so monitoring may be necessary

Cultural:
- treatments for codling moth will also control leafrollers

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PEAR Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff.	MOA	Comments
PETAL FALL (continued)				
Pear Psylla	*Conventional:*			**Actara:** highly toxic to bees.
	Actara (thiamethoxam)	3-4	4	
	Admire Pro (imidacloprid)	3-4	4	**Admire, Bexar, Centaur, Esteem, Minecto:** max 2 applications/yr.
	Bexar (tolfenpyrad)	4	21	
	Cormoran (acetamiprid/novaluron)	4	4/15	**Cormoran:** max 95 oz/acre/yr. Phytotoxicity possible.
	Endigo ZC[R] (lambda-cyhalothrin/thiamethoxam)	3-4	3/4	
	Minecto Pro[R] (abamectin/cyantraniliprole)	3-4	6/28	**Assail:** max 4 applications/yr; use with oil.
	Nexter (pyridaben)	3-4	21	
	Voliam Flexi (thiamethoxam/chlorantraniliprole)	3	4/28	**Delegate WG:** use with adjuvant to improve control.
	Reduced Risk/Organic:			
	Assail 30SG, 70 WP (acetamiprid)	3-4	4	**Nexter:** max 1 application/yr.
	Aza-Direct[O] (azadirachtin)	2	UN	
	Captiva Prime[O] (canola oil/garlic oil)	2-3	NC	**Sivanto prime:** max 28 oz/acre/yr.
	Centaur WDG (buprofezin)	3	16	
	Delegate WG (spinetoram)	4	5	
	Esteem 35 WP (pyriproxyfen)	3	7	
	Exirel (cyantraniliprole)	4	28	
	Grandevo WDG[O] (*Chromobacterium subtsugae*)	---	NC	
	M-Pede[O] (potassium salts of fatty acids)	2-3	28	
	Sivanto prime (flupyradifurone)	---	4	
	Ultor, Movento (spirotetramat)	3-4	23	
	Venerate XC[O] (*Burkholderia* spp.)	2-3	NC	
	Verdepryn (cyclaniliprole)	---	28	

Pest Biology:
- eggs hatch during bloom and nymphs move to foliage
- feeding results in sticky honeydew, leaf burn, and fruit russeting

Scouting/Threshold:
- only treat in lieu of the dormant or delayed-dormant spray, if adults are still active at petal fall, or if psylla injury was severe in the previous year

Cultural:
- none

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PEAR Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff.	MOA	Comments
FRUIT PRESENT				
Codling Moth	*Conventional:*			Keep fruit protected through September 15.
	Belay (clothianidin) (10-14)	2-3	4	
	Carbaryl 4L (carbaryl) (14)	3	1	
	Cormoran (bifenthrin/imidacloprid) (14)	3-4	15/4A	**Altacor:** max 9 oz/acre/yr.
	Danitol 2.4 EC[R] (fenpropathrin) (14)	3	3	
	Endigo ZC[R] (lambda-cyhalothrin/thiamethoxam) (14-17)	3-4	3/4	**Assail, Voliam:** max 4 applications/yr; use with oil.
	Imidan 70-W (phosmet) (21)	3-4	1	
	Leverage 360[R] (beta-cyfluthrin/imidacloprid) (14)	2	3/4	**Belay:** max 0.2 lb/acre/yr.
	Minecto Pro[R] (abamectin/cyantraniliprole) (21)	3-4	6/28	**Carbaryl 4L:** do not apply during bloom or when weeds are blooming on orchard floor.
	Voliam Flexi (thiamethoxam/chlorantraniliprole) (14-21)	4	4/28	
	Voliam Xpress[R] (lambda-cyhalothrin/ chlorantraniliprole) (14-21)	4	3/28	**Cormoran:** max 95 oz/acre/yr. Phytotoxicity possible.
	Reduced Risk/Organic:			**Danitol:** max 2 applications/yr.
	Altacor (chlorantraniliprole) (14-17)	4	28	
	Assail 30SG, 70 WP (acetamiprid) (14)	3-4	4	**Entrust, Delegate:** max 4 applications/yr.
	Avaunt (indoxacarb) (14)	2-3	22	
	Dipel DF[O], XenTari[O] (*Bacillus thuringiensis*) (7)	3-4	11	**Exirel:** max 3 applications/yr.
	Cyd-X[O] (*Cydia pomonella* granulosis virus) (7)	2-3	NC	
	Delegate WG (spinetoram) (14)	4	5	**Imidan:** max 16 lb/acre/yr; do not apply within 25 ft of human structures.
	Entrust[O], Success (spinosad) (7)	2-3	5	
	Exirel (cyantraniliprole) (14-17)	4	28	
	Verdepryn (cyclaniliprole) (14-17)	---	28	**Leverage:** max 2.8 oz/acre/yr.
	Zivalgo (isocycloseram) (15)	3-4	30	**Minecto Pro:** max 24 oz/acre/yr.
				Zivalgo: max 3 applications/yr.

Pest Biology:
- larvae hatch from eggs laid on and near fruits

Scouting/Threshold:
- start treatment 10 days after petal fall or 220 degree-days after first adult moth activity

Cultural:
- trunk banding & fruit bagging
- remove fruit bins from orchards where larvae overwinter

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PEAR Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff.	MOA	Comments
FRUIT PRESENT (continued)				
Pear or Cherry Slug (Pear Sawfly) *(this pest rarely needs treatment in commercial orchards)*	*Conventional:*			Just one application will suffice. **Altacor:** max 9 oz/acre/yr.
	Voliam Xpress[R] (lambda-cyhalothrin/ chlorantraniliprole)	4	3/28	
	Reduced Risk/Organic:			
	Altacor (chlorantraniliprole)	4	28	
	Aza-Direct[O] (azadirachtin)	3	UN	
	Dipel DF[O], XenTari[O] (*Bacillus thuringiensis*)	---	11	
	Success (spinosad)	---	5	
	Surround WP[O] (kaolin clay)	1-2	NC	
	Pest Biology: • larvae feeds on the upper leaf surface causing skeletonizing in mid to late summer	*Scouting/Threshold:* • trees can tolerate low populations		*Cultural*: • none
San Jose Scale	*Conventional:*			**Assail:** max 4 applications/yr. **Belay:** max 0.2 lb/acre/yr. **Besiege:** max 31 oz/acre/yr. **Centaur WDG:** max 1 application/yr. **Cormoran:** max 95 oz/acre/yr. May cause phytotoxicity. **Diazinon:** max 2 applications/yr. Supply may not be available. **Esteem:** max 2 applications/yr. **Leverage:** max 2.8 oz/acre/yr. **Sivanto:** max 28 oz/acre/yr. **Transform:** max 8.5 oz/acre/yr.
	Admire Pro (imidacloprid)	2-3	4	
	Belay (clothianidin)	2	4	
	Besiege[R] (lambda-cyhalothrin/ chlorantraniliprole)	2-3	3/28	
	Cormoran (acetamiprid/novaluron)	3	4/15	
	Diazinon AG600[R] (diazinon)	3	1	
	Endigo ZC[R] (lambda-cyhalothrin/thiamethoxam)	3	3/4	
	Leverage 360[R] (beta-cyfluthrin/imidacloprid)	2	3/4	
	Transform WG (sulfoxaflor)	3	4	
	Reduced Risk/Organic:			
	Assail 30SG, 70 WP (acetamiprid)	3	4	
	Centaur WDG (buprofezin)	2	16	
	Entrapment FV[O] (xanthan gum)	---	NC	
	Esteem 35 WP (pyriproxyfen) + 1% hort. oil[O] (many brands)	4	7	
	Sivanto prime (flupyradifurone)	3-4	4	
	Venerate XC[O] (*Burkholderia* spp.)	2	NC	
	Pest Biology: • the immature crawler stage is active in late spring/early summer	*Scouting/Threshold:* • place double-sided tape around infested limbs and monitor for activity of crawlers across tape • apply 1 to 2 applications during crawler stage		*Cultural*: • none

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PEAR Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff.	MOA	Comments
FRUIT PRESENT (continued)				
Spider Mites	*Conventional:*			**Abamex:** using within 14 days of captan can cause phytotoxicity. Max 2 applications/yr.
	Agri-Flex[R] (thiamethoxam/abamectin)	4	4/6	
	Abamex[R] (abamectin)	3-4	6	
	Envidor 2 SC (spirodiclofen)	3-4	23	**Acramite, Envidor, Nexter, Onager, Savey, Vydate, Zeal:** max 1 application/yr.
	Nealta (cyflumetofen)	4	25	
	Nexter (pyridaben)	2-3	21	
	Onager (hexythiazox)	3	10	
	Savey 50 DF (hexythiazox)	2-4	10	**Agri-Flex:** apply before a threshold of 5 spider mites per leaf is reached. Using with an adjuvant is required.
	Vendex 50WP[R] (fenbutatin-oxide)	3	12	
	Vydate L[R] (oxamyl)	4	1	
	Reduced Risk/Organic:			
	Acramite 50WS (bifenazate)	4	UN	**M-Pede:** applications greater than 0.2% v/v after fruitset may cause marking on some pear varieties.
	Captiva Prime[O] (canola oil/garlic oil)	2-3	NC	
	Horticultural oil[O] (many brands)	---	NC	
	M-Pede[O] (potassium salts of fatty acids)	2-3	28	**Nealta, Vendex:** max 2 applications/yr.
	Zeal (etoxazole)	3-4	10	
	Zivalgo (isocycloseram)	3-4	30	**Zivalgo:** max 3 applications/yr. Do not apply during bloom or when weeds are blooming on orchard floor.

Pest Biology:
- most likely to become a problem during hot, dry conditions in late summer when mites reproduce rapidly

Scouting/Threshold:
- pears are highly sensitive to "mite burn." Leaves turn dark brown to black quickly. Look for small mites in late June on undersides of leaves, starting with lowest, interior leaves first

Cultural:
- predatory mites commonly suppress spider mites, so avoid insecticides unless necessary

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PEAR Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff.	MOA	Comments
FRUIT PRESENT (continued)				
Stink Bugs, including Brown Marmorated Stink Bug *(BMSB is not yet an economic pest in the Intermountain West)*	*Conventional:*			See fruit guide website (Spray Tables>Pear>Fruit Present>BMSB) for specific sprays. **Beleaf:** max 8.4 oz/acre/yr. **Brigade**: only allowed after petal fall. Must wait 30 days between applications. **Danitol:** max 2 applications/yr; not for BMSB **Gladiator:** max 38 oz/acre/yr. **Leverage, Tombstone:** max 2.8 oz/acre/yr.
	Asana XL[R] (esfenvalerate)	3	3	
	Belay (clothianidin)	---	4	
	Beleaf 50 SG (flonicamid)	4	29	
	Brigade 2EC[R] (bifenthrin)	4	3	
	Danitol 2.4 EC[R] (fenpropathrin)	4	3	
	Endigo ZC[R] (lambda-cyhalothrin/thiamethoxam)	4	3/4	
	Gladiator[R] (zeta-cypermethrin/avermectin)	---	3/6	
	Leverage 360[R] (beta-cyfluthrin/imidacloprid)	4	3/4	
	Swagger[R] (bifenthrin/imidacloprid)	3	3/4	
	Tombstone[R] (cyfluthrin)	3	3	
	Voliam Xpress[R] (lambda-cyhalothrin/ chlorantraniliprole)	3	3/28	
	Warrior II[R] (lambda-cyhalothrin)	2	3	

Pest Biology:
- these bugs migrate to nearby fruit trees when crops are harvested or weeds mowed

Scouting/Threshold:
- use a sweep net in neighboring fields or weedy edges

Cultural:
- do not mow nearby weeds or cover crops when fruit is present or the insects will move to fruit trees

Pest	Brand (ingredient) - (residual days)	Eff.	MOA	Comments
POST-HARVEST (EARLY FALL)				
Pearleaf Blister Mite and Rust Mites *(these pests rarely need treatment in commercial orchards)*	*Conventional:*			**Abamex:** max 2 applications/yr. **Acramite, Nexter:** max 1 application/yr. **Sevin 4F:** do not apply when weeds are blooming on orchard floor.
	Abamex[R] (abamectin)	4	6	
	Nexter (pyridaben)	4	21	
	Sevin 4F (carbaryl)	3	1	
	Reduced Risk/Organic:			
	Acramite 50WS (bifenazate)	4	UN	
	Captiva Prime[O] (canola oil/garlic oil)	2-3	NC	
	M-Pede[O] (potassium salts of fatty acids)	2-3	28	
	Sulfur (many brands)	3-4	M2	

Pest Biology:
- blister mites live in blisters on leaves throughout the summer
- adults move to bud scales to overwinter

Scouting/Threshold:
- look for russeting of fruit and leaves
- treat before leaves drop and mites move to buds to spend the winter

Cultural:
- none

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CHERRY (tart and sweet) Pest Management Recommendations

Pest Phenology Calendar

Pests (Listed in order of management activity)	Stages of Fruit Tree Development										
	 Dormant	 Green Tip	 Tight Cluster	 White Bud	 First Bloom	 Full Bloom	 Petal Fall	 Fruit Present			Post-Harvest
								June	July	August	
Phytopthora Collar Rot	inspect trees for overall health										inspect trees
	spread by zoospores, which may form when soil is saturated longer than 12-24 hours										
Bacterial Canker	prune dead limbs										prune dead limbs
	bacteria spread in splashing rain							cankers dormant			bacteria infect wounds
Cytospora Canker	prune dead limbs										prune dead limbs
	conidia are spread in splashing rain				new cankers develop			winter-damaged trees susceptible			
Iron Chlorosis										foliar testing	
	early spring soil treatments most effective							repeat foliar applications on new growth			
Black Cherry Aphid (sweet cherry)	⟷ monitor										monitor
	eggs on limbs			nymphs/winged and wingless adults on new growth				aphids move to nonfruit hosts			eggs on limbs
Powdery Mildew							monitor ⟷				monitor
	fungus overwinters as fruiting bodies on leaves			infections spread to new leaves							
White Apple Leafhopper						⟷ monitor					monitor
	eggs in wood				nymphs on leaves			nymphs/adults/eggs on leaves			eggs in wood
Western Cherry Fruit Fly							hang sticky traps June- July ⟷				
	pupae in soil						adults/eggs and larvae in fruit				pupae in soil
Cherry (Pear) Slug (minor pest)									monitor ⟷		monitor
	pupae in soil				adults/eggs and larvae on leaves						pupae in soil
Shothole Borer						stressed trees most susceptible to attack					monitor
	larvae underneath bark				adults/eggs/larvae underneath bark						larvae underneath bark
Spider Mites	miticides not recommended unless treatment thresholds exceeded; monitor lowest leaves/branches first										
	adults at base of tree			eggs/immatures/adults on ground cover and tree leaves							adults at base of tree

Arrows (⟷) indicate intervals during which a recommended spray treatment occurs, if pest is present.
Note: The indicated monitoring times should serve as guidelines for when to monitor and manage pests, if the pest has been a problem in the past. Monitoring helps to identify whether the targeted pest is present in the orchard at damaging levels before a pesticide is used.

CHERRY (Tart and Sweet) Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
DORMANT				
Bacterial Canker *(sweet cherry only)*	*Conventional:*			Apply copper as a dormant application before foliage buds swell. **Mastercop:** max 12 pt/acre/yr.
	Champ Formula 2, Kocide (copper hydroxide)	2	M1	
	Cuprofix Ultra 40 Disperss (basic copper sulfate)	---	M1	
	Reduced Risk/Organic:			
	Champ WG[O] (copper hydroxide)	2	M1	
	Cueva[O] (copper octanoate)	2	M1	
	CS 2005[O], Mastercop[O] (copper sulfate pentahydrate)	---	M1	
	Previsto[O] (copper octanoate)	2	M1	

Pest Biology:
- cankers start to ooze in spring

Scouting/Threshold:
- none

Cultural:
- prune out cankers before warm weather

Cytospora Canker	no effective fungicides			

Pest Biology:
- cankers develop on trunk and limbs in spring and in wet weather due to fungal infection
- stressed and older trees are most at risk

Scouting/Threshold:
- look for oozing from trunk and limbs

Cultural:
- keep trees growing vigorously
- prune out dead branches, especially those with cankers.

Shothole (Coryneum Blight) *(this disease rarely occurs on cherry)*	*Conventional:*			**CS 2005:** do not apply after full bloom. **Mastercop:** max 12 pt/acre/yr.
	Bravo Ultrex (chlorothalonil)	3	M5	
	Champ Formula 2, Kocide (copper hydroxide)	3	M1	
	Pristine (boscalid/pyraclostrobin)	3-4	7/11	
	Reduced Risk/Organic:			
	Badge X2[O] (copper oxychloride/copper hydroxide)	3	M1	
	CS 2005[O] (copper sulfate pentahydrate)	---	M1	
	Cueva[O] (copper octanoate)	3	M1	
	Mastercop[O] (copper sulfate pentahydrate)	---	M1	

Pest Biology:
- the fungus overwinters in cankers that ooze in spring

Scouting/Threshold:
- look for dead, oozing buds

Cultural:
- prune out infected twigs

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CHERRY (Tart and Sweet) Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
DELAYED DORMANT (Bud Swell - First White)				
Aphid Eggs (Black Cherry Aphid) *(sweet cherry only)*	*Conventional:*			Mix with 2-3% oil.
	Asana XL[R] (esfenvalerate)	---	3	
	Beleaf 50 SG (flonicamid) + 2% oil	3	29	**Beleaf:** max 8.4 oz/acre/yr.
	Diazinon AG600[R] (diazinon) + 2% oil	4	1	**Diazinon:** max 2 applications/yr. Supply may not be available.
	Warrior II[R] (lambda-cyhalothrin) (14)	---	3	
	Reduced Risk/Organic:			
	Horticultural oil[O] (many brands)	4	NC	
	Pest Biology: • overwinter as eggs on limbs	*Scouting/Threshold:* • look for black eggs on limbs		*Cultural*: • none
Crown Rot (*Phytophthora*)	*Conventional:*			**Ridomil Gold SL:** max 3 applications/yr.
	Ridomil Gold SL (mefenoxam)	3	4	
	Pest Biology: • *Phytophthora* causes root rot and crown rot (death of cambium) in wet, poorly drained conditions	*Scouting/Threshold:* • watch for trees that are slow to leaf out, have slow growth, or die back		*Cultural*: • remove dead/dying tree(s) and do not replant in the same site without improving drainage • avoid excessive irrigation
Shothole Borer	*Conventional:*			
	Asana XL[R] (esfenvalerate)	3	3	
	Pest Biology: • adults fly from spring to mid summer • usually attack stressed trees	*Scouting/Threshold:* • look for small (1/8 in. diameter) round emergence holes in limbs and trunk		*Cultural*: • keep trees healthy with adequate nutrition and irrigation
San Jose Scale (rarely a pest on cherry)	*Reduced Risk/Organic:*			Mix with 2-3% oil. In heavy infestations, apply second treatment targeting crawlers in early summer.
	Centaur WDG (buprofezin) + 2% oil	4	16	**Centaur WDG:** max 2 applications/yr.
	Esteem 35 WP (pyriproxyfen) + 2% oil	3-4	7	**Esteem:** max 15 oz/acre/yr.
	Horticultural oil[O] (many brands)	4	NC	
	Pest Biology: • overwinter as nymphs on limbs; an armored scale	*Scouting/Threshold:* • look for gray-white scale bodies on limbs		*Cultural*: • none

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Number shown after pesticide name is number of days product lasts (only applies to certain pests).

CHERRY (Tart and Sweet) Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
PETAL FALL				
Black Cherry Aphid *(Sweet cherry only)*	*Conventional:*			**Actara:** max 11 oz/acre/yr. Highly toxic to bees. **Admire Pro, Voliam Flexi:** max 14 oz/acre/yr. **Besiege:** max 31 oz/acre/yr. **Beleaf:** max 8.4 oz/acre/yr. **Leverage 360:** max 5.6 oz/acre/yr. **Movento:** max 15.3 oz/acre/yr. **Ultor:** max 24 oz/acre/yr. **Versys:** max 3 oz/acre/yr.
	Actara (thiamethoxam)	4	4	
	Admire Pro (imidacloprid)	4	4	
	Asana XL[R] (esfenvalerate)	---	3	
	Assail 30SG, 70 WP (acetamiprid)	4	4	
	Beleaf 50 SG (flonicamid)	4	29	
	Besiege[R] (lambda-cyhalothrin/ chlorantraniliprole)	4	3/28	
	Leverage 360[R] (beta-cyfluthrin/imidacloprid)	4	3/4	
	Voliam Flexi (thiamethoxam/chlorantraniliprole)	4	4/28	
	Reduced Risk/Organic:			
	Aza-Direct[O] (azadirachtin)	2-3	UN	
	M-Pede[O] (potassium salts of fatty acids)	2-3	28	
	Ultor/Movento (spirotetramat)	4	23	
	Versys Inscalis (afidopyropen)	---	9	

Pest Biology:
- aphid injury to new growth is evident by petal fall
- egg hatch starts soon after bud break

Scouting/Threshold:
- insecticide penetration is diminished after leaves start curling

Cultural:
- many beneficials suppress aphids; avoid insecticides unless necessary

Crown Rot (Phytophthora)	*Conventional:*			**Aliette:** apply to trees that may potentially become infected and repeat in 60 days. Non-bearing only. **Fosphite, Phostrol:** provide protection of trees adjacent to dead trees as foliar spray; not to be used on dying trees. Repeat 30 days later.
	Aliette WDG (aluminum tris)	2-3	33	
	Reduced Risk/Organic:			
	Fosphite (salts of phosphorous acid)	2	33	
	Phostrol (phosphorous acid)	2	33	

Pest Biology:
- *Phytophthora* causes root rot and crown rot (death of cambium) in wet, poorly drained conditions

Scouting/Threshold:
- watch for trees that are slow to leaf out, have slow growth, or die back

Cultural:
- remove dead/dying tree(s) and do not replant in the same site without improving drainage
- avoid excessive irrigation

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CHERRY (Tart and Sweet) Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
PETAL FALL (continued)				
Oblique-banded Leafroller (and rarely European and Fruittree Leafrollers) *(these pests are sporadic)*	*Conventional:*			**Altacor:** max 9 oz/acre/yr. **Besiege:** max 31 oz/acre/yr. **Bt products:** must be applied when larvae are less than 1/2 inch. **Delegate, Intrepid:** max 4 applications/yr. **Entrust, Success:** toxic to bees for 3 hours after application.
	Besiege[R] (lambda-cyhalothrin/ chlorantraniliprole)	4	28/3	
	Warrior II[R] (lambda-cyhalothrin)	4	3	
	Reduced Risk/Organic:			
	Altacor (chlorantraniliprole)	4	28	
	Dipel DF[O], XenTari[O] (*Bacillus thuringiensis*)	3-4	11	
	Delegate WG (spinetoram)	4	5	
	Entrust[O], Success (spinosad)	4	5	
	Intrepid 2F (methoxyfenozide)	4	18	
	Venerate XC[O] (*Burkholderia* spp.)	2-3	NC	

Pest Biology:
- OBLR overwinters as larvae on limbs; emerge in spring to feed on buds and leaves

Scouting/Threshold:
- look for rolled leaves with larvae or pupae inside and treat if 2 or more feeding clusters/tree
- in high populations, an additional treatment pre-harvest may be necessary

Cultural:
- none

Powdery Mildew	*Conventional:*			Do not apply more than 2 sequential applications of one MOA. **Biologicals:** (Serenade, etc.) and **oils** must be applied before infection; they act as a protectant. **Cevya:** max 15 oz/acre/yr. **Fontelis:** max 61 oz/acre/yr. **Gatten, Indar, Rhyme, Topguard:** max 4 applications/yr. **Luna Sensation:** max 27.1 oz/acre/ yr. **Merivon, Quash:** max 3 applications/yr. **PropiMax, Torino, Vivando:** max 2 applications/yr. **Quadris Top:** max 56 oz/acre/yr. **Quintec:** max 17.4 oz/acre/yr.
	Cabrio EG (pyraclostrobin) (10-14)	4	11	
	Cevya (mefentrifluconazole) (10)	2-3	3	
	Indar 2F (fenbuconazole) (10)	---	3	
	Inspire Super (difenoconazole/cyprodinil) (10-14)	3-4	3/9	
	Luna Experience (tebuconazole/fluopyram) (10-14)	4	3/7	
	Luna Sensation (fluopyram/trifloxystrobin) (10-14)	4	7/11	
	Merivon Xemium (fluxapyroxad/pyraclostrobin) (10-14)	4	7/11	
	Ph-D (polyoxin D zinc salt) (7)	3	19	
	Procure 480SC (triflumizole) (7-14)	3-4	3	
	Pristine (boscalid/pyraclostrobin) (10-14)	4	7/11	
	Quadris Top (difenoconazole/azoxystrobin) (14)	4	3/11	
	Quash (metconazole) (10-14)	3	3	
	Quilt Xcel (propiconazole/azoxystrobin) (10-14)	3-4	3/11	
	Quintec (quinoxyfen) (10-14)	3-4	13	
	Rally 40 WSP (myclobutanil) (10-14)	3-4	3	
	Rhyme (flutriafol) (10)	4	3	
	Tilt, PropiMax EC (propiconazole) (10-14)	3	3	
	Topguard EQ (flutriafol/azoxystrobin) (10)	---	3/11	
	Topsin M WSB (thiophanate-methyl) (14)	2-3	1	
	Torino (cyflufenamid) (10)	---	U6	
	Vivando (metrafenone) (10)	4	50	

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CHERRY (Tart and Sweet) Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
PETAL FALL (continued)				
Powdery Mildew (continued)	*Reduced Risk/Organic:*			**Sonata:** works best early in season.
	Abound (azoxystrobin) (10-14)	4	11	
	Fontelis (penthiopyrad) (10-14)	4	7	**Sulfur:** may burn leaves, especially when temps are >90°F
	Gatten (flutianil) (10-14)	4	U13	
	Kaligreen[O], MilStop[O] (potassium bicarbonate) (5-7)	1	NC	
	Ph-D, OSO 5%SC (polyoxin D zinc salt) (7)	---	19	
	Sulfur (many brands) (7)	3	M2	
	Regalia CG[O] (*Reynoutria sachalinensis*) (7)	---	P5	
	Serenade Opti[O] (*Bacillus subtilis*) (7)	2	BM2	
	Sonata[O] (*Bacillus pumilis*) (7)	2	BM2	
	Theia[O] (*Bacillus subtilis*) (7)	---	BM2	

Pest Biology:
- spore-producing structures overwinter on dead leaves and in cracks on the trunk; new infections begin in spring after rains/ irrigation
- infections on cherry stems make fruit more difficult to shake off tree

Scouting/Threshold:
- start treatments at the onset of disease as a protectant fungicide and continue on a 7-14 day schedule.
- repeat during spring or summer as conditions warrant.

Cultural:
- do not let irrigation land on foliage

FRUIT PRESENT				
Grasshoppers	*Conventioal:*			**Dimilin:** max 2 applications/yr. For non-crop areas only (borders, fence rows, roadsides, etc.)
	Dimilin 2L[R] (iflubenzuron)	---	15	
	EcoBran (carbaryl)	---	1A	**EcoBran:** this is a bait; reapply after rain.

Pest Biology:
- overwinter as eggs in the soil, and hatch in spring; nymph to adult takes 5 molts

Scouting/Threshold:
- apply bait in spring along roads, ditches, fences, and weedy areas; adults are more difficult to treat

Cultural:
- for more information, see Chapter 2, Grasshoppers.

Oblique-banded Leafroller (and rarely European and Fruittree) *(these pests are sporadic)*	*Conventional:*			**Altacor:** max 9 oz/acre/yr.
	Besiege[R] (lambda-cyhalothrin/ chlorantraniliprole)	4	3/28	**Besiege:** max 31 oz/acre/yr.
	Warrior II[R] (lambda-cyhalothrin)	4	3	**Cormoran:** max 95 oz/acre/yr.
				Delegate WG, Intrepid 2F: max 4 applications/yr.

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CHERRY (Tart and Sweet) Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
FRUIT PRESENT (continued)				
Oblique-banded Leafroller (continued)	*Reduced Risk/Organic:*			**Entrust, Success:** max 3 applications/yr. Toxic to bees for 3 hours after application. **Exirel:** max 0.4 lb/acre/yr. **Bt products:** must be applied when larvae are less than 1/2 inch **Zivalgo:** max 2 applications/yr.
	Altacor (chlorantraniliprole)	4	28	
	Dipel DF[O], XenTari[O] (*Bacillus thuringiensis*)	3-4	11	
	Delegate WG (spinetoram)	4	5	
	Entrust[O], Success (spinosad)	4	5	
	Exirel (cyantraniliprole)	4	28	
	Intrepid 2F (methoxyfenozide)	4	18	
	Venerate XC[O] (*Burkholderia* spp.)	---	NC	
	Zivalgo (isocycloseram)	---	30	
	Pest Biology: • OBLR does not feed on fruit, but causes sanitation issue • 2 summer generations; larvae present mid-July in northern Utah and again in late August	*Scouting/Threshold:* • larvae difficult to find; look for rolled leaves and treat when 3 rolled leaves/tree are found		*Cultural*: • none
Pear or Cherry Slug (Pear Sawfly *(this pest is rarely a problem in commercial orchards)*	*Conventional:*			One application should suffice.
	Voliam Xpress[R] (lambda-cyhalothrin/ chlorantraniliprole)	4	3/28	
	Warrior II[R] (lambda-cyhalothrin)	4	3	
	Reduced Risk/Organic:			
	AzaGuard[O], Azatin O[O] (azadirachtin)	3	UN	
	Pest Biology: • larvae feed on the upper leaf surface causing skeletonizing • trees can tolerate low populations	*Scouting/Threshold:* • look for larvae on top of leaves in late June		*Cultural*: • none
Prionus Root Borer	*Reduced Risk/Organic:*			Set out traps in late June and empty weekly.
	AlphaScents Prionus lure and trap (pheromone mass trapping)	3	NC	
	Pest Biology: • a root-boring beetle that can cause crop losses; larvae spend several years in roots and beetles emerge in summer	*Scouting/Threshold:* • at least 3 years of trapping is required to bring population levels down.		*Cultural*: • mass trapping can reduce populations. Bury a 5-gal bucket to the top edge in soil. Place large funnel on opening and clip lure from handle. Secure handle upright by a zip-tie inserted in a hole drilled on one side of the bucket and tightened around the bail.

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CHERRY (Tart and Sweet) Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
FRUIT PRESENT (continued)				
Shothole Borer	*Conventional:*			
	Asana XL[R] (esfenvalerate)	3	3	
	Pest Biology: • adults fly from spring to mid summer • usually attack stressed trees			*Scouting/Threshold:* • look for small (1/8 in. diameter) round emergence holes in limbs and trunk; *Cultural*: • keep trees healthy with adequate nutrition and irrigation
Spider Mites	*Conventional:*			**Acramite, Envidor, Onager, Savey, Zeal:** max 1 application/yr. **Abamex, Nealta, Nexter, Vendex:** max 2 applications/yr. **Magister:** do not apply before petal fall. Max one application per season. **Zivalgo:** max 2 applications/yr. Do not apply during bloom or when weeds are blooming on orchard floor. Reduction in numbers takes a few days.
	Abamex[R] (abamectin)	2-3	6	
	Envidor 2 SC (spirodiclofen)	4	23	
	Magister SC (fenazaquin)	---	21	
	Nealta (cyflumetofen)	4	25	
	Nexter (pyridaben)	4	21	
	Onager (hexythiazox)	3	10	
	Savey 50 DF (hexythiazox)	4	10	
	Vendex 50WP[R] (fenbutatin-oxide)	3	12	
	Reduced Risk/Organic:			
	Acramite 50WS (bifenazate)	4	20	
	Captiva Prime[O] (canola oil/garlic oil)	2-3	NC	
	Entrapment FV[O] (xanthan gum)	---	NC	
	M-Pede[O] (potassium salts of fatty acids)	2-3	28	
	Zeal (etoxazole)	4	10	
	Zivalgo (isocycloseram)	4	30	
	Pest Biology: • most likely to become a problem during hot, dry conditions in late summer when mites reproduce rapidly • spider mite activity slows in Sept			*Scouting/Threshold:* • look for small mites on undersides of leaves in the lower interior canopy first • a repeat application may be necessary after harvest; *Cultural*: • avoid insecticides unless necessary to protect predators • provide adequate water to trees into fall
Spotted Wing Drosophila	*Conventional:*			Monitoring in individual orchards is important to know if this pest is present. **Baythroid:** max 5.6 oz/acre per year. **Bexar:** max 2 applications/yr.
	Baythroid XL[R] (beta-cyfluthrin)	4	3	
	Bexar (tolfenpyrad)	3	21	
	Cormoran (acetamiprid/novaluron)	3-4	4/15	
	Imidan 70-W (phosmet)	3	1	

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CHERRY (Tart and Sweet) Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
FRUIT PRESENT (continued)				
Spotted Wing Drosophila (continued)	*Reduced Risk/Organic:*			**Cormoran:** max 95 oz/acre/yr.
	Aza-Direct[O] (azadirachtin)	2-3	UN	
	Delegate WG (spinetoram)	3	5	**Delegate WG:** max 4 applications/ yr.
	Entrust[O], Success (spinosad)	2	5	
	Exirel (cyantraniliprole)	4	28	**Entrust, Success, Verdepryn:** max 3 applications/yr.
	Tersus (pyrethrins)	3	3	
	Verdepryn (cyclaniliprole)	---	28	**Imidan:** max 7.5 lb/acre/yr; tart cherries only.

Pest Biology:
- occurs in Intermountain West, but not currently an economic pest on tree fruits.
- adult female has saw-like ovipositor and will lay eggs inside fruit

Scouting/Threshold:
- adults can be monitored with a sticky trap and specialized lure.
- only treat if adults are detected or neighboring crops are known to be infested

Cultural:
- destroy dropped and over-ripened fruits as these are attractive to this fly

Western Cherry Fruit Fly	*Conventional:*			**Actara:** max 11 oz/acre/yr. Highly toxic to bees.
	Actara (thiamethoxam) (7)	3	4	
	Admire Pro (imidacloprid) (10)	3	4	**Altacor, Entrust:** max 9 oz/acre/yr.
	Asana XL[R] (esfenvalerate) (10)	3	3	
	Assail 30SG, 70 WP (acetamiprid) (7-14)	3	4	**Assail, Delegate:** max 4 applications/yr.
	Baythroid XL[R] (beta-cyfluthrin) (14)	3	3	
	Cormoran (acetamiprid/novaluron) (14)	3-4	4/15	**Baythroid, Leverage 360:** max 5.6 oz/acre/yr.
	Imidan 70-W (phosmet) (10)	3-4	1	
	Leverage 360[R] (beta-cyfluthrin/imidacloprid) (14)	3-4	3/4	**Cormoran:** max 95 oz/acre/yr.
	Malathion 57 EC (malathion) (3-7)	4	1	
	Minecto Pro[R] (abamectin/cyantraniliprole) (10-14)	3-4	6/28	**Exirel:** use with adjuvant for best results
	Mustang Maxx[R] (zeta-cypermethrin) (14-17)	3	3	
	Carbaryl 4L (carbaryl) (7)	2-3	1	**GF-120:** because the product is thick and has high viscosity, it should be mixed with water outside the tank first, such as in a five-gallon bucket with an electric drill.
	Voliam Xpress[R] (lambda-cyhalothrin/ chlorantraniliprole) (10)	3-4	3/28	
	Warrior II[R] (lambda-cyhalothrin) (14)	2-3	3	
	Reduced Risk/Organic:			
	Altacor (chlorantraniliprole) (14)	2	28	**Imidan:** tart cherries only.
	Delegate WG (spinetoram) (10)	3	5	
	Entrust[O], Success (spinosad) (7)	2	5	**Minecto Pro:** max 24 oz/acre/yr.
	Exirel (cyantraniliprole) (10-14)	4	28	
	GF-120 NF[O] (spinosad + bait) (7)	2-4	5	**Success:** max 29 oz/acre/yr.
	Verdepryn (cyclaniliprole) (14)	---	28	

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CHERRY (Tart and Sweet) Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
FRUIT PRESENT (continued)				
Western Cherry Fruit Fly (continued)				
Comments, continued:				
	Verdepryn: max 3 applications/yr. Use higher rate where populations are high.			
	Voliam Xpress: max 31 oz/acre/yr.			
	Pest Biology: • overwinter as pupae in the soil, adults emerge from late spring through summer; larvae (maggots) feed within fruits • maggots feed in fruit for 2-3 weeks, then drop to ground to pupate			*Scouting/Threshold:* • adults can be monitored with Pherocon AM® traps plus ammonium carbonate lures • adults cannot penetrate cherry skin for egg-laying until fruits turn a salmon blush color • begin treatments when fruits in most exposed locations develop a salmon blush color *Cultural*: • landscape fabric and dense ground covers under trees reduce pupation and adult emergence
White Apple Leafhopper	*Conventional*:			**Assail:** max 4 applications/yr. **Leverage 360:** max 5.6 oz/acre/yr. **Voliam Flexi:** max 14 oz/acre/yr.
	Actara (thiamethoxam)	4	4	
	Admire Pro (imidacloprid)	4	4	
	Asana XL[R] (esfenvalerate)	4	3	
	Assail 30SG, 70 WP (acetamiprid)	3	4	
	Leverage 360[R] (beta-cyfluthrin/imidacloprid)	4	3/4	
	Voliam Flexi (thiamethoxam/chlorantraniliprole)	4	4/28	
	Warrior II[R] (lambda-cyhalothrin)	---	3	
	Reduced Risk/Organic:			
	Aza-Direct[O] (azadirachtin)	2	UN	
	Captiva Prime[O] (canola oil/garlic oil)	2-3	NC	
	M-Pede[O] (potassium salts of fatty acids)	2-3	28	
	Pest Biology: • leafhoppers migrate from apples to cherry and are most noticeable in summer			*Scouting/Threshold:* • monitor with beating tray; if population exceeds one nymph per terminal, treat before older nymphs (with long wing pads) are present *Cultural*: • none
POST-HARVEST				
Powdery Mildew	*Reduced Risk/Organic:*			Apply oil no later than 7 to 10 days after harvest.
	Horticultural oil[O] (many brands)	3	NC	
	Pest Biology: • in mid to late summer, the fungus forms overwintering spores			*Scouting/Threshold:* • if mycelium is seen at harvest, an oil application can help prevent formation of overwintering spores (chasmothecia) *Cultural*: • none

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CHERRY (Tart and Sweet) Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
POST-HARVEST (continued)				
Western Cherry Fruit Fly	*Conventional:*			If fruit remains on the tree post-harvest, consider one final treatment.
	Admire Pro (imidacloprid)	3	4	
	Dimethoate 4EC (dimethoate)	4	1	**Altacor:** max 9 oz/acre/yr.
	Reduced Risk/Organic:			
	Altacor (chlorantraniliprole)	2	28	**Delegate WG**: max 4 applications/yr.
	Delegate WG (spinetoram)	3	5	
	Verdepryn (cyclaniliprole)	---	28	**Dimethoate:** apply at least 7 days after harvest.
	Pest Biology: • adults continue to lay eggs as long as fruit are present	*Scouting/Threshold:* • none		*Cultural*: • none
FALL				
Bacterial Canker (*Pseudomonas syringae*) *(sweet cherry only)*	*Conventional:*			Make first application before fall rains. **Fixed coppers** in fall are effective. **Mastercop:** max 12 pt/acre/yr.
	Champ Formula 2, Kocide (copper hydroxide)	2	M1	
	Cuprofix Ultra 40 Disperss (basic copper sulfate)	---	M1	
	Reduced Risk/Organic:			
	Badge X2[O] (copper oxychloride/copper hydroxide)	2	M1	
	Champ WG[O] (copper hydroxide)	---	M1	
	Cueva[O] (copper octanoate)	2	M1	
	Mastercop[O] (copper sulfate pentahydrate)	---	M1	
	Previsto[O] (copper hydroxide)	---	M1	
	Pest Biology: • the pathogen can cause infections in cool weather	*Scouting/Threshold:* • look for oozing on buds and twigs		*Cultural*: • keep trees healthy and do not prune in wet weather
Shothole (Coryneum Blight) *(this disease rarely occurs on cherry)*	*Conventional:*			Do not apply excessive copper. **Mastercop:** max 12 pt/acre/yr.
	Champ Formula 2, Kocide (copper hydroxide)	2	M1	
	Bravo Ultrex or Weather Stik (chlorothalonil)	3	M5	
	Reduced Risk/Organic:			
	Badge X2[O] (copper oxychloride/copper hydroxide)	3	M1	
	Cueva[O] (copper octanoate)	3	M1	
	Flint Extra (trifloxystrobin)	---	11	
	Mastercop[O] (copper sulfate pentahydrate)	---	M1	
	Pest Biology: • the fungus infects fresh leaf scars for overwintering in fall	*Scouting/Threshold:* • treat once at 50% leaf fall for good control and to protect overwintering buds		*Cultural*: • none

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CHERRY (Tart and Sweet) Pest Management Recommendations

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[R] = restricted use pesticide

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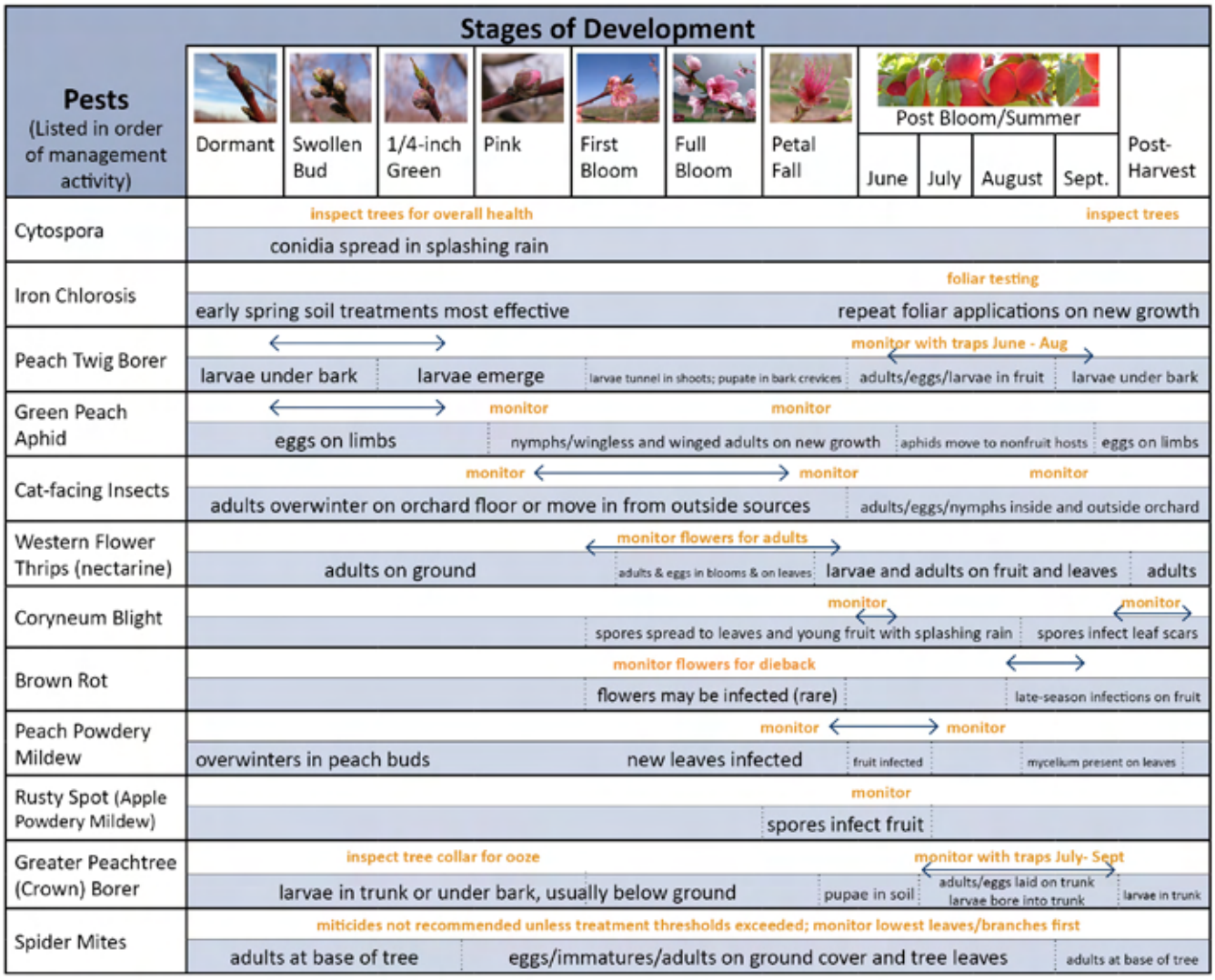
PEACH/NECTARINE Pest Management Recommendations

Pest Phenology Calendar



Arrows (⟷) indicate intervals during which a recommended spray treatment occurs, if pest is present.
Note: The indicated monitoring times should serve as guidelines for when to monitor and manage pests, if the pest has been a problem in the past. Monitoring helps to identify whether the targeted pest is present in the orchard at damaging levels before a pesticide is used.

PEACH/NECTARINE Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
DELAYED DORMANT (Swollen Bud to First Pink)				
Cytospora Canker	no fungicides are effective; only cultural controls			Research is ongoing to find effective options.
	Pest Biology: • cankers develop on trunk and limbs and ooze gum • stressed trees, and trees with winter injury are most at risk	*Scouting/Threshold:* • watch for gummosis on scaffold limbs		*Cultural*: • keep trees vigorous • prune as close to bloom as possible; also remove branches with cankers • do not prune in rain
Brown Mite (Eggs) *(these pests rarely need treatment)*	*Conventional:* Gladiator[R] (zeta-cypermethrin/avermectin) *Reduced Risk/Organic:* Captiva Prime[O] (canola oil/garlic oil) Horticultural oil[O] (many brands)	 --- --- 3-4	 3/6 NC NC	Oil alone is sufficient. **Onager, Savey 50 DF:** max 1 application/yr.
	Pest Biology: • both mite species overwinter as eggs on limbs	*Scouting/Threshold:* • if mites were severe in the prior season, plan to treat now		*Cultural*: • none
Green Peach Aphid (Eggs) *(also targets overwintering Peach Twig Borer)*	*Conventional:* Asana XL[R] (esfenvalerate) + oil Diazinon AG600[R] (diazinon) + oil *Reduced Risk/Organic:* Captiva Prime[O] (canola oil/garlic oil) Horticultural oil[O] (many brands)	 4 4 2-3 3-4	 3 1 NC NC	Horticultural oil (2-3%) plus insecticide is more effective at killing overwintering eggs. **Diazinon:** max 2 applications/yr. Supply may not be available.
	Pest Biology: • overwinter as eggs near buds	*Scouting/Threshold:* • if aphid populations were heavy the prior year, plan to apply a delayed-dormant treatment		*Cultural*: • none

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PEACH/NECTARINE Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
DELAYED DORMANT (Swollen Bud to First Pink) (continued)				
Peach Leaf Curl *(this disease rarely needs treatment)*	*Conventional:*			Only one application needed; dormant or at leaf fall are the only opportunities for treatment. **Important:** Research out of Colorado State University shows that coppers can damage bark, creating wounds for cytospora canker. Apply coppers at your own discretion.
	Bravo Ultrex (chlorothalonil)	4	M5	
	Champ Formula 2, Kocide (copper hydroxide)	2-3	M1	
	Ziram 76DF (ziram)	4	M3	
	Reduced Risk/Organic:			
	Badge X2[O] (copper oxychloride/copper hydroxide)	2	M1	
	C-O-C-S WDG (copper oxychloride)	3	M1	
	Champ WG[O], Nu-Cop 50 DF[O] (copper hydroxide)	2-3	M1	
	Cueva[O] (copper octanoate)	3	M1	
	Cuprofix Ultra 40 (basic copper sulfate)	2-3	M1	
	Mastercop[O] (copper sulfate pentahydrate)	---	M1	
	Previsto[O] (copper hydroxide)	---	M1	

Pest Biology:
- caused by fungus *Taphrina deformans;* treat in spring only
- occurs sporadically with excessive spring rains

Scouting/Threshold:
- only treat if present the prior year (thick, curled red-yellow leaves form in spring, and turn yellow-green in summer)

Cultural:
- none

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
Shothole (Coryneum Blight) *(the optimum timing is at leaf drop in fall)*	*Conventional:*			**Important:** Research out of Colorado State University shows that coppers can damage bark, creating wounds for cytospora canker. Apply coppers at your own discretion. **Bravo:** do not apply between shuck split and harvest.
	Bravo Ultrex, Weather Stik (chlorothalonil)	3	M5	
	Champ Formula 2, Kocide (copper hydroxide)	3	M1	
	Ziram 76DF (ziram)	4	M3	
	Reduced Risk/Organic:			
	Badge X2[O] (copper oxychloride/copper hydroxide)	2-3	M1	
	C-O-C-S WDG (copper oxychloride)	3	M1	
	Champ WG[O], Nu-Cop 50 DF[O] (copper hydroxide)	2-3	M1	
	Cueva[O] (copper octanoate)	2-3	M1	
	Cuprofix Ultra 40 (basic copper sulfate)	2-3	M1	
	Mastercop[O] (copper sulfate pentahydrate)	---	M1	
	Previsto[O] (copper hydroxide)	---	M1	

Pest Biology:
- fungus overwinters in dead buds
- in spring, it spreads to leaves in warm, wet weather

Scouting/Threshold:
- look for dead buds with a shiny ooze
- one spray at this timing

Cultural:
- prune out small cankers during dormancy

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PEACH/NECTARINE Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
BLOOM				
Brown Rot *(rarely occurs in commercial orchards and if so, it usually appears near harvest)*	*Conventional:*			One application at this timing only if disease was severe the prior year. **Fontelis:** max 61 oz/acre/yr. **Kenja, Scala, Quash:** max 3 applications/yr. **Quilt Xcel:** do not allow to touch apples.
	Inspire Super (difenoconazole/cyprodinil)	4	3/9	
	Kenja 400 SC (isofetamid)	4	7	
	Luna Experience (tebuconazole/fluopyram)	3	3/7	
	Luna Sensation (fluopyram/trifloxystrobin)	4	7/11	
	Pristine (boscalid/pyraclostrobin)	3-4	7/11	
	Quadris Top (difenoconazole/azoxystrobin)	4	3/11	
	Quash (metconazole)	4	3	
	Quilt Xcel (propiconazole/azoxystrobin)	4	3/11	
	Rally 40 WSP (myclobutanil)	4	3	
	Scala SC (pyrimethanil)	3-4	9	
	Tilt (propiconazole)	4	3	
	Topsin M WSB (thiophanate-methyl)	4	1	
	Reduced Risk/Organic:			
	Abound (azoxystrobin)	4	11	
	Elevate 50WDG (fenhexamid)	4	17	
	Fontelis (penthiopyrad)	4	7	
	Vangard WG (cyprodinil)	4	9	

Pest Biology:
- fungus overwinters on infected fruit on the orchard floor or in the tree
- spores may spread in warm, wet weather in spring to flowers

Scouting/Threshold:
- in the Intermountain West, most infections occur on ripening fruit in mid to late summer (in monsoon rains)

Cultural:
- prune out small cankers (look for dead buds with gumming) during dormancy

Peach Twig Borer	*Reduced Risk/Organic:*			Bt is a good option during bloom to reduce the overwintering population because it is safe on bees.
	Dipel DF[O] (*Bacillus thuringiensis* sub. *kurstaki*)	3-4	11	
	XenTari[O] (*Bacillus thuringiensis* sub. *aizawai*)	3-4	11	

Pest Biology:
- overwinter as young larvae in the tree and emerge to feed on new growth at bud burst

Scouting/Threshold:
- treat at this time based on last year's injury level

Cultural:
- none

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PEACH/NECTARINE Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
PETAL FALL				
Borers (Shothole, Flatheaded) *(uncommon)*	*Conventional:*			Repeat applications every 14-21 days until mid-summer
	Asana XL[R] (esfenvalerate)	3	3	
	Warrior II[R] (lambda-cyhalothrin)	3	3	
	Pest Biology: • attack trunks and limbs of trees under stress • prevent infestations in at-risk trees (young, stressed, or in decline) when adults are active from spring to mid-summer			*Scouting/Threshold:* • treatments only necessary when borer populations are known to be high in an area • look for sawdust-like frass, loose peeling bark, and exit holes *Cultural*: • maintain tree health to prevent infestation • prune out dead/dying limbs immediately and remove debris
Brown Mite *(these pests rarely need treatment in commercial orchards)*	*Conventional:*			**Acramite, Envidor, Savey:** max 1 application/yr. **Nexter:** most effective when applied when population size is low. Max 2 applications/yr. **Vendex:** max 2 applications/yr.
	Envidor 2 SC (spirodiclofen)	4	23	
	Nexter (pyridaben)	4	21	
	Savey 50 DF (hexythiazox)	4	10	
	Vendex 50WP[R] (fenbutatin-oxide)	4	12	
	Reduced Risk/Organic:			
	Acramite 50WS (bifenazate)	4	20	
	Captiva Prime[O] (canola oil/garlic oil)	2-3	NC	
	Horticultural oil[O] (many brands)	2-3	NC	
	Pest Biology: • mites become active in spring, and thrive in cool conditions • brown mites feed on leaves at night and rest on twigs at day			*Scouting/Threshold:* • brown mites occur sporadically; look for small reddish-brown dots on lower leaf surface or shake branch over paper *Cultural*: • none
Lygus Bug	*Conventional*:			Note that early season application of a pyrethroid can disrupt beneficial mites. **Baythroid XL:** max 5.6 oz/acre/yr. **Beleaf:** max 3 applications/yr. **Besiege:** max 31 oz/acre/yr. **Danitol 2.4 EC:** max 2 applications/yr; not for BMSB. **Venom:** max 6 oz/acre/yr. Hazardous to bees.
	Baythroid XL[R] (beta-cyfluthrin)	4	3	
	Beleaf 50 SG (flonicamid)	4	29	
	Besiege[R] (lambda-cyhalothrin/ chlorantraniliprole)	3	3/28	
	Danitol 2.4 EC[R] (fenpropathrin)	3	3	
	Venom (dinotefuran)	4	4	
	Warrior II[R] (lambda-cyhalothrin)	4	3	
	Reduced Risk/Organic:			
	Aza-Direct[O] (azadirachtin)	2	UN	
	Pyganic[O], Tersus (pyrethrins)	2	3	

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PEACH/NECTARINE Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
PETAL FALL (continued)				
Lygus Bug (continued)				
	Pest Biology: • piercing mouthparts cause scarring and cat-facing injury to fruits • overwinter in alfalfa or other field crops and migrate to nearby fruit trees when field crops are harvested	*Scouting/Threshold:* • control in surrounding crops can keep plant bugs from moving to trees • use a sweep net to determine population density		*Cultural*: • remove heavy weeds on borders and attractive weeds in orchard ground cover
Peach Twig Borer	*Reduced Risk/Organic:*			**Entrust, Success:** apply only if Bt was not used during bloom. **Isomate:** hang up to 1 month before expected biofix to increase efficacy.
	Entrust (spinosad)	3	5	
	Isomate PTB-TT[O] (mating disruption)	4	---	
	Success (spinosad)	3	5	
	Pest Biology: • overwinter as young larvae in the tree and emerge to feed on new growth at bud burst	*Scouting/Threshold:* • spray at this timing only if you missed the bloom time Bt application		*Cultural*: • none at this time
Western Flower Thrips *(mainly a problem on nectarines)*	*Reduced Risk/Organic:*			One application should suffice. **Delegate WG:** max 4 applications/ yr. **Entrust, Success:** toxic to bees until dry.
	Aza-Direct[O] (azadirachtin)	2	UN	
	BotaniGard ES (*Beauveria bassiana* strain GHA)	2	UNF	
	Delegate WG (spinetoram)	3-4	5	
	Entrust (spinosad)	4	5	
	Grandevo WDG[O] (*Chromobacterium subtsugae*)	---	NC	
	Success (spinosad)	4	5	
	Pest Biology: • overwinter as adults in protected areas on the ground and move to trees during bloom • feeding on young nectarines results in deep scarring and gumming	*Scouting/Threshold:* • shake flower clusters inside a paper cup or on dark paper to look for thrips adults; check 5-6 clusters on several trees • treat when there is more than 1 adult per cluster		*Cultural*: • none

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PEACH/NECTARINE Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
SHUCK SPLIT				
Aphids (Green Peach Aphid, Plum Aphid)	*Conventional:*			**Actara:** max 11 oz/acre/yr.
	Actara (thiamethoxam)	4	4	
	Admire Pro (imidacloprid)	4	4	**Admire Pro:** do not apply during bloom or when bees are active. Max 8.4 oz per acre/yr.
	Asana XL[R] (esfenvalerate)	4	3	
	Assail 30SG, 70 WP (acetamiprid)	4	4	**Belay:** max 0.2lb/acre/yr. Peach only
	Belay (clothianidin)	4	4	
	Beleaf 50 SG (flonicamid)	4	29	**Beleaf:** max 3 applications/yr.
	Leverage 360[R] (beta-cyfluthrin/imidacloprid)	4	3/4	
	Versys Inscalis (afidopyropen)	4	9	**Leverage, Versys:** max 2 applications/yr.
	Voliam Flexi (thiamethoxam/chlorantraniliprole)	4	4/28	
	Reduced Risk/Organic:			**Voliam Flexi:** max 14 oz/acre/yr. Hazardous to bees.
	Aza-Direct[O] (azadirachtin)	2	UN	
	Captiva Prime[O] (canola oil/garlic oil)	2-3	NC	
	Horticultural oil[O] (many brands)	4	NC	
	M-Pede[O] (potassium salts of fatty acids)	2-3	28	

Pest Biology:
- overwinter as eggs on limbs and become active in spring, causing severe leaf curl
- green peach aphid can sometimes cause deep scarring on nectarine fruit

Scouting/Threshold:
- check undersides of leaves on terminal twigs
- look for curled leaves

Cultural:
- many beneficial insects help suppress aphids, so avoid insecticides unless necessary

Peach Twig Borer	*Reduced Risk/Organic:*			Hang dispensers after bloom or after biofix.
	Checkmate PTB-XL (mating disruption)	2-3	NC	

Pest Biology:
- summer generation larvae tunnel into fruit

Scouting/Threshold:
- hang traps at 300 DD in a non-MD site to determine first moth flight (biofix)

Cultural:
- hang dispensers in upper third of canopy

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PEACH/NECTARINE Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
SHUCK SPLIT (continued)				
Powdery Mildew	*Conventional:*			Start application at the onset of disease and repeat as needed.
	Inspire Super (difenoconazole/cyprodinil) (10-14)	3	3/9	
	Luna Experience (tebuconazole/fluopyram) (10-14)	3	3/7	**Fontelis:** max 61 oz/acre/yr.
	Luna Sensation (fluopyram/trifloxystrobin) (10-14)	3	7/11	**Kaligreen, Milstop:** must be applied every 5-7 days while humid weather persists as a preventive.
	Merivon Xemium (fluxapyroxad/pyraclostrobin) (10-14)	3	7/11	
	Pristine (boscalid/pyraclostrobin) (10-14)	3	7/11	**Merivon Xemium:** max 20.1 oz/acre/yr.
	Quadris Top (difenoconazole/azoxystrobin) (14)	4	3/11	
	Quash (metconazole) (10-14)	3	3	**Quash:** max 3 applications/yr. Most effective prior to infection.
	Quilt Xcel (propiconazole/azoxystrobin) (10-14)	3	3/11	
	Rally 40WSP (myclobutanil) (10-14)	4	3	**Quilt Xcel:** do not allow to touch apples.
	Rhyme (flutriafol) (10)	3	3	
	Tilt (propiconazole) (10-14)	2-3	3	**Sulfur products:** do not apply at temperatures >85°F.
	Vivando (metrafenone) (10)	3	50	
	Reduced Risk/Organic:			**Vivando:** max 2 applications/yr.
	Fontelis (penthiopyrad) (10-14)	4	7	
	Horticultural oil[O] (many brands) (5)	2	NC	
	Kaligreen[O], Milstop[O] (potassium bicarbonate) (7)	2-3	NC	
	Ph-D, OSO 5%SC[O] (polyoxin D zinc salt) (7)	2-3	19	
	Sulfur (many brands) (5-7)	3	M2	
	M-Pede[O] (potassium salts of fatty acids) (5-7)	2	28	
	Quintec (quinoxyfen) (10-14)	4	13	
	Regalia CG[O] (*Reynoutria sachalinensis*) (7)	1-2	P5	
	Serenade ASO[O] (*Bacillus subtilis* strain QST 713) (7)	1	BM2	
	Serenade MAX[O] (*Bacillus subtilis* strain QST 713) (7)		BM2	
	Sonata[O] (*Bacillus pumilis* strain QST 2808) (7-14)	1-2	44	
	Theia[O] (*Bacillus subtilis*)	---	BM2	

Pest Biology:
- apple powdery mildew causes "peach rusty spot"
- peach powdery mildew attacks leaves and fruit

Scouting/Threshold:
- treat when fruit is the size of a pea, especially if weather is wet and mildew was a problem the prior year
- treat from post-bloom through pit hardening

Cultural:
- none

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PEACH/NECTARINE Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
SHUCK-SPLIT (continued)				
Shothole (Coryneum Blight)	*Conventional:*			Repeat application as needed, especially before or after rains.
	Bravo Ultrex, Weather Stik (chlorothalonil) (14)	3	M5	
	Captan 80 WDG (captan) (7)	2	M4	**Bravo Ultrex, Bravo Weatherstik:** do not use after shuck split.
	Luna Sensation (fluopyram/trifloxystrobin) (10-14)	4	7/11	
	Merivon Xemium (fluxapyroxad/pyraclostrobin) (10-14)	4	7/11	**CS 2005**: max 18 lb/acre/yr.
	Pristine (boscalid/pyraclostrobin) (10-14)	4	7/11	
	Quash (metconazole) (10-14)	3	3	**Fontelis**: max 61 oz/acre/yr.
	Topguard EQ (flutriafol/azoxystrobin) (7-10)	2	3/11	
	Ziram 76DF (ziram) (14)	4	M3	**Merivon, Quash:** max 3 applications/yr.
	Reduced Risk/Organic:			**Topguard, Flint Extra:** max 4 applications/yr.
	CS 2005[O] (copper sulfate pentahydrate) (5)	2-3	M1	
	Flint Extra (trifloxystrobin) (10-14)	3-4	11	
	Fontelis (penthiopyrad) (10-14)	3	7	
	Regalia CG[O] (*Reynoutria sachalinensis*) (7-10)	1-2	P5	

Pest Biology:
- fungus spreads from leaf infections to fruit

Scouting/Threshold:
- look for small purple to brown spots on leaves and purple spots on fruit and new shoots

Cultural:
- none

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
FRUIT PRESENT				
Brown Rot *(rare in orchards)*	*Conventional:*			Apply to ripening fruit before or just after heavy rainstorms only if disease was present the prior year.
	Captan 80 WDG (captan)	2-3	M4	
	Cevya (mefentrifluconazole)	3	3	
	Indar 2F (fenbuconazole)	4	3	**Cevya, Kenja, Scala, Quash:** max 3 applications/yr.
	Inspire Super (difenoconazole/cyprodinil)	4	3/9	
	Kenja 400 SC (isofetamid)	4	7	**Sulfur products:** do not apply at temperatures >85°F.
	Pristine (boscalid/pyraclostrobin)	3-4	7/11	
	Quadris Top (difenoconazole/azoxystrobin)	4	3/11	
	Quash (metconazole)	4	3	
	Rally 40 WSP (myclobutanil)	4	3	
	Scala 5 SC (pyrimethanil)	3-4	9	
	Reduced Risk/Organic:			
	Elevate 50WDG (fenhexamid)	4	17	
	Sulfur (many brands)	2-3	M2	

Pest Biology:
- spores from existing infections may spread to ripening fruit in periods of monsoon rains

Scouting/Threshold:
- watch fruit for small lesions of whitish spores. Infected fruit quickly shrivels.

Cultural:
- remove or mow fallen fruit
- prevent fruit wounds from insects such as stink bugs

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PEACH/NECTARINE Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
FRUIT PRESENT (continued)				
Grasshoppers	*Conventioal:*			**Dimilin:** max 2 applications/yr. For non-crop areas only (borders, fence rows, roadsides, etc.) **EcoBran:** this is a bait; reapply after rain.
	Dimilin 2L[R] (iflubenzuron)	---	15	
	EcoBran (carbaryl)	---	1A	
	Pest Biology: • overwinter as eggs in the soil, and hatch in spring; transition from nymph to adult takes 5 molts	*Scouting/Threshold:* • treat nymphs in spring along roads, ditches, fences, and weedy areas; adults are more difficult to treat		*Cultural*: • for more information, see Chapter 2, Grasshoppers
Greater Peachtree Borer (Crown Borer, Trunk Borer)	*Conventional:*			Spray lower 12-18" of trunk. Repeat at interval shown. **Isomate-P:** mating disruption is very effective and lasts all season. Hang dispensers right after first trap catch or by mid-June. **Pounce 25 WP:** max 3 applications/year.
	Asana XL[R] (esfenvalerate) (21)	3	3	
	Pounce 25 WP[R] (permethrin) (21)	3	3	
	Warrior II[R] (lambda-cyhalothrin) (21)	3	3	
	Reduced Risk/Organic:			
	Aza-Direct[O] (azadirachtin) (7)	2-3	UN	
	Isomate-P[O] (mating disruption)	4	NC	
	Pest Biology: • adults emerge in mid to late June in most locations (3-4 weeks earlier in southern UT and CO) and continue through Sept.	*Scouting/Threshold:* • hang pheromone traps in early June to determine first moth activity • apply treatments to susceptible trees after moth flight and maintain protection through mid September		*Cultural*: • prevent dense weed growth around base of trees
Lygus and Stink Bugs, including Brown Marmorated Stink Bug *(BMSB is not yet an economic pest in the Intermountain West)*	*Conventional*:			Early season application of pyrethroids can disrupt beneficial mites. **Actara:** max 11 oz/acre/yr. Highly toxic to bees. **Danitol 2.4:** max 2 applications/yr; not for BMSB. **Endigo ZC:** max 19 oz/acre/yr. **Leverage 360:** max 5.6 oz/acre/yr.
	Actara (thiamethoxam)	3	4	
	Asana XL[R] (esfenvalerate)	3	3	
	Besiege[R] (lambda-cyhalothrin/ chlorantraniliprole)	3	28/3	
	Danitol 2.4 EC[R] (fenpropathrin)	3	3	
	Endigo ZC[R] (lambda-cyhalothrin/thiamethoxam)	4	3/4	
	Lannate LV[R], Lannate SP[R] (methomyl)	4	1	
	Leverage 360[R] (beta-cyfluthrin/imidacloprid)	3	3/4	
	Scorpion 35SL (dinotefuran)	4	4	
	Venom (dinotefuran)	---	4	
	Voliam Flexi (thiamethoxam/chlorantraniliprole)	3	4/28	
	Voliam Xpress[R] (lambda-cyhalothrin/ chlorantraniliprole)	3	3/28	

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PEACH/NECTARINE Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
FRUIT PRESENT (continued)				
Lygus and Stink Bugs, including Brown Marmorated Stink Bug (continued)	*Reduced Risk/Organic:*			**Venom:** max 6 oz/acre/yr. Hazardous to bees. **Voliam Flexi:** max 14 oz/acre/yr. Hazardous to bees. **Voliam Express, Besiege:** max 31 oz/acre/yr. **Zivalgo:** max 2 applications/yr.
	Entrapment FV[O] (xanthan gum)	---	NC	
	Zivalgo (isocycloseram)	---	30	

Pest Biology:
- piercing mouthparts cause cat-facing injury to fruits
- may migrate to fruits when nearby fields are harvested or weeds dry

Scouting/Threshold:
- control in surrounding crops can keep plant bugs from moving to trees
- use a sweep net to determine population density

Cultural:
- remove heavy weeds on borders and attractive weeds in orchard ground cover

Oblique-banded Leafrollers *(this pest rarely needs treatment on peach)*	*Conventional:*			**Altacor:** max 9 oz/acre/yr. **Besiege:** max 31 oz/acre/yr. **Delegate WG, Intrepid:** max 4 applications/yr. **Endigo:** max 19oz/acre/yr. **Exirel, Entrust, Success, Verdepryn:** max 3 applications/yr. **Bt products:** must be applied when larvae are less than 1/2 inch. **Zivalgo:** max 2 applications/yr.
	Besiege[R] (lambda-cyhalothrin/ chlorantraniliprole)	4	3/28	
	Endigo ZC[R] (lambda-cyhalothrin/thiamethoxam)	4	4/3	
	Reduced Risk/Organic:			
	Altacor (chlorantraniliprole)	4	28	
	Dipel DF[O], XenTari[O] (*Bacillus thuringiensis*)	3-4	11	
	Delegate WG (spinetoram)	4	5	
	Entrust, Success (spinosad)	4	5	
	Exirel (cyantraniliprole)	4	28	
	Intrepid 2F (methoxyfenozide)	4	18	
	Verdepryn (cyclaniliprole)	---	28	
	Zivalgo (isocycloseram)	---	30	

Pest Biology:
- overwinter as immatures on limbs; can feed on leaves and fruit, causing scarring

Scouting/Threshold:
- look for rolled leaves with larvae inside

Cultural:
- none

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PEACH/NECTARINE Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
FRUIT PRESENT (continued)				
Peach Twig Borer	*Conventional:*			One or two sprays needed per generation, dependent on pest pressure.
	Asana XL[R] (esfenvalerate) (14-18)	3	3	
	Cormoran (acetamiprid/novaluron) (14)	3	4/15	
	Danitol 2.4 EC[R] (fenpropathrin) (14-18)	2-3	3	
	Imidan 70-W (phosmet) (21)	3	1	**Altacor:** max 9 oz/acre/yr.
	Kendo 22.8 CS[R] (lambda-cyhalothrin) (14)	3	3	
	Minecto Pro[R] (abamectin/cyantraniliprole) (14-21)	3-4	6/28	**Bt products:** must be applied when larvae are less than 1/2 inch.
	Voliam Flexi (thiamethoxam/chlorantraniliprole) (14-21)	3-4	4/28	**Entrust, Exirel, Success:** max 3 applications/yr.
	Voliam Xpress[R] (lambda-cyhalothrin/ chlorantraniliprole) (14-21)	3-4	3/28	**Cormoran:** max 95 oz/acre/yr.
	Reduced Risk/Organic:			**Danitol:** max 2 applications/yr.
	Altacor (chlorantraniliprole) (14-21)	4	28	
	Aza-Direct[O] (azadirachtin) (7-10)	2	UN	**Delegate WG, Intrepid:** max 4 applications/yr.
	Dipel DF[O], XenTari[O] (*Bacillus thuringiensis* sub. *kurstaki*) (7)	3-4	11	
	Delegate WG (spinetoram) (14-21)	3	5	**Minecto Pro:** max 24 oz/yr. Must mix with adjuvant or oil.
	Entrust (spinosad) (7)	2-3	5	
	Exirel (cyantraniliprole) (14-21)	4	28	
	Grandevo WDG[O] (*Chromobacterium subtsugae*) (7)	---	NC	**Verdepryn:** max 33 oz/acre/r.
	Intrepid 2F (methoxyfenozide) (10-14)	2-3	18	**Voliam Flexi:** max 14 oz/acre/yr. Hazardous to bees.
	Success (spinosad) (7)	2-3	5	
	Venerate XC[O] (*Burkholderia* spp) (7)	---	NC	
	Verdepryn (cyclaniliprole) (14-17)	---	28	**Voliam Express:** max 31 oz/acre/ yr.

Pest Biology:
- summer generation larvae tunnel into fruit

Scouting/Threshold:
- hang pheromone traps at 300 DD to determine first moth flight
- time fruit protective sprays at 300-400 degree-days after first adult moth activity

Cultural:
- prune out "flagged" shoots to remove overwintering larvae

Prionus Root Borer	*Reduced Risk/Organic:*			Set out traps in late June and empty weekly.
	AlphaScents Prionus lure and trap (mass trapping)	3	NC	

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PEACH/NECTARINE Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
FRUIT PRESENT (continued)				
Prionus Root Borer (continued)				
Pest Biology: • a root-boring beetle that can cause crop losses; larvae spend several years in roots and beetles emerge in summer	*Scouting/Threshold:* • at least 3 years of mass trapping is required to bring population levels down.			*Cultural*: • mass trapping can reduce populations. Bury a 5-gal bucket to the top edge in soil. Place large funnel on opening and clip lure from handle. Secure handle upright by a zip-tie inserted in a hole drilled on one side of the bucket and tightened around the bail.
Root Weevils	*Conventional*:			**Belay:** peaches only.
	Belay (clothianidin)	---	4	
	Carbaryl 4L (carbaryl)	---	1	**Botanigard:** must contact the insect; spray at night within one day of mixing.
	Voliam Xpress[R] (lambda-cyhalothrin/ chlorantraniliprole)	3-4	3/28	
	Reduced Risk/Organic:			**Nematodes:** targets larvae; apply to moist soil and keep soil moist for 14 days; products have 2 week shelf life.
	BotaniGard ES (*Beauveria bassiana* strain GHA)	2	UN	
	NemaSeek[O] (*Heterorhabditis bacteriophora)*	2-3	UN	
Pest Biology: • larval grubs feed on roots and adults emerge in late spring to feed on leaf edges at night	*Scouting/Threshold:* • starting in late spring, monitor lowest leaves for the first sign of leaf feeding; treat at this time			*Cultural*: • none
Shothole (Coryneum Blight)	*Conventional:*			**Fontelis:** max 61 oz/acre/yr.
	Captan 80 WDG (captan) (5-7)	3	M4	
	Luna Sensation (fluopyram/trifloxystrobin) (7-14)	4	7/11	**Merivon Xemium, Quash:** max 3 applications/yr.
	Merivon Xemium (fluxapyroxad/pyraclostrobin) (7-14)	4	7/11	
	Pristine (boscalid/pyraclostrobin) (7-14)	4	7/11	
	Quash (metconazole) (14)	3	3	
	Ziram 76DF (ziram) (14)	3	M3	
	Reduced Risk/Organic:			
	Fontelis (penthiopyrad) (7-14)	3	7	
	Regalia CG[O] (*Reynoutria sachalinensis*) (7-10)	1-2	P5	
Pest Biology: • fruit is susceptible to infection up to harvest (causing sunken rot in cold storage) • four hours of moisture are needed for infection	*Scouting/Threshold:* • to prevent spread, treat pre-harvest only if 4 or more hours of rain or moisture occurs frequently • watch leaves and fruit throughout the season for lesions			*Cultural*: • none

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PEACH/NECTARINE Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
FRUIT PRESENT (continued)				
Spider Mites	*Conventional:*			**Akari 5 SC:** use on non-bearing trees only.
	Abamex[R] (abamectin)	3	6	
	Akari 5 SC (fenpyroximate)	4	21	**Acramite, Envidor, Onager, Savey, Zeal:** max 1 application/yr.
	Envidor 2 SC (spirodiclofen)	4	23	
	Nealta (cyflumetofen)	4	25	**Nexter:** works best when applied before mites reach economic threshold. Max 2 applications/yr.
	Nexter (pyridaben)	4	21	
	Onager Optek (hexythiazox)	3	10	**Vendex, Abamex, Nealta:** max 2 applications/yr.
	Savey 50 DF (hexythiazox)	4	10	
	Vendex 50WP[R] (fenbutatin-oxide)	3	12	**Zivalgo:** max 2 applications/yr. Do not apply during bloom or when weeds are blooming on orchard floor.
	Reduced Risk/Organic:			
	Acramite 50WS (bifenazate)	4	20	
	Captiva Prime[O] (canola oil/garlic oil)	2-3	NC	
	Entrapment FV[O] (xanthan gum)	---	NC	
	Horticultural oil[O] (many brands)	2-3	NC	
	M-Pede[O] (potassium salts of fatty acids)	2-3	28	
	Zeal (etoxazole)	4	10	
	Zivalgo (isocycloseram)	4	30	

Pest Biology:
- most likely to become a problem during hot, dry conditions in late summer

Scouting/Threshold:
- look for mite activity on lowest, interior leaves first

Cultural:
- to protect predatory spider mites, avoid insecticides (especially pyrethroids) unless necessary

Spotted Wing Drosophila (*not currently an economic pest*)	*Conventional:*			Monitoring in individual orchards will be important to know if this pest is present. Do not treat if not found.
	Asana XL[R] (esfenvalerate)	3-4	3	
	Danitol 2.4 EC[R] (fenpropathrin)	2-3	3	**Danitol, Malathion:** max 2 applications/yr.
	Malathion 57 EC (malathion)	3	1	
	Minecto Pro[R] (abamectin/cyantraniliprole)	3-4	6/28	**Entrust, Exirel, Success:** max 3 applications/yr.
	Reduced Risk/Organic:			
	Delegate WG (spinetoram)	3	5	**Minecto Pro:** max 24 oz/yr. Must mix with adjuvant or oil.
	Entrust, Success (spinosad)	2	5	
	Exirel (cyantraniliprole)	4	28	
	Grandevo WDG[O] (*Chromobacterium subtsugae*)	2-3	NC	

Pest Biology:
- occurs in Intermountain West, but not currently an economic pest on tree fruits.
- adult female has saw-like ovipositor and will lay eggs inside fruit

Scouting/Threshold:
- adults can be monitored with a sticky trap and specialized lure.
- only treat if adults are detected or neighboring crops are known to be infested

Cultural:
- destroy dropped and over-ripened fruits as these are attractive to this fly

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PEACH/NECTARINE Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
FRUIT PRESENT (continued)				
Walnut Husk Fly	*Conventional:*			**Sevin 4F:** one or two sprays may be needed, 14 days apart.
	Asana XL[R] (esfenvalerate) (14)	3	3	
	Imidan 70-W (phosmet) (14-21)	3	1	
	Sevin 4F (carbaryl) (10-14)	3	1	**Entrust, Success:** works best when mixed with bait, or use GF-120.
	Warrior II[R] (lambda-cyhalothrin) (14-18)	3	3	
	Reduced Risk/Organic:			**Verdepryn:** max 3 applications/yr.
	Entrust (spinosad) (7)	2-3	5	
	GF-120 NF[O] (spinosad + bait) (7)	3	5	
	Success (spinosad) (7)	2-3	5	
	Verdepryn (cyclaniliprole) (14-21)	---	28	

Pest Biology:
- adults start emerging in mid-summer and lay eggs in fruit
- risk is greater where unsprayed walnut trees are near peach or nectarine trees

Scouting/Threshold:
- adults can be monitored with Pherocon AM traps
- treat by seven days after adult flies are caught or beginning in late July

Cultural:
- none

PRE-HARVEST				
Boxelder Bug	*Reduced Risk/Organic:*			
	M-Pede[O] (potassium salts of fatty acids)	2-3	28	
	Pyganic[O], Tersus (pyrethrins)	3	3	

Pest Biology:
- adults move into the orchard as fruit ripens

Scouting/Threshold:
- watch ripening fruit or use a beating tray to determine presence

Cultural:
- harvest fruit as it ripens and remove fallen fruit

Earwigs	*Conventional:*			**Sevin 4F:** make applications no more than once every seven days and no more than three times per crop.
	Sevin 4F (carbaryl)	3	1	
	Warrior II[R] (lambda-cyhalothrin)	3	3	
	Reduced Risk/Organic:			**Warrior**: 14-day PHI.
	Entrust, Success (spinosad)	3	5	
	Pyganic[O], Tersus (pyrethrins)	2	3	

Pest Biology:
- adults climb trees and feed on ripening fruit about 2 weeks before maturity
- they can also be beneficial predators of other insects

Scouting/Threshold:
- look for damage where fruit touch, or under leaves; earwigs leave behind black droppings
- tie corrugated cardboard rolls to trunks to monitor

Cultural:
- band tree at trunk with sticky adhesive

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PEACH/NECTARINE Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
PRE-HARVEST (continued)				
Bacterial Canker *(this disease rarely occurs on peach in the Intermountain West)*	*Conventional:* Kocide (copper hydroxide)	2	M1	Treat limbs before frost. **Important:** Research out of Colorado State University shows that coppers can damage bark, creating wounds for cytospora canker. Apply coppers at your own discretion.
	Reduced Risk/Organic: Badge X2[O] (copper oxychloride/copper hydroxide)	2	M	
	Champ WG[O], Previsto[O] (copper hydroxide)	---	M1	
	Cueva[O] (copper octanoate)	2	M1	
	Cuprofix Ultra 40 (copper sulfate)	2	M1	
	Mastercop[O] (copper sulfate pentahydrate)	---	M1	

Pest Biology:
- overwinters in wood and goes dormant; sometimes buds are killed in early winter

Scouting/Threshold:
- none

Cultural:
- none

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
FALL TIMING				
Shothole (Coryneum Blight)	*Conventional:* Bravo Ultrex, Weather Stik (chlorothalonil)	3	M5	**Important:** Research out of Colorado State University shows that coppers can damage bark, creating wounds for cytospora canker. Apply coppers at your own discretion. **Bravo**: can only be used after harvest and before shuck-split. **Fixed coppers** or **Ziram** are effective.
	Captan 80 WDG (captan)	3	M4	
	Champ Formula 2, Kocide (copper hydroxide)	3	M1	
	Ziram 76DF (ziram)	4	M3	
	Reduced Risk/Organic: Badge X2[O] (copper oxychloride/copper hydroxide)	3	M1	
	Champ WG[O], Nu-Cop 50 DF[O] (copper hydroxide)	2-3	M1	
	C-O-C-S WDG (copper oxychloride)	3	M1	
	Cueva[O] (copper octanoate)	2-3	M1	
	Cuprofix Ultra 40 (basic copper sulfate)	2-3	M1	
	Mastercop[O] (copper sulfate pentahydrate)	---	M1	

Pest Biology:
- fungus infects fresh leaf scars at leaf fall and overwinters as cankers which ooze in spring

Scouting/Threshold:
- treat at 50% leaf fall once for good control and to protect overwintering buds

Cultural:
- none

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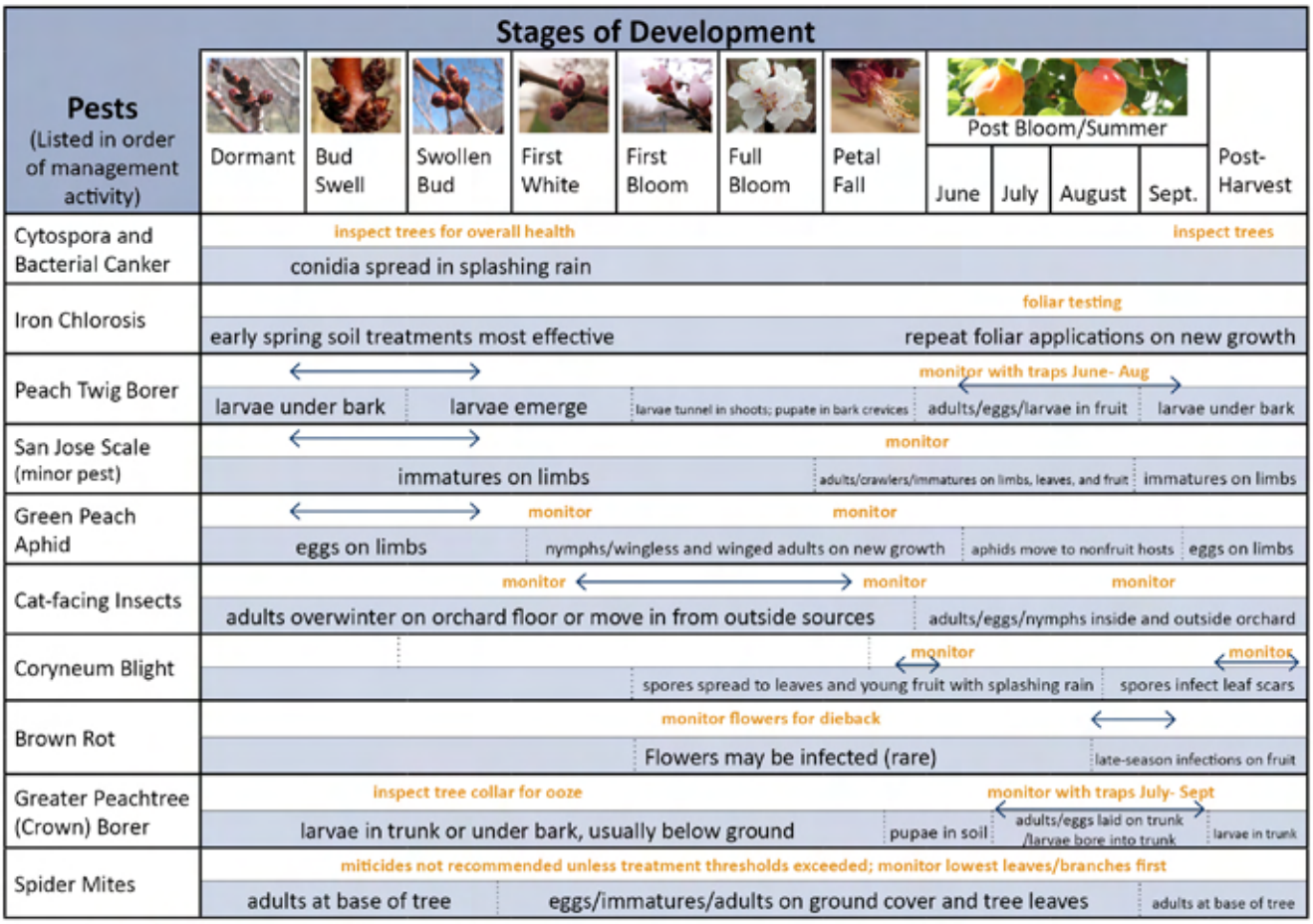
APRICOT Pest Management Recommendations

Pest Phenology Calendar



Arrows (⟷) indicate intervals during which a recommended spray treatment occurs, if pest is present.
Note: The indicated monitoring times should serve as guidelines for when to monitor and manage pests, if the pest has been a problem in the past. Monitoring helps to identify whether the targeted pest is present in the orchard at damaging levels before a pesticide is used.

APRICOT Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
DORMANT				
Bacterial Canker	*Conventional:*			Apply copper as a dormant application before foliage bud swell. Make first application before fall rains.
	Champ Formula 2, Kocide (copper hydroxide)	2	M1	
	Reduced Risk/Organic:			
	Badge X2[o] (copper oxychloride/copper hydroxide)	2	M1	**CS 2005:** max 18 lb/acre/yr.
	Cueva[o] (copper octanoate)	2	M1	
	Cuprofix Ultra 40 (basic copper sulfate)	---	M1	**Mastercop:** max 12 pt/acre/yr.
	CS 2005[o], Mastercop[o] (copper sulfate pentahydrate)	2	M1	
	Previsto[o] (copper hydroxide)	---	M1	
	Pest Biology: • cankers start to ooze in spring	*Scouting/Threshold:* • none		*Cultural*: • keep trees vigorous • prune out cankers (but not in wet weather)
Cytospora Canker	no effective fungicides			Research is ongoing to find effective options.
	Pest Biology: • cankers develop on trunk and limbs in spring and in wet weather due to fungal infection • stressed and older trees are most at risk	*Scouting/Threshold:* • look for oozing from trunk and limbs		*Cultural*: • keep trees growing vigorously • prune out dead branches, especially those with cankers
Shothole (Coryneum Blight) *(the optimum timing is fall)*	*Conventional:*			Fixed coppers or Ziram are effective.
	Bravo Ultrex, Weather Stik (chlorothalonil)	3	M5	
	Champ Formula 2, Kocide (copper hydroxide)	3	M1	**Bravo Ultrex, Bravo Weatherstik**: can only be used after harvest and before shuck-split.
	Ziram 76DF (ziram)	4	M3	
	Reduced Risk/Organic:			**Mastercop:** max 12 pt/acre/yr.
	Badge X2[o] (copper oxychloride/copper hydroxide)	2-3	M1	
	Champ WG[o], Nu-Cop 50 DF[o] (copper hydroxide)	2-3	M1	
	C-O-C-S WDG (copper oxychloride)	3	M1	
	Cueva[o] (copper octanoate)	2-3	M1	
	Cuprofix Ultra 40 (basic copper sulfate)	2-3	M1	
	Mastercop[o] (copper sulfate pentahydrate)	---	M1	
	Pest Biology: • fungus overwinters in dead buds	*Scouting/Threshold:* • look for dead buds with oozing		*Cultural*: • prune out dead twigs

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APRICOT Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
DELAYED DORMANT (Swollen Bud to First White)				
Aphid Eggs (Green Peach Aphid, Mealy Plum Aphid)	*Conventional:*			Oil alone is sufficient for suppression of aphid eggs.
	Asana XL[R] (esfenvalerate) + 2% oil	4	3	
	Diazinon AG600[R] (diazinon) + 2% oil	4	1	**Asana XL:** use with 2% oil.
	Reduced Risk/Organic:			
	Horticultural oil[O] (many brands)	2	NC	**Diazinon:** use with 2% oil. Max 2 applications/yr. Supply may not be available.
	Pest Biology: • aphids overwinter as eggs on twigs	*Scouting/Threshold:* • if aphid populations were heavy the prior year, plan to apply a dormant treatment		*Cultural*: • none
PETAL FALL TO SHUCK SPLIT				
Borers (Shothole, Flatheaded) *(uncommon pests)*	*Conventional:*			Repeat applications every 14-21 days until mid-summer
	Asana XL[R] (esfenvalerate)	3	3	
	Warrior II[R] (lambda-cyhalothrin)	3	3	
	Pest Biology: • attack trunks and limbs of trees under stress • prevent infestations in at-risk trees (young, stressed, or in decline) when adults are active from spring - mid summer	*Scouting/Threshold:* • treatments only necessary when borer populations are known to be high in an area • look for sawdust-like frass, loose peeling bark, and exit holes		*Cultural*: • maintain tree health to prevent infestation • prune out dead/dying limbs immediately and remove debris
Peach Twig Borer	*Reduced Risk/Organic:*			Bt is a good option to reduce the population because it is safe on bees.
	Dipel DF[O], XenTari[O] (*Bacillus thuringiensis*)	3-4	11	
	Entrust[O] (spinosad)	3	5	
	Isomate PTB-TT[O] (mating disruption)	4	---	
	Success (spinosad)	3	5	**Isomate:** hang up to 1 month before expected biofix to increase efficacy.
	Pest Biology: • overwinter as young larvae in protected nests on twigs	*Scouting/Threshold:* • treat at this timing if PTB was a problem last year • hang pheromone traps in a non-MD site at 300 DD to determine first moth flight		*Cultural*: • hang MD dispensers in upper third of canopy

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APRICOT Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
PETAL FALL TO SHUCK SPLIT (continued)				
Shothole (Coryneum Blight)	*Conventional:*			Do not make more than two sequential applications before alternating to a fungicide with a different mode of action. **Abound:** toxic to apples. **Bravo:** do not apply after shuck split. **Flint Extra, Topguard:** max 4 applications/yr. **Fontelis:** max 61 oz/acre/yr. **Merivon:** max 3 applications/yr. **Rovral:** use with 0.5-1% oil. Max 2 applications/yr. **Quilt Xcel:** do not allow to touch apples.
	Bravo Ultrex (chlorothalonil) (14)	3	M5	
	Captan 80 WDG (captan) (7)	3	M4	
	Flint Extra (trifloxystrobin) (10-14)	---	11	
	Inspire Super (difenoconazole/cyprodinil) (10-14)	3-4	3/9	
	Luna Experience (tebuconazole, fluopyram) (10-14)	3	3/7	
	Luna Sensation (fluopyram/trifloxystrobin) (10-14)	4	7/11	
	Merivon (fluxapyroxad/pyraclostrobin) (10-14)	4	7/11	
	Pristine (boscalid/pyraclostrobin) (10-14)	4	7/11	
	Quadris Top (azoxystrobin/difenoconazole) (10-14)	3-4	3/11	
	Quilt Xcel (propiconazole/azoxystrobin) (10-14)	---	3/11	
	Rovral (iprodione) (10-14)	3	2	
	Topguard EQ (flutriafol/azoxystrobin) (7-10)	---	3/11	
	Ziram 76DF (ziram) (14)	4	M3	
	Reduced Risk/Organic:			
	Abound (azoxystrobin) (10-14)	3	11	
	Fontelis (penthiopyrad) (10-14)	4	7	
	Regalia CG^{O} (*Reynoutria sachalinensis*) (7-10)	---	P5	

Pest Biology:
- protect new leaves and fruit at this time

Scouting/Threshold:
- watch for small purple spots on leaves and new shoots

Cultural:
- none

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
FRUIT PRESENT				
Earwigs	*Conventional:*			**Entrust:** max 9 oz/acre/yr. **Success:** max 29 oz/acre/yr.
	Carbaryl 4L (carbaryl) (7)	3	1	
	Reduced Risk/Organic:			
	Entrust^{O}, Success (spinosad) (7)	3	5	

Pest Biology:
- adults climb trees and feed on ripening fruit
- they can also be beneficial predators of other insects

Scouting/Threshold:
- look for damage where fruit touch, or under leaves; earwigs leave behind black droppings
- tie corrugated cardboard rolls to trunks to monitor

Cultural:
- band tree at trunk with sticky adhesive

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APRICOT Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
FRUIT PRESENT (continued)				
Grasshoppers	*Conventional*:			**Dimilin 2L:** for non-crop areas only (borders, fence rows, roadsides, etc.)
	Dimilin 2L[R] (diflubenzuron)	3	15	
	EcoBran (carbaryl)			**EcoBran:** this is a bait; reapply after rain.
	Pest Biology: • overwinter as eggs in the soil, and hatch in spring; nymph to adult takes 5 molts	*Scouting/Threshold:* • treat nymphs in spring along roads, ditches, fences, and weedy areas; adults are more difficult to treat		*Cultural*: • for more information, see Chapter 2, Grasshoppers.
Greater Peachtree Borer (Crown Borer, Trunk borer)	*Conventional:*			Two sprays needed on lower trunk: early July and early August.
	Asana XL[R] (esfenvalerate) (21)	3	3	
	Warrior II[R] (lambda-cyhalothrin) (21)	3	3	**Mating disruption:** hang dispensers right after first trap catch; one application lasts all season.
	Mating Disruption (organic):			
	Isomate-P[O] (mating disruption)	4	NC	
	Pest Biology: • adults emerge in mid to late June in most locations (3-4 weeks earlier in southern UT and CO) and continue through Sept.	*Scouting/Threshold:* • hang pheromone traps in mid June		*Cultural*: • keep trees healthy • avoid dense weed growth at tree base
Lygus Bug	*Conventional*:			Note that early season application of pyrethroids can disrupt beneficial mites.
	Actara (thiamethoxam)	3	4	
	Asana XL[R] (esfenvalerate)	2	3	
	Danitol 2.4 EC[R] (fenpropathrin)	3	3	**Actara:** max 11 oz/acre/yr. Highly toxic to bees.
	Endigo ZC[R] (lambda-cyhalothrin/thiamethoxam)	4	3/4	
	Leverage 360[R] (beta-cyfluthrin/imidacloprid)	3	3/4	**Danitol:** max 2 applications/yr; not for BMSB.
	Voliam Flexi (thiamethoxam/chlorantraniliprole)	3	4/28	
	Voliam Xpress[R] (lambda-cyhalothrin/ chlorantraniliprole)	3	3/28	**Endigo ZC:** max 19 oz/acre/yr
				Leverage 360: max 5.6 oz/acre/yr.
				Voliam Flexi: max 14 oz/acre/yr.

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APRICOT Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
FRUIT PRESENT (continued)				
Lygus and Stink Bugs (continued)				
Comments, continued:				
	Voliam Express: max 31 oz/acre/yr.			
	Zivalgo: max 2 applications/yr.			
Pest Biology: • populations are highest where orchards border alfalfa fields; bugs may move to developing fruit to feed	*Scouting/Threshold:* • prevent piercing-sucking bugs from feeding on new fruit if cat-facing injury was a problem in the previous year or if high populations of bugs are observed now			*Cultural*: • remove heavy weed zones
Peach Twig Borer	*Conventional:*			One or two sprays needed per generation, dependent on pest pressure.
	Asana XL[R] (esfenvalerate) (14-17)	3	3	
	Danitol 2.4 EC[R] (fenpropathrin) (14-17)	2-3	3	
	Imidan 70-W (phosmet) (21)	3	1	
	Minecto Pro[R] (abamectin/cyantraniliprole) (14-17)	3-4	6/28	**Bt products:** must be applied when larvae are less than 1/2 inch.
	Voliam Flexi (thiamethoxam/chlorantraniliprole) (14-17)	3-4	4/28	**Danitol:** max 2 applications/yr.
	Voliam Xpress[R] (lambda-cyhalothrin/chlorantraniliprole) (14-17)	3-4	3/28	**Delegate WG:** max 4 applications/yr.
	Reduced Risk/Organic:			**Entrust:** max 9 oz/acre/year.
	Aza-Direct[O] (azadirachtin) (7)	2	UN	
	Delegate WG (spinetoram) (14-17)	3	5	**Minecto Pro:** max 24 oz/yr. Must mix with adjuvant or oil.
	Dipel DF[O], XenTari[O] (*Bacillus thuringiensis*) (5-7)	3-4	11	
	Entrust[O] (spinosad) (7)	2-3	5	
	Exirel (cyantraniliprole) (14-17)	4	28	**Success, Exirel:** max 3 applications/yr.
	Grandevo WDG[O] (*Chromobacterium subtsugae*) (7)	---	NC	
	Success (spinosad) (7)	2-3	5	**Voliam Flexi:** max 14 oz/acre/yr.
	Venerate XC[O] (*Burkholderia* spp.) (7)	---	NC	**Voliam Express:** max 31 oz/acre/yr.
Pest Biology: • larvae prefer to tunnel into new shoots and tender twigs in first generation	*Scouting/Threshold:* • time fruit protective sprays at 300 to 360 degree days after biofix (first moth flight)			*Cultural*: • none

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APRICOT Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
FRUIT PRESENT (continued)				
Prionus Root Borer	*Reduced Risk/Organic:*			Set out traps in late June and empty weekly.
	AlphaScents Prionus lure and trap (mass trapping)	3	NC	

Pest Biology:
- a root-boring beetle that can cause crop losses; larvae spend several years in roots and beetles emerge in summer

Scouting/Threshold:
- at least 3 years of trapping is required to bring population levels down.

Cultural:
- mass trapping can reduce populations. Bury a 5-gal bucket to the top edge in soil. Place large funnel on opening and clip lure from handle. Secure handle upright by a zip-tie inserted in a hole drilled on one side of the bucket and tightened around the bail.

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
Shothole (Coryneum Blight)	*Conventional:*			**Flint Extra:** max 15.2 oz/acre/yr.
	Captan 80 WDG (captan) (7)	3	M4	
	Flint Extra (trifloxystrobin) (7-14)	---	11	**Fontelis:** max 61 oz/acre/yr.
	Luna Sensation (fluopyram/trifloxystrobin) (10-14)	4	7/11	**Merivon Xemium:** max 20.1 oz/acre/yr.
	Merivon Xemium (fluxapyroxad/pyraclostrobin) (10-14)	4	7/11	**Quash:** max 3 applications/yr.
	Pristine (boscalid/pyraclostrobin) (10-14)	4	7/11	**Quilt Xcel:** do not allow to touch apples.
	Quash (metconazole) (10-14)	3	3	**Topguard EQ:** max 4 applications/yr.
	Quilt Xcel (propiconazole/azoxystrobin) (10-14)	---	3/11	
	Topguard EQ (flutriafol/azoxystrobin) (7-10)	---	3/11	
	Ziram 76DF (ziram) (14)	3	M3	
	Reduced Risk/Organic:			
	Abound (azoxystrobin) (10-14)	2	11	
	Fontelis (penthiopyrad) (10-14)	3	7	
	Regalia CG^{O} (*Reynoutria sachalinensis*) (7-10)	---	P5	

Pest Biology:
- fruit is susceptible up to harvest (causing sunken rot in cold storage)
- four hours of moisture are needed for infection

Scouting/Threshold:
- to prevent spread, treat pre-harvest only if 4 or more hours of rain or moisture occurs frequently
- watch leaves and fruit throughout the season for lesions

Cultural:
- none

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APRICOT Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
FRUIT PRESENT (continued)				
Spotted Wing Drosophila *(Not currently an economic pest in intermountain west)*	*Conventional:*			Monitoring in individual orchards will be important to know if this pest is present. Do not treat if not found. **Bexar, Danitol, Zivalgo:** max 2 applications/yr. **Delegate WG:** max 4 applications/yr. **Entrust:** max 9 oz/acre/yr. **Exirel, Success:** max 3 applications/yr. **Minecto Pro:** max 24 oz/yr. Must mix with adjuvant or oil.
	Bexar (tolfenpyrad)	3	21	
	Danitol 2.4 EC[R] (fenpropathrin)	3	3	
	Minecto Pro[R] (abamectin/cyantraniliprole)	3-4	6/28	
	Reduced Risk/Organic:			
	Delegate WG (spinetoram)	3	5	
	Entrust[O], Success (spinosad)	2	5	
	Exirel (cyantraniliprole)	4	28	
	Zivalgo (isocycloseram)	---	30	

Pest Biology:
- occurs in Intermountain West, but not currently an economic pest on tree fruits.
- adult female has saw-like ovipositor and will lay eggs inside fruit

Scouting/Threshold:
- adults can be monitored with a sticky trap and specialized lure.
- only treat if adults are detected or neighboring crops are known to be infested

Cultural:
- destroy dropped and over-ripened fruits as these are attractive to this fly

Boxelder Bug	*Reduced Risk/Organic:*			
	M-Pede[O] (potassium salts of fatty acids)	2-3	28	
	Pyganic[O], Tersus (pyrethrins)	3	3	

Pest Biology:
- adults move into the orchard as fruit ripens

Scouting/Threshold:
- watch ripening fruit or use a beating tray to determine presence

Cultural:
- harvest fruit as it ripens and remove fallen fruit

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APRICOT Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
FALL				
Bacterial Canker	*Conventional:*			Treat limbs before frost.
	Kocide (copper hydroxide)	2	M1	**CS 2005:** max 18 lb/acre/yr.
	Reduced Risk/Organic:			**Mastercop:** max 12 pt/acre/yr.
	Badge X2[O] (copper oxychloride/copper hydroxide)	2	M1	
	Champ WG[O], Nu-Cop 50 DF[O] (copper hydroxide)	2	M1	
	Cueva[O] (copper octanoate)	2	M1	
	Cuprofix Ultra 40 (basic copper sulfate)	---	M1	
	CS 2005[O], Mastercop[O] (copper sulfate pentahydrate)	2	M1	
Shothole (Coryneum Blight)	*Conventional:*			**Bravo**: can only be used after harvest (and before shuck-split).
	Bravo Ultrex, Weather Stik (chlorothalonil)	3	M5	
	Captan 80 WDG (captan)	3	M4	**Fixed coppers** or **Ziram** are effective.
	Champ Formula 2, Kocide (copper hydroxide)	3	M1	
	Ziram 76DF (ziram)	4	M3	**Mastercop:** max 12 pt/acre/yr.
	Reduced Risk/Organic:			
	Badge X2[O] (copper oxychloride/copper hydroxide)	3	M1	
	Champ WG[O], Nu-Cop 50 DF[O] (copper hydroxide)	2-3	M1	
	C-O-C-S WDG (copper oxychloride)	3	M1	
	Cueva[O] (copper octanoate)	2-3	M1	
	Cuprofix Ultra 40 (basic copper sulfate)	2-3	M1	
	Mastercop[O] (copper sulfate pentahydrate)	---	M1	
	Previsto[O] (copper hydroxide)	---	M1	

Pest Biology:
- overwinters in wood and goes dormant; sometimes buds are killed in early winter

Scouting/Threshold:
- none

Cultural:
- none

Pest Biology:
- infects fresh leaf scars in fall

Scouting/Threshold:
- treat at 50% leaf fall once for good control and to protect overwintering buds

Cultural:
- none

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APRICOT Pest Management Recommendations

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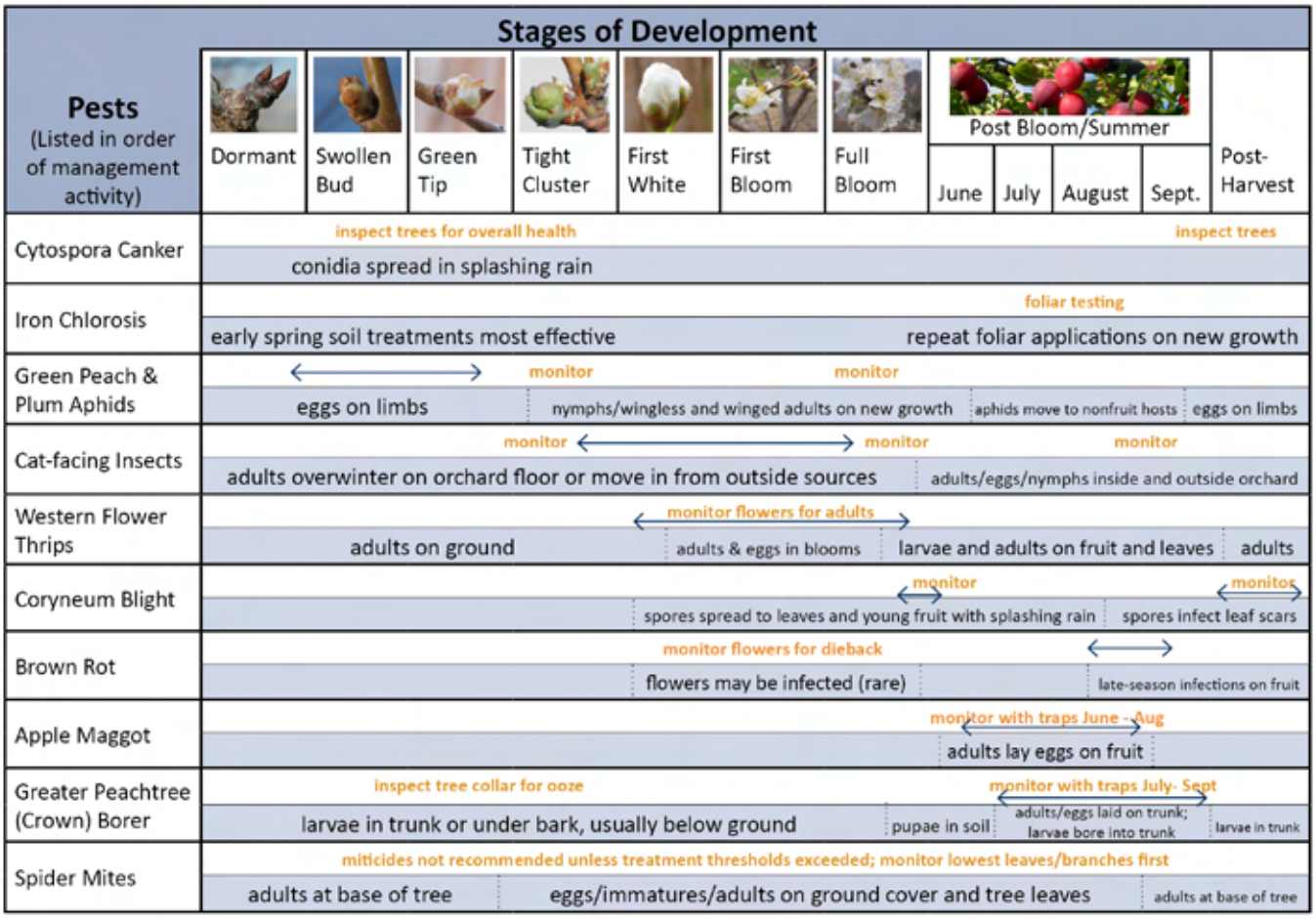
PLUM Pest Management Recommendations

Pest Phenology Calendar



Arrows (⟷) indicate intervals during which recommended management activities occur, if pest is present.
Note: The indicated monitoring times should serve as guidelines for when to monitor and manage pests, if the pest has been a problem in the past. Monitoring helps to identify whether the targeted pest is present in the orchard at damaging levels before a pesticide is used.

PLUM Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
DELAYED DORMANT (Swollen Bud to First Pink)				
Aphid Eggs (Green Peach Aphid, Plum Aphid, Mealy Plum Aphid, Leaf Curl Plum Aphid)	*Conventional:*			Oil alone is sufficient for suppression of aphid eggs.
	Asana XL[R] (esfenvalerate) + 2% oil	4	3	
	Diazinon AG600[R] (diazinon) + 2% oil	4	1	**Asana XL:** use with 2% oil.
	Reduced Risk/Organic:			
	Horticultural oil[O] (many brands)	2	NC	**Diazinon:** use with 2% oil. Max 2 applications/yr. Supply may not be available.
	Pest Biology: • aphids overwinter as eggs on limbs			*Scouting/Threshold:* • if aphid populations were heavy the prior year, plan to apply a dormant treatment
	Cultural: • none			
Cytospora Canker	no fungicides are effective			Research is ongoing to find effective options.
	Pest Biology: • cankers develop on trunk and limbs and start oozing in spring • stressed, older trees, and trees wounded by winter injury or borers are most at risk			*Scouting/Threshold:* • watch for oozing cankers on scaffold limbs
	Cultural: • keep trees growing vigorously • prune out dead branches, especially those with cankers			
BLOOM				
Brown Rot *(rarely a problem on plum)*	*Conventional:*			One application at this timing only if disease was severe the prior year.
	Rally 40 WSP (myclobutanil)	4	3	
	Captan 80 WDG (captan)	2-3	M4	**Scala SC:** max 54 oz/acre/yr.
	Pristine (boscalid/pyraclostrobin)	3-4	7/11	
	Scala SC (pyrimethanil)	3-4	9	
	Reduced Risk/Organic:			
	Elevate 50WDG (fenhexamid)	4	17	
	Pest Biology: • fungus overwinters on infected fruit on the orchard floor or in the tree • spores may spread in warm, wet weather in spring to flowers			*Scouting/Threshold:* • in the Intermountain West, most infections occur on ripening fruit in mid to late summer (in monsoon rains)
	Cultural: • prune out small cankers (look for dead buds with gumming) during dormancy			

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PLUM Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
PETAL FALL				
Borers (Shothole, Flatheaded) *(uncommon pests)*	*Conventional:*			Repeat applications every 14-21 days until mid-summer
	Asana XL[R] (esfenvalerate)	3	3	
	Warrior II[R] (lambda-cyhalothrin)	3	3	
Western Flower Thrips *(uncommon on plum)*	*Conventional:*			Just one application will suffice. **Entrust, Success**: toxic to bees for 3 hours after treatment. **Voliam Flexi:** max 14 oz/acre/yr.
	Voliam Flexi (thiamethoxam/chlorantraniliprole)	---	4/28	
	Reduced Risk/Organic:			
	Delegate WG (spinetoram)	4	5	
	Entrust[O] (spinosad)	4	5	
	Success (spinosad)	4	5	
SHUCK SPLIT				
Aphids (Green Peach Aphid, Mealy Plum Aphid, Leaf Curl Plum Aphid)	*Conventional:*			**Actara:** max 11 oz/acre/yr. Highly toxic to bees. **Admire Pro:** do not apply during bloom or when bees are active. Max 14 oz/acre/yr. **Leverage 360:** max 5.6 oz/acre/yr. **Movento, Ultor:** max 15.3 oz/acre/yr; use with adjuvant.
	Actara (thiamethoxam)	4	4	
	Admire Pro (imidacloprid)	4	4	
	Assail 30SG, 70 WP (acetamiprid)	4	4	
	Leverage 360[R] (beta-cyfluthrin/imidacloprid)	4	3/4	
	Movento, Ultor (spirotetramat)	---	23	
	Versys Inscalis (afidopyropen)	---	9	
	Voliam Flexi (thiamethoxam/chlorantraniliprole)	4	4/28	

Pest Biology:
- attack trunks and limbs of trees under stress
- prevent infestations in at-risk trees (young or stressed) when adults are active, from spring - mid summer

Scouting/Threshold:
- treatments only necessary when borer populations are known to be high in an area
- look for sawdust-like frass, loose peeling bark, and exit holes

Cultural:
- maintain tree health to prevent infestation
- prune out dead/dying limbs immediately and remove debris

Pest Biology:
- overwinter as adults in protected areas on the ground and move to trees during bloom
- feeding on young fruit results in russeting

Scouting/Threshold:
- shake flower clusters inside a paper cup or on dark paper to look for thrips adults; check 5-6 clusters on several trees
- treat when there is more than 1 adult per cluster

Cultural:
- none

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PLUM Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
SHUCK SPLIT (continued)				
Aphids (continued)	*Reduced Risk/Organic:*			**Versys Inscalis:** max 2 applications/yr.
	Aza-Direct^{O} (azadirachtin) (7)	2	UN	
	Captiva Prime^{O} (canola oil/garlic oil) (5)	2-3	NC	**Voliam Flexi:** max 14 oz/acre/yr. Toxic to bees.
	Horticultural oil^{O} (many brands) (5)	4	NC	
	M-Pede^{O} (potassium salts of fatty acids) (7)	2-3	28	

Pest Biology:
- some species cause severe leaf curl, but migrate to an alternate host for the summer

Scouting/Threshold:
- check undersides of leaves on terminal twigs
- look for curled leaves

Cultural:
- avoid insecticides unless necessary to protect beneficials

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
FRUIT PRESENT				
Apple Maggot (*This fly occurs wherever native black hawthorn grows in Idaho, Utah. It has not caused economic damage in commercial orchards in the Intermountain West.*)	*Conventional:*			**Admire Pro**: do not apply when bees are active.
	Admire Pro (imidacloprid) (10)	3	4	
	Asana XL^{R} (esfenvalerate) (14)	2	3	**Altacor:** max 9 oz/acre/yr.
	Assail 30SG, 70 WP (acetamiprid) (14)	3	4	
	Cormoran (acetamiprid/novaluron) (14)	4	4/15	**Carbaryl 4L:** do not apply during bloom or when weeds are blooming on orchard floor.
	Gladiator^{R} (zeta-cypermethrin/avermectin) (17)	3	3/6	
	Imidan 70-W (phosmet) (21)	3	1	**Cormoran:** max 95 oz/acre/yr.
	Leverage 360^{R} (beta-cyfluthrin/imidacloprid) (14)	4	3/4	**Delegate:** max 28 oz/acre/yr.
	Carbaryl 4L (carbaryl) (14)	3	1	
	Voliam Xpress^{R} (lambda-cyhalothrin/ chlorantraniliprole) (14-17)	4	3/28	**Entrust, Success:** max 29 oz/acre/ yr.
	Warrior II^{R} (lambda-cyhalothrin) (14-17)	3	3	
	Reduced Risk/Organic:			**Gladiator:** max 57 oz/acre/yr.
	Altacor (chlorantraniliprole) (14-17)	2	28	
	Delegate WG (spinetoram) (14)	3	5	**Imidan**: max 13 lb/acre/yr.
	Entrust^{O} (spinosad) (7)	2	5	
	GF-120 NF^{O} (spinosad + bait) (7)	2-4	5	**Leverage 360:** max 2 application/ year.
	Success (spinosad) (7)	2	5	
	Verdepryn (cyclaniliprole) (14-21)	---	28	**Verdepryn:** max 3 applications/yr.
				Voliam Express: max 31 oz/acre/ yr.

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PLUM Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
FRUIT PRESENT (continued)				
Apple Maggot (continued)				
	Pest Biology: • overwinter as pupae and flies start emerging in late June, continuing through September • females lay eggs under fruit skin and maggots feed on flesh; larger, softer fruits are more susceptible	*Scouting/Threshold:* • hang yellow sticky traps starting in early July, focusing on borders next to abandoned orchards • according to Cornell University, treat when 5 flies per trap are caught		*Cultural*: • hawthorn is preferred host; remove nearby trees if apples become infested
Brown Rot *(rarely a problem on plum)*	*Conventional:*			One or more application at this timing only if fruit was diseased the year prior. Apply to ripening fruit before or just after rainstorms. **Fontelis:** max 61 oz/acre/yr.
	Captan 80 WDG (captan)	2-3	M4	
	Pristine (boscalid/pyraclostrobin)	3-4	7/11	
	Rally 40 WSP (myclobutanil)	4	3	
	Reduced Risk/Organic:			
	Elevate 50WDG (fenhexamid)	4	17	
	Fontelis (penthiopyrad)	4	7	
	Pest Biology: • spores from existing infections may spread to ripening fruit in periods of monsoon rains	*Scouting/Threshold:* • watch fruit for small lesions of whitish spores. Infected fruit quickly shrivels.		*Cultural*: • remove or mow fallen fruit • prevent fruit wounds from insects such as stink bugs
Grasshoppers	*Conventional*:			**Dimilin 2L:** for non-crop areas only (borders, fence rows, roadsides, etc.) **EcoBran:** a bait that is most effective on nymphs. Do not use if rain within 8 hours.
	Dimilin 2L[R] (diflubenzuron)	3	15	
	EcoBran (carbaryl)	---	1A	
	Pest Biology: • overwinter as eggs in the soil, and hatch in spring; nymph to adult takes 5 molts	*Scouting/Threshold:* • treat nymphs in spring along roads, ditches, fences, and weedy areas; adults are more difficult to treat		*Cultural*: • for more information, see Chapter 2, Grasshoppers.

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PLUM Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
FRUIT PRESENT (continued)				
Greater Peachtree Borer (Crown Borer, Trunk Borer) *(peachtree borer not usually a problem on plum)*	*Conventional:* Asana XL[R] (esfenvalerate) (21) Warrior II[R] (lambda-cyhalothrin) (21) *Mating Disruption (organic):* Isomate-P[O] (mating disruption)	 3-4 3-4 4	 3 3 NC	Only lower 12-18" of trunk should be sprayed. **Isomate-P:** mating disruption is very effective and lasts all season. Hang dispensers by early July.
Oblique-banded Leafrollers *(this pest rarely needs treatment)*	*Conventional:* Cormoran (acetamiprid/novaluron) (14) *Reduced Risk/Organic:* Altacor (chlorantraniliprole) (14) Dipel DF[O], XenTari[O] (*Bacillus thuringiensis*) (7) Delegate WG (spinetoram) (14) Entrust[O], Success (spinosad) (7) Exirel (cyantraniliprole) (14-17) Intrepid 2F (methoxyfenozide) (10-14) Verdepryn (cyclaniliprole) (14-21) Zivalgo (isocycloseram) (14)	 3 4 3-4 4 4 4 4 --- ---	 4/15 28 11 5 5 28 18 28 30	**Altacor:** max 9 oz/acre/yr. **Bt products:** must be applied when larvae are less than 1/2 inch. **Cormoran:** max 95 oz/acre/yr. **Delegate:** max 28 oz/acre/yr. **Exirel:** max 3 applications/yr. **Entrust, Success:** max 29 oz/acre/yr. **Intrepid:** max 4 applications/yr. **Verdepryn:** max 33 oz/acre/yr. **Zivalgo:** max 2 applications/yr.

Pest Biology:
- adults emerge in mid to late June in most locations (3-4 weeks earlier in southern UT and CO) and continue through Sept.

Scouting/Threshold:
- hang pheromone traps in early June to determine first moth activity
- apply treatments to susceptible trees after moth flight through mid September

Cultural:
- prevent dense weed growth around base of trees

Pest Biology:
- overwinter as eggs or immatures on limbs; can feed on leaves and fruit, causing scarring

Scouting/Threshold:
- look for rolled leaves with larvae inside

Cultural:
- none

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PLUM Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
FRUIT PRESENT (continued)				
Peach Twig Borer	*Conventional:*			One or two sprays needed per generation, dependent on pest pressure.
	Asana XL[R] (esfenvalerate) (14-18)	3	3	
	Cormoran (acetamiprid/novaluron) (14)	3	4/15	
	Danitol 2.4 EC[R] (fenpropathrin) (14-18)	2-3	3	**Altacor:** max 9 oz/acre/yr.
	Imidan 70-W (phosmet) (21)	3	1	
	Voliam Flexi (thiamethoxam/chlorantraniliprole) (14-21)	3-4	4/28	**Bt products:** must be applied when larvae are less than 1/2 inch.
	Voliam Xpress[R] (lambda-cyhalothrin/ chlorantraniliprole) (14-17)	3-4	3/28	**Cormoran:** max 95 oz/acre/yr.
	Reduced Risk/Organic:			**Danitol:** max 2 applications/yr.
	Altacor (chlorantraniliprole) (14-17)	4	28	
	Aza-Direct[O] (azadirachtin) (7)	2	UN	**Delegate:** max 4 applications/yr.
	Dipel DF[O], XenTari[O] (*Bacillus thuringiensis*) (7)	3-4	11	
	Delegate WG (spinetoram) (14-17)	3	5	**Entrust, Success:** max 29 oz/acre/ yr.
	Entrust[O] (spinosad) (7)	2-3	5	
	Exirel (cyantraniliprole) (14-17)	4	28	**Voliam Express:** max 31 oz/acre/ yr.
	Grandevo WDG[O] (*Chromobacterium subtsugae*) (7)	---	NC	
	Success (spinosad) (7)	2-3	5	**Voliam Flexi:** max 14 oz/acre/yr.
	Venerate XC[O] (*Burkholderia* spp.) (7)	---	NC	

Pest Biology:
- larvae prefer to tunnel into new shoots and tender twigs in first generation

Scouting/Threshold:
- time fruit protective sprays at 300 to 360 degree days after biofix (first moth flight)

Cultural:
- none

Prionus Root Borer	*Reduced Risk/Organic:*			Set out traps in late June and empty weekly.
	AlphaScents Prionus lure and trap (mass trapping)	3	NC	

Pest Biology:
- a root-boring beetle that can cause crop losses; larvae spend several years in roots and beetles emerge in summer

Scouting/Threshold:
- at least 3 years of trapping is required to bring population levels down.

Cultural:
- mass trapping can reduce populations. Bury a 5-gal bucket to the top edge in soil. Place large funnel on opening and clip lure from handle. Secure handle upright by a zip-tie inserted in a hole drilled on one side of the bucket and tightened around the bail.

Eff = Efficacy, 4 is most efficacious, and 1, least. Information collected from a variety of sources. **MOA** = Mode of Action [R] = restricted use pesticide [O] = OMRI approved organic pesticide **NC** = not classified **---** = efficacy unknown

Number shown after pesticide name is number of days product lasts (only applies to certain pests).

PLUM Pest Management Recommendations

Pest	Brand (ingredient) - (residual days)	Eff	MOA	Comments
FRUIT PRESENT (continued)				
Spider Mites	*Conventional:*			**Abamex:** max 2 applications/yr; do not apply during bloom.
	Abamex[R] (abamectin)	2-3	6	
	Akari 5 SC (fenpyroximate)	---	21	**Acramite, Envidor, Onager, Savey, Zeal:** max 1 application/yr.
	Envidor 2 SC (spirodiclofen)	4	23	
	Nealta (cyflumetofen)	4	25	
	Nexter (pyridaben)	---	21	**Akari 5 SC:** non-bearing trees only.
	Onager (hexythiazox)	3	10	
	Savey 50 DF (hexythiazox)	4	10	
	Vendex 50WP[R] (fenbutatin-oxide)	3	12	**Nealta, Nexter, Vendex:** max 2 applications/yr.
	Reduced Risk/Organic:			
	Acramite-50WS (bifenazate)	4	20	**Zivalgo:** max 2 applications/yr. Do not apply during bloom or when weeds are blooming on orchard floor.
	Captiva Prime[O] (canola oil/garlic oil)	2-3	NC	
	Horticultural oil[O] (many brands)	2-3	NC	
	M-Pede[O] (potassium salts of fatty acids)	2-3	28	
	Zeal (etoxazole)	4	10B	
	Zivalgo (isocycloseram)	---	30	

Pest Biology:
- most likely to become a problem during hot, dry conditions in late summer when mites reproduce rapidly

Scouting/Threshold:
- look for mite activity on lowest, interior leaves first

Cultural:
- to protect predatory spider mites, avoid insecticides (especially pyrethroids) unless necessary

PRE-HARVEST				
Earwigs	*Conventional:*			**Entrust, Success:** max 29 oz/acre/yr.
	Carbaryl 4L (carbaryl)	3	1	
	Reduced Risk/Organic:			**Carbaryl 4L:** make applications no more than once every seven days and no more than three times per crop.
	Entrust[O], Success (spinosad)	3	5	

Pest Biology:
- adults climb trees and feed on ripening fruit
- they can also be beneficial predators of other insects

Scouting/Threshold:
- look for damage where fruit touch, or under leaves; earwigs leave behind black droppings
- tie corrugated cardboard rolls to trunks to monitor

Cultural:
- band tree at trunk with sticky adhesive

Eff = Efficacy, 4 is most efficacious, and 1, least. Information collected from a variety of sources.
MOA = Mode of Action
[R] = restricted use pesticide
[O] = OMRI approved organic pesticide
NC = not classified
--- = efficacy unknown
Number shown after pesticide name is number of days product lasts (only applies to certain pests).

CHAPTER 8 ORCHARD FLOOR AND WEED MANAGEMENT

Weeds are major pests competing with trees for water, nutrients, and in extreme cases, light. Weeds can also provide habitat for rodents that can feed on tree bark and roots. Weeds especially compete with young trees and trees grafted onto dwarfing/semi-dwarfing rootstocks. For example, grass growing near the trunk of apple trees delays the onset of fruiting, reduces trunk circumference, and reduces shoot growth. Early and mid-season weed control (May-July) has greater impacts on tree growth and yields than late season control (August). Grasses are more competitive than broadleaf weeds, and adding nitrogen does not overcome the competition.

Just as orchardists develop management plans to deal with insect and disease pests, an orchard floor management plan will help keep weeds in check. The plan is best determined before the orchard is planted. Management practices should be executed in a timely manner during the lifetime of the orchard.

Management Systems

In-row weed management tools include herbicides, mulches, and tillage (Table 1), and should be used to establish a vegetation free zone of 2.5 to 3 feet on each side of a row of trees, giving a total strip width of 5 to 6 feet. This strip provides an area where most roots will grow without competition from weeds or grass sod.

In-row grass cover around mature trees has been used by many growers in the past. It can be effective on steep slopes where erosion is a problem or trees planted on vigorous rootstocks (MM.111, MM.106, or seedling). Planting a cover crop in rows has not been effective in the western U.S.

Alley vegetation typically includes perennials and drought tolerant grasses. The grass alley provides a solid path for equipment travel, helps prevent soil erosion, helps maintain soil structure, and aids water infiltration. Depending on the vegetation sown, weed invasion can be minimized and sod establishment can be fairly quick. The alleys may be kept as bare soil with shallow tillage or herbicides, but there are several drawbacks. Bare soils lead to soil erosion, loss of organic matter, increases soil compaction, and increases dust.

In-row Herbicides

Typically, 2-3 herbicide applications are applied in-row per year. They are typically not viable weed management tools for organic orchards since organic herbicides have limited efficacy and are prohibitively expensive, in particular when perennial weeds are present. See the last section for more herbicide information.

In-row Cultivation

Shallow cultivation is the most common weed management practice in organic orchards. There are several cultivators designed for in-row weed management in orchards and vineyards (Weed badger , Wonder Weeder , Ladurner Cultivator , Rinieri EL in-row rotatory harrow). Cultivation may improve water infiltration of some soils, but frequent shallow cultivation damages feeder roots near the soil surface and often results in reduced tree growth and yields. Irrigation systems should be de¬signed to avoid damage if growers plan to use in-row cultivation. In alleys, traditional field cultivators (disc or sweeps) can be used. Cultivation is most effective on annual weed seedlings and must be repeated every few weeks during the growing season. Frequent cultivation breaks down soil structure, making the soil more prone to erosion and compaction.

In-row Mulches

Mulches conserve soil moisture, reduce soil temperature, and initially inhibit annual weed growth around trees, but aside from woodchips or bark, they can provide a sheltered habitat for voles. Effective plant or compost-based mulches include straw, sawdust or shavings, hay, leaves, chipped prunings, or shredded newsprint. The effects of mulches on soil properties and weed control will depend on the type and depth of mulch applied. Mulches are expensive to obtain and apply on an annual or biennial basis. Some growers use clippings of alley cover crop as mulch in the row (mow-and-blow system) using a side delivery mower. Organic mulches do not control and can encourage perennial weeds like quackgrass, Canada thistle, and

Table 1. Weed management options in orchards

Tool	Advantages	Disadvantages
Herbicides	• Effective • Easy to apply • Can act selectively • Typically the least expensive: Less time required and lower cost per acre.	• Requires training/education to avoid risks of non-target effects: worker safety, crop injury, environmental contamination • Organic herbicides are expensive-not economical
Cultivation	• Effective on small annual weeds • Can be used in organic systems	• May damage soil structure, shallow tree roots, and irrigation system • May spread perennial weeds • Provides short term control- must be repeated every few weeks
Mulches: Synthetic plastic or woven weed barriers	• Effective and low maintenance • Can be used in organic systems	• Must be applied prior to planting • Interfere with soil application of fertilizer • Limited lifespan • Can provide habitat for rodents
Mulches: Plant/ Compost based	• Effective on annual weeds if applied to sufficient depth (>3 inches) • Increase soil quality and nutrition • Can be used in organic systems	• Costly • Can tie up Nitrogen • Often need to be reapplied every few years • Can provide habitat for rodents
Mowing	• Reduced seed spread • Useful as quick/rescue treatment or in established orchards (>4-6 yrs. old) on larger rootstocks	• Often used after weed competition has occurred • Repeated applications required
Heat (Flaming, steam, electric shock)	• Effective on small annual weeds • Can be used in organic systems	• May damage trees and irrigation system.

Adapted from Ontario Ministry of Ag., Food, and Rural Affairs. Pub 310 integrated pest management for apples. Orchard weed management and Granatstein and Sanchez 2009.

field bindweed. Mulches must be applied more than 3-4 inches deep to prevent annual weeds from growing through. Organic mulches may bring in additional weed seeds and/or new weed species. As they decompose, some organic mulch materials high in carbon tie up available soil nitrogen, but have been shown to increase soil qualities and tree growth over the long term.

Weed barriers, synthetic plastic film, or spun bonded polyester fabric mulches are additional management options. These products are typically applied prior to planting and the trees are planted into the weed barrier. They have a limited lifespan that varies from a single season (thin film plastic mulch) to several seasons (spun fabric). They are allowed in organic production but must be removed completely before they break down. Synthetic mulches create a barrier to soil-applied fertilizer. Plant nutrition management may have to rely more on fertigation and foliar application. Alternatively, some growers will apply two strips of fabric mulch on either side of the row and remove in the winter to discourage rodents and amend soils (WSU-organic weed management).

In-row Alternative Weed Control Practices

Other less commonly used orchard weed management practices include mowing or heat. Mowing is used most often when a cover is grown in the row or as a rescue treatment for weeds that have escaped control and can help reduce weed seed production.

Heat, typically provided with a propane torch, can be effective but only for small, annual broadleaf weeds. Grasses and perennial weeds will be damaged but will quickly grow back. Flame weeders can damage trees and irrigation systems. Other forms of using heat (e.g. steam, electrical shock) are being researched but are not widely used at this time.

Alley Vegetation

Vegetation in the alleys is an important component of orchard floor management. It maintains soil structure, encourages water infiltration, reduces erosion, reduces mud and dust, and maintains an acceptable driving surface for equipment. A perennial vegetation cover can be established with grasses, broadleaf plants (including legumes) or a mixture, although a selecting just one type is often easier to manage than multiple species. Choice of alley vegetation depends on if alleys are irrigated. Drought- tolerant species, like hard fescue, should be used if alleys are not irrigated.

Grasses are the most common vegetation used. There are many species and mixtures avail¬able, so orchardists can choose what is best suited to each particular situation. Several low growing perennial rye grasses and fescues are available and allow easy orchard access even when headed out. Many orchards use grass cover alone as it allows easier control of broadleaf weeds with selective herbicides.

Legumes can be used as alley cover to grow additional nitrogen in the orchard. Mowing and discharging the nitrogen-rich plant material in the tree row effectively bands the nitrogen next to the tree roots. Plant adaptability to the Intermountain West climate greatly influences the legumes that can be considered. Alleyway-grown alfalfa has been shown to produce 50 pounds of nitrogen per acre in an orchard system. A drawback to this type of system is the lack of control over the timing of nitrogen availability. If the nitrogen becomes available late in the season, then this could create a flush of shoot growth that would delay hardening off of the orchard tree and increase susceptibility to early winter injury. Considerations on the time of mowing could appropriately add the nitrogen according to tree needs, and limit potential negative effects. Alfalfa does not hold up well to wheel traffic and is not shade tolerant enough to persist in older orchards.

Use of legume plants does come with a few disadvantages. Stink bugs and lygus can feed on the plants, and after mowing, they could move to the trees and feed on fruits, causing cat-facing injury. Legumes are also preferred food for pocket gophers and voles. Legumes require more irrigation than some other plants. In an established orchard environment, alfalfa and alfalfa-clover mixes were shown to transpire more than twice as much water as a conventional grass alleyway. Although legumes add nitrogen to the orchard soil, the fertility benefits may not outweigh the cost of managing increased pest populations or maintaining proper soil moisture where irrigation water is limited.

Alley Vegetation Establishment

Preparation for perennial regulation establishment should begin at the same time as preparation for orchard establishment. Perennial weeds such as thistles and aggressive bunch grasses should be controlled with a non-residual herbicide such as glyphosate. Have the soil tested and apply and incorporate any phosphorus or potassium fertilizer as indicated in the soil test.

Grasses can be planted in either the spring or late summer (August 15 to September 15). Late summer establishment is preferred because warmer soils result in rapid germination, and because annual weeds that germinate at the same time should be killed by fall frosts before they flower and produce seed.
Legumes are best planted in the spring after the soil has warmed and can be worked. Usually, legumes are planted with grasses to obtain the benefits of both types of plants.

Alley Vegetation Maintenance

Once a cover is established, required maintenance includes fertilizing, mowing, irrigating, and controlling weeds. No nitrogen fertilizer beyond that provided for the trees should be required, especially if a grass/legume mixture is used because legumes can capture atmospheric nitrogen and make it available to grasses (or other non-legume vegetation).

Grass covers will require mowing several times each year. A mowing height of 3-4 inches is best. The flowering period of spring is also the critical time for frost protection. A closely mowed orchard floor can radiate more energy back into the orchard than one

with tall vegetation. Mow again when seed heads have formed on grasses but before the seed has matured. Once grasses have set seed, less growth will occur after mowing. Mowing just before harvest will facilitate moving shakers, bins, ladders, and boxes through the orchard. If much regrowth occurs after harvest, the or¬chard should be mowed again in the late fall to remove habitat favorable for rodents.

Irrigation required for alley vegetation should be low. Perennial grasses can go dormant in the summer when irrigation is sporadic, but will regrow in the fall with cooler and wet weather. However, in arid areas like the Intermountain West, periodic irrigation may be required.

Herbicides Applications

Herbicides have various modes of action, but are grouped as either pre-emergent or post-emergent. Pre-emergent herbicides are active in the soil against germinating seedlings and require incorporation into the soil with tillage or precipitation. Some pre-emergent herbicides can slow root growth of trees. Pre-emergent herbicides that are more mobile in the soil are often more effective but are not labeled for use in newly planted orchards.

Post-emergent herbicides are active against vegetation that is already up and growing. They can further be categorized as contact or systemic. Post-emergent systemic herbicides can also be divided as selective (e.g. 2,4-D only controls broadleaf weeds and sethoxydim only controls grasses) or non-selective (e.g. glyphosate) that affect any plant.

Effective weed control programs utilize both pre-emergent and post-emergent herbicides. When the initial fall or spring herbicide application includes both a pre-emergent and post-emergent material, the flush of weeds that have already germinated is controlled and the new weeds are kept from growing—providing longer control. If a second herbicide application is required later in the season, a post-emergent product usually is sufficient. Check the product labels for allowable tank-mix combinations.

Herbicide applications must be made with a well-maintained and accurately-calibrated sprayer. Fixed boom applicators with flat fan or low-drift nozzles at low pressures (15-25 psi) are best for herbicide application, unless the label specifies otherwise. Low pressure application reduces the number of very small droplets. Small droplets are prone to drift.

Use extreme caution when applying herbicides to newly planted and young trees. Ensure the soil has completely settled before applying pre-emergent herbicides. Post-emergent herbicides can be absorbed through the tender bark of young trees resulting in tree damage or death. Some product labels restrict application to newly planted trees. Carefully read the label before application.

Rotate the herbicides used. Rotating re¬duces “weed shifting” where weeds that are tolerant to the materials being used can thrive. This is particularly important for pre-emergent herbicides. Be sure to rotate to an herbicide with a different mode of action. For example, simazine and diuron have the same mode of action, so alternating these products would not have the desired result.

Herbicide use best practices:

- Use an accurately-calibrated fixed boom sprayer, flat fan or low drift nozzles, low pressure and constant speed.
- Read the full herbicide label before making an application. Labels change over time and applicators must follow the label for the product they are using. Wear the personal protective equipment specified on the label for the product(s) being used. Store herbicides in a secure location in accordance with label requirements.
- Use herbicide sprayers only for herbicides and clean sprayers thoroughly following application—especially following 2,4-D.
- Dispose of excess spray material properly. Avoid contact with non-target vegetation.

Herbicides Labeled for Fruit Crops

See REI and PHI Table in Chapter 6 for other restrictions

Crop	Weeds Treated	Formulation Name (active ingredient)	Remarks
PRE-EMERGENT			
ALL	annual grasses and listed broadleaves	Alion (indaziflam)	Apply to dry soil and wait 48 hours before irrigation. Irrigation or rainfall should be received within 21 days following application.
Apple, pear, cherry	annual and perennial grasses and broadleaves	Casoron 4G (dichlobenil)	Apply Nov. to March when soil temp is below 45˚ F. Rain/irrigation is needed for activation; shallow incorporation recommended.
ALL	annual broadleaves and suppression of grasses	Chateau SW (flumioxazin)	Limited to 24 oz per year. Moisture is necessary to activate pre-emergence applications. **Apple**: apply only between harvest and pink stage. **Stone fruit and pear**: apply only between harvest and bud break.
ALL	annual broadleaves and suppression of grasses	Goal 2XL (oxyfluorfen)	Do not apply between bud swell and harvest (dormant application only).
Apple, pear, peach	annual grasses and broadleaves	Karmex DF (diuron)	Do not treat trees grafted on full dwarf rootstocks. Maximum 1 application/year.
ALL	annual and perennial grasses and listed broadleaves	Kerb 50-W[R] (pronamide)	Apply as post-harvest application when temperatures are below 55˚ F. Rain or irrigation required to activate. Maximum 1 application/year.
ALL	annual grasses and broadleaves	Matrix SG (rimsulfuron)	Weeds are controlled 60-90 days after application. If weeds are present at application, a labeled burn down herbicide such as glyphosate, or paraquat, will improve control. Do not use in mix water above 8.0 pH. Best results when soil is moist at the time of application and 0.5 inch rainfall occurs within 2 weeks of treatment.
Apple, pear, tart cherry	annual grasses and broadleaves	Princep 4L (simazine)	One application per year. Do not apply to gravelly or sandy soil.
ALL	annual and perennial grasses and broadleaves	Relsion (glufosinate/indaziflam)	Apply to dry soil and wait 48 hours before irrigation. Irrigation or rainfall should be received within 21 days following application. Maximum 3 applications/year.
Apple, peach	annual grasses and broadleaves	Sinbar WDG (terbacil)	Maximum rate is 1 lb per year. Can be used on non-bearing pear, cherry, apricot, and plum. Not registered in Idaho or Montana.
ALL	annual grasses and broadleaves	Solicam DF (norflurazon)	Apply from fall to early spring. Rainfall or irrigation of 0.5 inch is necessary for activation. Not registered in Idaho or Montana.

[R] = restricted use pesticide

Herbicide Sprays, continued

Crop	Weeds Treated	Formulation Name (active ingredient)	Remarks
PRE-EMERGENT (continued)			
ALL	annual grasses and listed broadleaves	Surflan AS (oryzalin)	Rainfall or irrigation to 0.5 inch required for activation.
ALL	annual and perennial grasses and broadleaves	Tetris SG (rimsulfuron)	Weeds are controlled 60-90 days after application. Rain or irrigation required to activate. Maximum rate is 4 oz/acre/year.
POST-EMERGENT			
ALL	annual broadleaves; green suckers	Aim EC (carfentrazone)	Use anytime of the season, always with surfactant. Mix with glyphosate or paraquat for better control.
ALL	annual and some perennial broadleaves	Amine 4, Saber, others (2,4-D amine)	Do not apply during bloom or near irrigation times. Do not apply to bare ground. Maximum 2 applications per year and 75 days between applications.
ALL	annual broadleaves and suppression of grasses	Chateau SW (flumioxazin)	**Apple**: apply only between harvest and pink stage. **Stone fruit and pear**: apply only between harvest and bud break. Limited to 24 oz per year. Use with an adjuvant.
Stone fruits	listed annual and perennial grasses	Fusilade DX (fluazifop-P)	Always add non-ionic surfactant. Rainfast in 1 hour.
ALL	annuals and some perennial grasses and broadleaves	glyphosate	Rate depends on weed species and stage of growth. Does not provide residual control; can be mixed with labeled pre-emergence herbicides. Avoid contact with all tree parts.
ALL	most annual grasses and broadleaves and top kill of perennial weeds	Gramoxone SL[R] (paraquat)	Repeat applications are necessary for sustained control. Always add non-ionic surfactant. Maximum 5 applications/year.
ALL	listed annual and perennial broadleaves	Hulk (Florpyrauxifen-benzyl)	Maximum 2 applications/year.
Pome fruits, peach	annual grasses and broadleaves	Karmex DF (diuron)	**Pome fruits**: apply March – May only. Do not treat trees grafted on full dwarf rootstocks. Maximum 1 application/year.
ALL	annual and perennial grasses and broadleaves	Relsion (glufosinate/indaziflam)	Rainfall within 4 hours may diminish the efficacy of application. Maximum 3 applications/year.
ALL	annual and perennial grasses and broadleaves	Rely (glufosinate)	**Pome fruit**: Maximum 3 applications/year. **Stone fruit:** Maximum 2 applications/year.
ALL but plum *(plum is non-bearing application only)*	annual and perennial grasses	Poast (sethoxydim)	Use with 1.25% oil. Do not mix with other herbicides. Do not apply within 1 hour of rainfall. Will not work on drought-stressed grasses.
ALL	annual and perennial grasses and broadleaves	Scythe (pelargonic acid)	Contact non-selective burn down control of a variety of weeds. Can be mixed with glyphosate.

[R] = restricted use pesticide

Herbicide Sprays, continued

Crop	Weeds Treated	Formulation Name (active ingredient)	Remarks
POST-EMERGENT (continued)			
Stone fruits	perennial broadleaves	Stinger (clopyralid)	Apply while weeds are generally small and actively growing. Do not exceed 2/3 pt/ac/year. Highly leachable in light soils.
ALL	annual grasses and listed broadleaves	Surflan (oryzalin)	Mix with glyphosate or paraquat. Rainfall or irrigation to 0.5 inch required for activation.
ALL	annual and perennial grasses and broadleaves	Tetris SG (rimsulfuron)	Mix with glyphosate or paraquat. Maximum rate is 4 oz/acre/year.
NON-BEARING			
ALL	annual broadleaves and suppression of grasses	Chateau WDG (flumioxazin)	Do not apply to trees established less than one year, unless protected with non-porous wraps.
ALL	listed annual and perennial grasses	Fusilade DX (fluazifop-P)	Always add non-ionic surfactant. Rainfast in 1 hour.
ALL	listed broadleaves	Gallery 75 (isoxaben)	Pre-emergence only. Only apply to settled soil with no cracks. Rainfall or irrigation of 0.5 inch required within 21 days of application.
ALL	annual and perennial grasses	Poast (sethoxydim)	Use with 1.25% oil. Do not mix with other herbicides. Do not apply within 1 hour of rainfall. Will not work on drought-stressed grasses. Peach, nectarine, and plum are very tolerant of Poast and it may be applied over the top of non-bearing trees.
ALL	annual grasses and listed broadleaves	Prowl 3.3 EC (pendimethalin)	Pre-emergence herbicide. Use before bud swell. Rain or irrigation required within 21 days of application.
ALL	annual grasses and broadleaves	Reglone (diquat)	Post-emergence herbicide. Complete coverage essential.
ALL	annual and perennial grasses and broadleaves	Rely (glufosinate)	**Pome fruit**: Maximum 3 applications/ year. **Stone fruit:** Maximum 2 applications/year.
Apple, apricot, cherry, peach, pear, plum	annual grasses and broadleaves	Sinbar WDG (terbacil)	For non-bearing, newly-planted trees, make the first application after a significant rainfall or irrigation that will settle the soil around the base of the tree. Not registered in Idaho or Montana.
ALL	annual grasses and listed broadleaves	Snapshot 2.5 TG (isoxaben+trifluralin)	Pre-emergence herbicide; 0.5 inch rain or irrigation required within three days of application.

Additional Resources

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CHAPTER 9 RODENT MANAGEMENT

Rodents, primarily voles, can significantly damage orchard trees. In the winter when other food is scarce, voles will gnaw the bark from trees up to the snow line. In severe cases hundreds of trees can be completely girdled in just one winter. Young trees are more vulnerable than older trees. Managing the orchard floor to reduce habitat is a critical part of keeping vole populations below action thresholds.
Both meadow voles and pine voles can be found throughout orchard areas in the Intermountain West. Voles rarely live for more than 1 year. Litters contain up to 12 pups and females can reproduce in any season. Females reach reproductive maturity in 3 weeks and a fecund female can have about four litters per year. Under favorable conditions, vole populations can increase rapidly.

An effective vole management plan in orchards consists of five components:

- Habitat destruction
- Scarce food supply
- Exclusion
- Facilitating predators
- Baiting with rodenticide

Voles can injure or destroy trees.

Habitat Destruction

Like all mammals, voles require shelter from the elements and from predators. Vegetation in orchards and nearby fence rows or brush piles provide adequate habitat. These types of habitats, however, also encourage predators that could feed on voles, as well as beneficial pollinators, predatory insects, and desirable game birds.

If necessary, the most efficient means of destroying habitat is to mow the orchard close. The last mowing in the fall should cut remaining vegetation short. Orchards that are clear cultivated sometimes leave tufts of vegetation around each tree. This is prime vole habitat and may encourage trunk girdling in the winter. Chipping or burning brush piles reduces habitat. Keeping fence rows clear also removes rodent habitat. Equipment "bone yards" can also provide shelter for rodents. Leaving no place to hide will reduce vole population.

Mulches can also be vole habitat and their potential as habitat must be weighed against their desirable characteristics such as moisture retention and weed restriction.

Scarce Food supply

Voles feed on a variety of materials. Their preferred diet is high energy content foods such as green tissues, seeds, nuts, and fruit. When preferred foods are absent, they will eat woody materials and bark. Fruit that falls to the ground as part of the harvest process provides voles with their preferred diet. With adequate food, populations can skyrocket in the fall. Flail chopping dropped apples will cause them to decompose faster and provides less food for rodents.

Exclusion

It is not possible to exclude voles from entire orchard blocks, but it is possible to exclude access to the trunks of individual trees. Trunk guards will help protect trunks against vole feeding. Various commercial products are widely available. An inexpensive trunk guard can be made using 1/4 or 1/2-inch mesh galvanized hardware cloth. Cut an 18 inch square and make a cylinder around the trunk and fasten the two edges with wire. Place the cylinder 2-3 inches into the soil to discourage burrowing under the guard.

Facilitating predators

Birds of prey are important predators of voles and gophers. The kestrel is a small hawk that is an excellent predator for mouse, vole, and large insect control. Kestrels will return to maintained boxes year after year, but are highly territorial.

The barn owl, because of its voracious appetite for gophers, voles, and mice, is a valuable friend to the orchardist. During a 4-month nesting season, a barn owl family may consume about 1000 rodents per year. The barn owl population in the West is dwindling partially due to lack of nesting sites, which orchard growers can improve by providing boxes. If rodenticides are used, select the least toxic options, since predator birds may die from consuming dying rodents.

To attract birds of prey:

- **Kestrels**: Screw nesting boxes to power poles, trees, or freestanding posts 10-20 feet above ground, away from human activity. Install up to 1 per 5 acres to increase chances of nesting, but note that a pair may defend up to 250 acres. Adding a bit of nesting material (twigs, wood shavings) can help attract the birds. Monitor each box weekly and remove starling nests. Clean boxes each year.
- **Barn owls**: To attract/keep birds on the farm, keep old wooden barns; they will not nest in metal barns. Nest boxes on trees or 15-30 ft steel posts facing east and away from roads or busy orchard activities can be used in place of cavity trees or abandoned buildings. A tall tree within 50 yards of the nest box is necessary to provide cover. Owls may patrol up to 200 acres per nesting site. The boxes must be cleaned yearly and kept free of starlings.
- **Other large raptors**: Perches are necessary for owls and raptors to spot their prey. Retain old trees in edge plantings or install posts with a 2x4 across the top to facilitate hunting activities. Adequate perching structures will encourage raptors to remain on site year around and can provide valuable winter predation.

Barn owl boxes (left) should have the appropriately-sized entrance hole, and be mounted to a building or tall, sturdy post.

Kestrels are excellent predators of small mammals. Their nest boxes (right) must be cleaned yearly.

See "A Guide for Attracting Wildlife for Pest Control on Farmland in Utah" and related designs for nest boxes, perches, and promoting wintering raptors on farmland, at extension.usu.edu/productionhort/files/AttractingWildlifePestControl.pdf.

Baiting with Rodenticides

Baiting may be necessary if populations are still high—especially in the fall. Population action thresholds are determined by placing 50 to 100 apple slices in a block of trees. Slices should be placed under some sort of cover such as a wooden shingle or small plank supported by a stone. After 24 hours return to the orchard and count the number of slices that are missing or that show feeding. When 20% to 25% of slices are missing or show feeding, the potential exists for serious vole damage and further action is warranted.

Effective baiting requires presenting the bait in a setting so rodents will feed and so non-target animals don't have access to the bait. An inexpensive bait station is made using PVC pipe and tees. Use 1½ or 2-inch PVC pipe. Cut the pipe into 4-5 inch segments and push a piece of pipe into each opening of the tee. Place the bait stations in the orchard unbaited for a week or two to allow habituation. To place the bait, lift up the sidearm of the tee and place a small quantity of bait in the tee, then lay it back down flat. Voles are likely to feed on bait when they can see all the way through the tube and when they don't have to "back

Comparison of Two Rodenticide Groups

Anticoagulants	Zinc Phosphide
Comes in various formulations and more widely used	Comes in various formulations and not as widely used
Dangerous to raptors and scavengers	Somewhat safer for raptors and scavengers
Broadly toxic to mammals and must be handled with care	Broadly toxic to mammals and must be handled with care
Kills slowly; may engender bait shyness	Kills quickly

out" of the pipe. The openings are small enough to keep non-target animals from the bait and the bait is protected from moisture.

When using rodenticides read and follow the label directions. Store them in a dry place where other animals and children do not have access. Wear appropriate personal protective equipment (especially rubber gloves) to protect yourself.

A bait station made from PVC pipe laid in an orchard at the transition from grass to vegetation free zone. A bait station protects the bait from weather and from non-target consumption.

Common Rodenticides Used in Orchards

Rodenticide	Type	Days of Feeding	Bird Toxicity Risk	Mammal Toxicity Risk
Warfarin	Anticoagulant	Multiple	Slight	Low
Bromethalin	Non-anticoagulant	Single	Low	Low
Zinc phosphide	Non-anticoagulant	Single	Low	Slight

CHAPTER 10 PLANT GROWTH REGULATORS AND THINNING

Plant growth regulators (PGRs) are used to control bloom, thin fruit, regulate growth, and adjust harvest timing of orchard crops. PGRs are absorbed by plant cells, primarily through the leaves and fruit where they interact with the biochemical "machinery" of the plant. They work by mimicking naturally occurring plant hormones, or by blocking the production or activity of natural plant hormones.

Types of Plant Growth Regulators

Plant growth regulators (PGRs) mimic the natural plant hormones, and others act by blocking either the synthesis or the activity of plant hormones. They are produced in one part of a plant and translocated to another part where, at very low concentrations, it stimulates a physiological response. They may promote or inhibit growth. Plant hormones also occur naturally.

Plant hormones and PGRs can be grouped into five classes of compounds: auxins, gibberellins, cytokinins, abscisic acid, and ethylene, each of which is described briefly below.

Auxins

These are primarily growth-promoting substances that contribute to the elongation of shoots, but at high concentrations they can inhibit growth of lateral buds preventing branching. Auxins are generally produced in apical buds, young leaves, and developing seeds. In addition to being used as plant growth regulators, auxins can also be used as herbicides (2,4-D and other phenoxy herbicides). In apple production, NAA and NAD are synthetic auxins that can be used to thin fruit, inhibit water sprout and sucker growth, and prevent pre-harvest fruit drop. Carbaryl, while not strictly an auxin, has a similar chemical structure and has similar activity in fruit thinning.

Gibberellins

Gibberellins also promote growth. They are produced in very young leaves, developing seeds, fruit, and roots. Gibberellins cause cell elongation during shoot growth, and are involved in regulation of dormancy. Commercially, gibberellins have been used to improve fruit size, prevent fruit russeting, and induce lateral branching. Several growth retardants, including Prohexadione calcium (Apogee, Kudos) limit biosynthesis of gibberellins and thus inhibit shoot growth.

Cytokinins

Cytokinins promote cell division. They are thought to be produced in the roots and by young fruit. Cytokinins are involved in apical dominance, branching, and stimulating bud initiation. Benzyladenine is a synthetic cytokinin used for fruit thinning (MaxCel). Combinations of benzyladenine and gibberellins (ex. Promalin) are used to improve fruit shape and to stimulate lateral branching.

Abscisic Acid

Abscisic acid (ABA) is a growth inhibitor. ABA is produced in mature leaves along with many other plant tissues where it controls the dormancy of buds and seeds and inhibits shoot growth. It also appears to be involved in plant response to water stress. Commercial formulations of ABA (ProTone) can be used to accelerate color development in grapes, for post-bloom thinning of apples and to accelerate fall defoliation in a number of fruit crops.

Ethylene

This is the only known gaseous plant hormone. Many plant organs synthesize ethylene, and it moves readily in the air surrounding the tree. Usually, ethylene has an inhibitory effect on plants and is most commonly associated with plant stress. It promotes abscission of leaves and fruits, inhibits shoot elongation, favors caliper development, and, along with auxin, inhibits lateral bud development. On the other hand, it can break dormancy in buds and seeds and causes rapid ripening of apples. In apples, ethylene is involved in the transition of fruit from being physiologically mature to ripe. Once exposed to ethylene, their storage life is shortened.

Ethephon is a synthetic compound that releases ethylene upon application and is used for fruit thinning and for synchronizing fruit ripening and abscission in preparation for mechanical harvest. ACC (Aminocyclopropane carboxylic, trade name Accede) is the natural precursor to ethylene synthesis in the plant and acts similar to ethephon. It is used for thinning of apples and peaches.

AVG (aminoethoxyvinyl glycine, tradename ReTain) interferes with ethylene biosynthesis, allowing fruit to hang on trees longer and lengthens storage life. 1-MCP (1-Methylcyclopropene, trade name SmartFresh) blocks the receptor for ethylene, preventing ethylene action. Since 1-MCP is a gas, it has been used in storage facilities to slow post-harvest ripening. A sprayable formulation of 1-MCP (Harvista) can be applied to apples and pears before harvest, to slow fruit maturation and extend postharvest storage life. The sprayable formulation can be applied to sweet cherries during bloom to increase fruit set and is used on cultivars such as Regina that tend to have poor fruit set.

Factors Affecting Plant Response to PGRs

The effectiveness of PGR applications are determined by 1) how much of the active ingredient is absorbed by the plant and reaches the appropriate tissue or cells, and 2) how sensitive the plant is to the PGR. Environmental conditions at the time of application, formulation of the material, and method of application all affect plant absorption. Tree age, tree vigor, dosage, timing, and cultivar all interact to affect plant sensitivity. By understanding the role of each of these variables, you will be better equipped to adjust PGR applications to compensate for year-to-year and block-to-block variation.

Environmental Conditions

Weather conditions before, during, and after applications affect response to PGRs. Warm temperatures, slow drying conditions, and healthy foliage will enhance absorption and increase plant response. Cool temperatures, fast drying conditions, and damaged trees or foliage will decrease plant response. Because low humidity and high temperatures are typical of Intermountain West, evening or night-time applications are typically best to allow for proper drying time and to avoid volatilization and photo-degradation of PGRs.

Tree Vigor and Age

Weak trees and young trees are more responsive to PGRs. Stressors such as lack of water, low nitrogen, or plant or leaf injury also increase sensitivity. Doses should be decreased, or application eliminated for trees that are stressed. Although damaged foliage can reduce absorption, weak trees can still be oversensitive to PGR applications.

Dosage

Compared to crop protectants (insecticides and fungicides) PGRs have a relatively narrow acceptable dose range, where overdose can result in negative side effects. Conversely, when the dose is too low, none of the desired response will be achieved. Therefore, PGRs should be applied in very precise and low concentrations. Extreme care must be taken to mix and apply these chemicals accurately to avoid incorrect dosage. Because applying the correct dose is more difficult for low-volume sprays, PGRs should be applied as dilute high-volume sprays (100 + gallons per acre) to ensure proper and uniform coverage. Growers that only have access to low-volume sprayers should use the highest volume possible.

Spray Tank Considerations

Surfactants are a class of spray tank additives that affect the surface tension properties of the spray solution, which increases leaf wetting in order to increase absorption. Read the PGR product label carefully before including a surfactant. Many of the commercial PGRs come formulated with surfactants to provide the proper solution characteristics for leaf wetting. Adding more surfactant to the spray tank solution may not appreciably improve PGR delivery and may decrease retention of the spray solution on the surface of the plant.

Many PGRs are sensitive to spray solution pH, where the stability and activity of the PGR molecules are best in slightly acidic solution. Many of the PGRs are weak organic acids, and when placed in alkaline water typical of the Intermountain West, become negatively

charged. These materials cannot move into the plant in this negatively charged ("dissociated") form. A spray tank buffer will improve both the stability and uptake of the PGR. PGRs should not be tank mixed with pesticides.

Timing

PGRs can cause different effects when applied at different times during the season. For a predictable response to occur, PGRs must be applied in a narrow time period, usually within a few days.

Cultivar

Different cultivars display varying degrees of responsiveness to PGR application. This is especially true for chemical thinning.

Evaluating and Monitoring Plant Response

To evaluate the effectiveness of PGR treatments, leave some trees untreated for comparison. Keeping detailed accurate records of application rates, weather, and plant response will help in making adjustments for future years to achieve the optimal response.

Thinning Apple Fruit with PGRs

Apple trees typically produce more flowers and fruit than are needed to produce a full crop of marketable fruit. Many of the excess fruitlets will drop shortly after petal fall, or later, during June drop. In a good crop year, the remaining crop load will still be too large for individual fruit to develop marketable size. Additionally, heavy crop loads inhibit the ability of trees to develop blossom buds for the following year, resulting in biennial bearing. Thinning the crop will maximize fruit size and quality and allow for adequate flower bud initiation for the following year.

Fruit size is determined by the total cell number per fruit. In apples, cell division ceases by about 30 days after full bloom. Therefore, final fruit size is influenced greatly within the first month after bloom. Likewise, initiation of flower buds for the subsequent year's crop also occurs within the first month after bloom. To optimize both fruit size and return bloom, excess fruit must be removed during this period. Chemical thinning preferentially removes small, weak fruit.

Apple thinning can be broken into two categories: blossom and post-bloom thinning (petal fall to ~20mm fruit diameter). Chemistry and mode of thinning varies between these two timings. At bloom, the objective is to inhibit fertilization of flowers so that fruit do not form. Lime sulfur is the primary blossom thinner. Post-bloom thinning works by magnifying the fruit abscission mechanism that occurs when growth of the fruit cannot be supported by available carbohydrates. There are numerous post-bloom thinners that are summarized below. Blossom and post-bloom thinners are often used in conjunction in a multi-step ("nibble") approach.

Determining Crop Load

The following questions will help you evaluate whether your crop needs to be thinned. Remember, it is better to be conservative when applying thinning materials. It's possible to take more fruit off but not to put fruit back on.

- *How many seeds are present?* When fruitlets are 3-5 mm, cut open a few and count the seeds. Fruitlets with fewer than five developing seeds are more likely to drop naturally and will be easier to thin than fruitlets with more than five seeds.
- *What color are the seeds?* Tan or brown seed color at this time of the season indicates that the seeds are not viable, whereas viable seeds will be white to yellow. Fruitlets with fewer viable seeds are more likely to drop naturally and are also more sensitive to chemical thinners. In some cultivars, the color of the pedicel (stem) is also an early indicator of whether the fruitlets will persist beyond June drop. Red color in the pedicel indicates that the fruitlet will likely not persist.
- *Does the tree have too many apples?* If fruit clusters are within 6-8 inches of each other and if there are more than two fruitlets developing in each cluster, there are too many apples on the tree.
- *What was the crop load like last year?* Trees will thin more easily in the year following a heavy crop.
- *What was bee activity like in the orchard?* Were pollination conditions good or less than ideal? Remember that bees don't like to work in cloudy, rainy, or windy weather any more than you do.

Blossom Thinning

Blossom thinning of apple relies on letting a desired number of flowers be fertilized (typically earliest blooming "king" flower in a cluster) and inhibiting fertilization of later developing flowers. As such, timing of application is critical and multiple applications are often needed. A visual assessment of open bloom can be used to time applications, with a first application at 20% open bloom and a follow-up application at 80%. The pollen tube growth model (https://ptgm.newa.cornell.edu/) can also be used to time applications. This model predicts pollen tube growth rates from weather data. The model is initiated when the desired number of setting flowers is open and the first application is made when the model predicts those flowers have been fertilized. A second application is then made when the model predicts ~50% pollen tube growth of subsequent developing models.

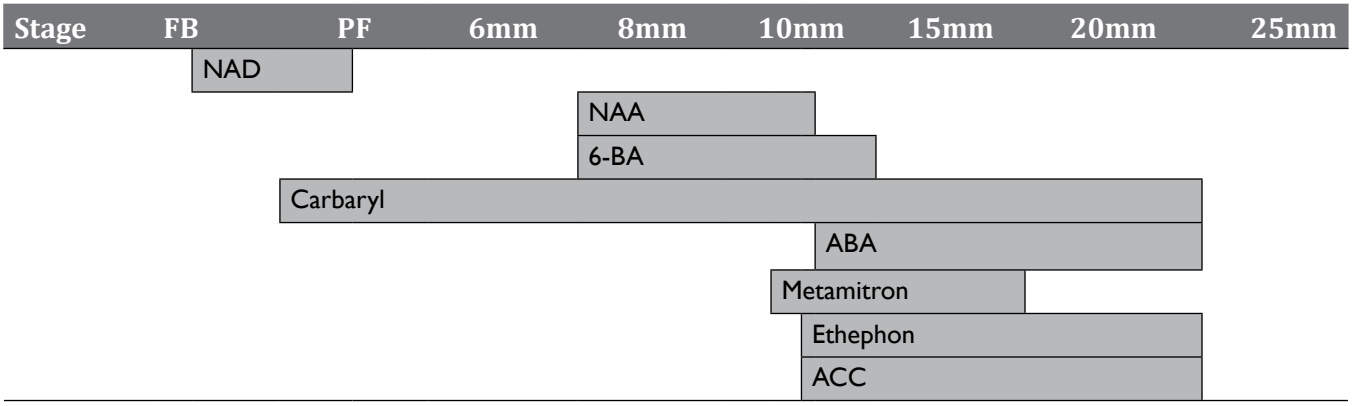
Lime sulfur is the most widely used blossom thinner, it thins by inhibiting pollen tube growth and reducing photosynthesis. When applied alone, the recommended rate of lime sulfur ranges from 4 to 10% v/v. Adding oil (2% v/v fish oil, 1% v/v dormant petroleum oil, or 1-1.5% v/v summer oil) lowers recommended rate of lime sulfur to 1.5 to 2%. As a caustic chemistry, phytotoxicity is a concern and is more likely when temperatures at application are greater than 85°F or when drying conditions are slow. Effects of lime sulfur are visible by petal fall where actively growing fruit can be distinguished from non-fertilized flowers. This is a good time to asses the level of post-bloom thinning needed.

Post-Bloom Thinning

There are a number of PGR-based materials available for post-bloom fruit thinning. The best material to use will depend on the cultivar, the condition of the trees, and time of application

- **ABA** (ProTone) is a natural plant hormone.
- **ACC** (Accede) is a natural precursor that stimulates the release of ethylene within the plant.
- **Carbaryl** (Sevin) is an insecticide that has thinning action.
- **Benzyladenine** (MaxCel, Exilis 9.5 SC, RiteWay) contains a synthetic analog of the cytokinin plant hormone.
- **Ethephon** (Ethephon 2SL, Verve, motivate 2L) releases ethylene.
- **Metamitron** (Brevis SC) is a photosynthetic inhibitor
- **Naphthalene acetic acid** (NAA; Fruitone L, Fruitine N, PoMaxa, Refine 3.5L and Refine 3.5 WSG) is a synthetic auxin growth regulator.
- **Naphthalene acetamide** (NAD, Amid-thin) is also a synthetic auxin growth regulator.

Timing of these chemistries varies and are associated with fruit size Since fruit diameter tends to vary with time of day, measure the fruit at the same time each day beginning at petal fall to determine optimum timing. See table on previous page. In a semi-arid climate, a non-ionic surfactant is recommended



Post bloom thinning period by growth stage and days after bloom. Approximate growth stage for when each chemistry is most effective is given. FB = Full Bloom; PF = Petal Fall. Figure adapted from Schwallier (1996).

with most of these chemistries. Under conditions where there is a risk of overthinning, not including a surfactant can lower efficacy and result in a desirable thinning response.

Effect of Weather on Thinning Agents

A growing amount of evidence suggests that PGRs sensitivity is related to the carbohydrate balance of the tree, as many act to temporarily inhibit photosynthesis. Carbohydrate balance is related to photosynthesis (supply) and respiration associated with plant growth (demand). Conditions that increase photosynthesis (sunny days) or that decrease respiration (cool nights) increase carbohydrates status. Conversely, low photosynthesis and/or high respiration lead to carbohydrate deficits. Trees with an excess of carbohydrates are much harder to thin than those with a carbohydrate deficit. The MaluSim model (newa.cornell.edu/apple-carbohydrate-thinning/) is an online tool available to predict tree carbohydrate status based on projected crop load (% of flowering spurs), stage of development (days after bloom) and on weather conditions (max and min temperature and light levels). Select the closest weather station to your orchard (only Utah and Idaho

Characteristics of Products for Thinning Apples

Rate	Timing	Effectiveness	Compatibility	Notes
ABA (ProTone)				
100 to 500 ppm in 100 gal/acre	1 or 2 applications 7 to 10 days apart, between 12 and 20 mm king fruit diameter	Mild thinner	Works synergistically with other thinning compounds	Organic option. Best if followed by 2-3 days of overcast conditions with temperatures in the mid-70s.
ACC (Accede)				
200 to 400 ppm in 100 gal/acre	From full bloom to 25 mm king fruit diameter. Most active at 15 to 20 mm.	Effective as a late thinner		Apply in cool conditions. Don't use on injured or stressed plants
CARBARYL (SEVIN XLR)				
1 to 2 pints per 100 gallons of water	Within 28 days after petal fall If cool weather persists, instead apply when king fruits are 10-15 mm in diameter	Effective as a mix-partner with 6-BA, NAA, or ethephon	NAA or NAD will improve results Can also be mixed with BA	May harm bees or beneficial insects; use the XLR formulation, lowest rate, and apply in evening, after petal fall.
BENZYLADENINE (MaxCel, Exilis 9.5 SC, RiteWay)				
75-200 ppm	When king fruits are 7-14 mm in diameter (generally 7-21 days after full bloom)	Use at 70-75°F for peak effectiveness	Works best in combination with Sevin	High temperatures within 8 hr of application will increase thinning. Apply at night for greatest drying time. Particularly beneficial for small fruited cultivars ('Gala'). More effective at cooler temperatures than NAA
ETHEPHON (Ethrel, Verve)				
50 to 150 ppm	Most effective as a late thinner (greater than 17 to 22 mm fruit diameter)	Higher rates for difficult to thin varieties	Can be mixed with carbaryl.	Promotes return bloom beyond the thinning effect. Golden Delicious and Rome are particularly sensitive. Do not apply when temps exceed 85°F

Table continues on next page

stations are currently available), enter a bloom date and estimated bloom density. The tool will then calculate current and forecasted carbohydrate status based on past and predicted weather conditions and make a recommendation for rate of PGR thinner.

Thinning Stone Fruit with PGRs

Accede is labelled for blossom thinning of peaches, nectarines, apricots, sweet/tart cherry, plum, plumcot, and prune from pink bud stage to petal fall. Accede has a direct thinning mechanism by activating break down of the abscission zone at the base of the flower. Therefore, delivering this chemistry to the abscission zone is critical to its efficacy. Labelled rates of Accede for peach/nectarine is 10 to 20 oz. per 100 gal. water (300 to 600 ppm). For apricot, sweet/tart cherry, plum, plumcot and prune the lower range of rate of lowered to 3.35 oz (3.35 to 20 oz per 100 gal.). Testing in Utah for blossom thinning peaches has found that earlier applications (first bloom compared to petal fall) and conditions that lengthen dry time after application (increasing water volume) have increased efficacy.

Application of some mildly caustic materials during full to late bloom has been used successfully in the past to reduce fruit set in both apples and stone fruits. Examples of these are ammonium thiosulfate (ATS), a foliar fertilizer; and lime sulfur, a fungicide. The mode of action is to allow pollination to occur on early blossoms and then damage the later blossoms with the caustic material, preventing further pollination.

Characteristics of Products for Thinning Apples, continued

Rate	Timing	Effectiveness	Compatibility	Notes
NAPHTHALENE ACETIC ACID (NAA; Fruitone L, Fruitine N, PoMaxa, Refine 3.5L and Refine 3.5 WSG)*				
5-15 ppm	When king fruits are 8-12 mm in diameter	Very effective and potent, use with caution Use at 70-75°F for peak effectiveness	Tank mix with carbaryl.	Use only on cultivars that mature after Sept. 1. Fruit may not size up as well as carbaryl or BA thinners, but NAA helps with return bloom.
NAPHTHALENE ACETAMIDE (NAD, Amid-thin)				
50 ppm	Between late bloom and petal fall (4-8 days after full bloom) Applications after petal fall result in poor thinning	Mild thinner	Carbaryl	For cultivars that mature before Sept. 1. On Red Delicious, it can cause excessive pygmy fruit.
METAMITRON (Brevis SC)				
16 to 48 fl. oz	Apply from 10 to 18 mm fruit diameter	At higher rate, potent thinner under carbohydrate limiting conditions	Carbaryl	Wait to apply if temperatures are forecasted to be greater than 84°F

***Additional notes on NAA**

- Weak trees and young trees are more sensitive to NAA.
- Shaded limbs tend to over thin.
- Light rain or dew within a few hours of application will increase uptake and thinning action.
- For some hard-to-thin cultivars, a combination of NAA and carbaryl will increase thinning. For this combination, the concentration of NAA should be decreased by half.
- NAA should not be combined with other PGRs such as Maxcel or Promalin. Studies with Red Delicious in Michigan indicated that applications of NAA and either Maxcel or Promalin within the same season resulted in excessive "pygmy" fruit.

Blossom thinning with these caustic materials in cold and frost-prone areas of the Intermountain West is extremely risky. Trials in Utah indicated that application of caustic bloom thinners to peaches, followed by cold but non-freezing temperatures, resulted in complete crop loss.

Using ACC (Accede) for Peach /Nectarine Thinning

Rate	Timing	Notes
Peaches/nectarines. 10 to 20 oz. in 100 gal. per acre (300 to 600 ppm). Apricot, sweet/tart cherry, plum, plumcot, prune. 3.35 to 20 oz in 100 gal. per acre.	Pink bud stage to petal fall	Limited testing on peach in Utah. Applications made earlier in bloom development and under conditions that promote slow dry time resulted in greater efficacy. Likely less phytotoxic than other blossom thinners

Manipulate Flowering with PGRs

PGRs can be used to manipulate flower development in multiple ways – lengthen flower longevity at bloom and induce or suppress flower initiation for the following year. AVG (ReTain), an ethylene biosynthesis inhibitor, has been shown to increase fruit set in a number of species, including: apple, cherry, European pear, pecan, and walnut. Greatest benefits are seen in cultivars that are prone to low fruit set. For example, in sweet cherry 'Regina' is a cultivar that consistently results in poor fruit set. Rates and timing vary slightly between species (see label for specific use), but general recommendations are to apply 1 to 2 pouches per 100 gal. water during bloom. In addition to a bloom application, in pear 1 pouch of ReTain at 10mm fruit diameter can also increase fruit set.

Application of gibberellic acid can be used in both pome and stone fruits to reduce the number of flower buds formed for the following season. GA3 (Falgro, ProGibb) has been used successfully to prevent overcropping of weak tart cherry trees, to delay fruiting in young tart cherry orchards, and to "thin" processing peaches where hand thinning and detailed pruning are not justified by the value of the crop.

As older tart cherry trees begin to decline, the natural tendency is for these trees to produce too many flower buds. If fruit are produced at lower nodes on one-year-old wood (which happens often in Montmorency), blind wood results because there are no vegetative buds to produce spurs or branches. Reducing the number of flower buds relative to vegetative buds allows for spur formation and greater long-term productivity.

In apples GA4+7 (Arrange) can be used to inhibit flower induction for the following year. This can be useful to break a biennial habit. There, GA4+7 is applied in the "off" year to avoid excessive flowering in the "on" year that makes trees challenging to adequately thin. Arrange applications are recommended to be applied from petal fall to 15 mm fruit size. A total of 256 fl. oz. (200 ppm in a 100 gal. mix) can be applied in a growing season. This can be made in a single application or split into 2 to 4 applications at 7 to 14 day intervals (depending on number of applications). As of Feb. 2026, Oregon and Washington are the only western states Arrange is registered in, but this may expand in the future.

Using Gibberellins (ProGibb, Falgro, Arrange) to Reduce Flower Bud Formation

Rate	Timing	Notes
GA3 in tart cherry. 4 – 18 grams a.i./acre Use higher rate on older trees. See label for specific rate.	2 to 4 weeks after bloom. Optimal is when 3 to 5 terminal leaves have fully expanded, or at 1 to 3 inches of shoot growth.	Similar applications can reduce flowering in non-bearing tart cherries.
GA4+7 in apple. 256 fl. oz. per 100 gal. (200 ppm) delivered in 1 to 4 applications (25 to 200 ppm per application).	Petal fall to 15 mm fruit diameter. Made in 1 to 4 applications. If multiple application, apply at 7 to 14 day intervals. 7 day intervals if using 3 or 4 applications.	Higher end of rate recommended for highly biennial cultivars.

Alternatively, PGRs can also be used to promote flowering in apple. NAA (Fruitone L, PoMaxa, Refine 3.5L, Fruitone N, and Refine WSG) and ethephon (Ethephon 2SL, Verve, Motivate 2L) can both be used to promote return bloom. This is particularly useful in highly biennial cultivars and years of heavy crop load or late thinning when there is a high risk of inadequate return bloom. Use patterns vary between NAA and ethephon, but both begin at 30 to 35 mm fruit diameter. For NAA, 4 bi-weekly sprays of 5 ppm are recommended. With ethephon 16 to 72 fl. oz. per 100 gal. per acre is recommended. Rate range is influenced by cultivar and cropload. For more annual cultivars (Gala, Red Delicious) use the lower rate range. The upper range is recommended for highly biennial cultivars (Fuji), particularly when cropload is excessive.

Managing Growth with PGRs

PGRs to manage vegetative growth can be lumped into two categories: reduction of tree vigor and induction of lateral branching.

There are many reasons to control an apple tree's vegetative vigor. Some of these reasons include:

- Overly vigorous trees take longer to prune and have more internal shading that reduces fruit coloring.
- Dense canopies require more sprays and are harder to cover adequately with pesticides.
- Trees planted too close together on overly vigorous rootstocks may also be a problem.
- Overly vigorous trees produce more succulent shoot growth. These succulent shoots are more susceptible to fire blight infection.

Prohexadione-calcium (PCA; Apogee, Kudos) is a PGR that interferes with the production of gibberellins in the plant. Gibberellins are plant hormones involved in shoot elongation. Inhibiting gibberellin production resulting in smaller cells and consequently decreased shoot growth. The effect of a single application of Apogee lasts only 2 to 3 weeks, depending on the inherent vigor of the tree and the time of the season. Once PCA has been applied to an orchard block, repeat applications at 2-week intervals are typically required until the season of maximum shoot growth has passed. When a repeat application is missed, there may be a "rebound" period when shoot growth resumes at a rate that appears to exceed that of untreated trees. In testing in Utah, 4 applications of 12 oz. PCA was found to effectively manage vigor in a non-bearing 'Honeycrisp' block that was otherwise exhibiting excessive vigor.

A beneficial effect of PCA is that trees are less susceptible to fire blight. While the number of infections does not appear to be affected, the rate at which the infections spread is reduced so that pruning out fire blight strikes in susceptible cultivars becomes more practical. See table below.

Using Prohexadione-calcium (Apogee, Kudos) to Control Apple Tree Vigor

Rate	Timing	Notes
INITIAL APPLICATION		Do not use more than 48 oz per acre in a 21-day period, or 99 oz per acre per season. Adjust water and product according to tree row volume.
18-36 oz per acre	1-3 inches of new growth.	
REPEAT APPLICATIONS		
9-24 oz per acre	Every 2-3 weeks until maximum shoot growth has passed.	

Inadequate lateral branching early in the development of an orchard can lead to "blind" wood along the trunk that lowers productivity in later years. Cytokinin (MaxCel, RiteWay, Excilis 9.5SC) alone or in combination with Gibberellins (perlan and promalin) are used to induce lateral branching in apples, non-bearing pears and sweet cherries. Multiple application methods are available: foliar, suspension in interior latex paint, or direct application to notched wood; rate will vary with method and species (refer to label for specific situations). Generally, rates are higher when carried in latex paint than applied as a foliar spray. Latex applications happen earliest in the spring when terminal buds begin to swell but before bud break. Mix recommended rate of product per volume latex paint and apply with brush or sponge to targeted area. On three-year-old or older wood notching directly above a dormant bud followed by application of a 6-BA product can promote branching. Best results are seen

when this is done on a warm spring day. When this is done after bud break care should be made to not apply solution to green tissue. Notching does pose a risk to open up the tree to fire blight and bacterial canker infections, so allow for wound healing or preventative steps before an infection event. Foliar applications happen the latest when 1 to 3" of new growth has developed.

Improve Apple Fruit Quality with PGRs

Preventing Fruit Russet

Fruit russet is a particularly common problem in Golden Delicious. It is typically caused by the presence of water on the fruit surface during the first 45 days of fruit development. High relative humidity, dew or rain, light frosts, and reaction to some pesticides may also cause russeting. Multiple applications of gibberellic acid (GA4+7) during the 45-day period after bloom has been shown to reduce fruit russeting. See table below.

Using GA_{4+7} (ProVide, NovaGibb) to Prevent Apple Fruit Russet

Rate	Timing	Notes
10-13 oz/100 gal	Start at late bloom or petal fall Repeat every 7-10 days for a total of 4 applications	Do not exceed 40 oz/acre in one season Can be mixed with pesticides Cannot be mixed with nutrient sprays or spreader-stickers Do not apply through irrigation

Improving Fruit Shape

A combination of benzyladenine (BA) and gibberellic acid (GA_{4+7}) is sold as Promalin or Perlan and can be used to increase fruit size and "typiness" (fruit length) of lobed apple varieties such as Delicious. Reports from Michigan and other eastern regions have shown a negative interaction between Promalin application and subsequent NAA thinning applications. However, this has not been as big of a problem in the West. See next table.

Use of BA and GA_{4+7} formulations to Improve Apple Fruit Shape

Rate of Promalin	Timing	Notes
SINGLE APPLICATION		Do not exceed 2 pints per acre in one season.
1-2 pints/ acre	Early king bloom to early petal fall.	
SPLIT APPLICATIONS		
½-1 pint/ acre	Apply first spray at start of king bloom. Apply second spray when remaining side blooms have opened.	

Managing Fruit Maturity and Abscission with PGRs

Controlling when fruits mature allows more efficient use of labor and other resources and prolongs the harvest season. For example, PGR applications could advance fruit maturity in one portion of a block, and delay maturity and improve storability in another.

Hastening Fruit Maturity

Apple

Ethephon applications will advance apple maturity by 3 to 5 days under favorable weather conditions. This product will also shorten the storage life of treated fruit, so avoid using it on any apples intended for long-term storage.

Ethephon also improves the color of red-skinned apples. Fruit requires cool nighttime temperatures and direct exposure to light for color development, even when ethephon has been applied. Proper training and pruning is critical to allow good light distribution within the canopy. Cultivars and strains that color poorly may not respond adequately to ethephon application. Do not use ethephon on yellow or green-skinned cultivars to advance fruit maturity. See the table above for rates and other information.

Tart Cherry

In tart cherries, ethephon speeds the process of fruit abscission (fruit drop). This allows for a synchronization of fruit drop for mechanical

harvesting. It also speeds the ripening and subsequent breakdown of cherry fruit and may contribute to more rapid softening. However, the fruit must be at or beyond the "straw" color before they will respond to ethephon. Green fruit have not yet developed the physiological ability to respond to ethephon.

Because daytime temperatures in the Intermountain West routinely exceed 85°F in the weeks leading up to tart cherry harvest, growers often reduce the rate by half, which seems to give the beneficial effect of synchronized fruit abscission but lessens the risk of harmful side effects. All of the fruit should be at the straw color before ethephon application. See the table below for rates and other information.

Apple Harvest Management

Some apple cultivars, particularly early ones, are susceptible to pre-harvest fruit drop. Most susceptible cultivars respond to a dilute application of NAA. Compared to other options, NAA works quickly to reduce preharvest drop (2 to 3 days after application) and can be applied closer to harvest with a 2 day PHI. 10 ppm NAA is generally considered an effective rate for drop control. Multiple applications can control drop for 10 to 14 days from the first application. However, NAA will not delay fruit maturity and when applied above 85°F may promote fruit softening. AVG (ReTain) blocks the formation of ethylene by plants and can be used to delay maturity and to hold fruit on the tree. Timing is critical as AVG acts by preventing the natural abscission process from beginning. However, if this process has already started, AVG applications are not effective. ReTain comes as a water-soluble pouch (1 pouch = 132 ppm). It can be applied 1 to 4 weeks before anticipated harvest at a rate of 1 to 2 pouch. Timing and rate will vary based on goal of application. For single-pick cultivars 1 to 2 pouches 3-to-4-weeks before harvest will delay harvest by 7 to 10 days. For managing multiple harvests, 1 pouch 1 to 2 weeks before anticipated harvest can shift the bulk of mature fruit to later harvests. Beyond fruit maturity, AVG can reduce stem end splitting in sensitive cultivars ('Gala', 'Honeycrisp'). In Utah, testing has shown that higher rates (1 compared to 0.5 pouch) closer to harvest are more effective at controlling stem end splitting. Delaying maturity with AVG can delay red coloration and promote further fruit growth. Use at least 100 gallons per acre and spray both sides of the row (no alternate row applications) to ensure good coverage. An organosilicone surfactant at 0.05 to 0.1% has been found to be the most effective at increasing uptake of AVG. PHI is 7 days.

Using Ethephon to Manage Fruit Maturity

Rate	Timing	Temperature	Notes
APPLE			
1/3 - 2/3 pint/100 gal to promote color development Mix with 10 ppm NAA/100 gal to slow abscission and fruit drop	15 to 20 days before anticipated harvest	Day: 75-85°F Night: 55-65°F Color development of fruit will not be enhanced when daytime temperatures above 90°F and night temperatures above 70°F	Select blocks for treatment that can be picked and packed over a period of 3 days Treat each selected block 2 to 3 days apart
CHERRY			
1/3-½ pint/acre in a dilute spray to synchronize fruit abscission (drop) for mechanical harvest	2 to 3 weeks before harvest	See apples, above At full rate, temperatures above 85°F increases fruit drop, and can cause gummosis	Fruit must be at or beyond "straw" color Do not apply to weak or stressed trees Rate provided is less than labeled rate to minimize risks from higher temperatures

1-MCP (Harvista) acts by blocking ethylene response and can be used to both reduce preharvest drop and improve post-harvest shelf life. An in-line injector is needed to introduce the product to the spray solution just before application. Application timing is based on starch degradation patterns and will vary based on cultivar. Contact the manufacturer for more information.

Delaying Sweet Cherry Fruit Maturity

Applications of gibberellic acid (GA3) can be used to extend the harvest season of sweet cherries. GA3 (ProGibb, Falgro) applied when fruit is translucent green to straw color at 16 to 48 grams a.i. per acre delays maturity by 5 to 7 days. The result is larger, firmer fruit with bright green stems and a longer storage life. GA3 also slows color and sugar accumulation, resulting in brighter color at harvest but lower soluble solids.

Conclusion

PGRs can be a useful aid in managing orchards, but require careful timing, mixing and application. Sloppy techniques will give disappointing results and will waste time and money. With careful record keeping, it will be possible to track from year to year which rates, materials and environmental conditions produce acceptable results on each cultivar.

Using NAA, AVG, or 1-MCP to Prevent Fruit Drop

Rate	Timing	Notes
NAA		
10-20 ppm Do not apply as a low volume concentrate spray	No earlier than 7 to 14 days before anticipated harvest To prevent drop, repeat application no less than 7 days later	Two applications max May cause fruit splitting on early season cultivars NAA will shorten the storage life of fruit
AVG (RETAIN)		
1 to 2 pouches per acre, dilute spray	21 to 28 days prior to anticipated start of harvest for single application	May be a split application (one pouch per application) with the first at 28 days before harvest, and the second 7 to 14 days later.
1-MCP (HARVISTA)		
48 to 242 oz. per acre, maximum of 242 oz per acre per season	21 to 28 days prior to anticipated start of harvest for single application	3 to 21 days prior to anticipated harvest

CHAPTER 11 NUTRITION

Proper fertility management is necessary to maintain fruit tree productivity, maximize the quality and health benefits of the fruit, and optimize the profits for the producer and processor. Soils of the arid Intermountain West are often characterized as calcareous, low in organic matter and high in salts. This can result in micronutrient deficiencies as well as poor nutrient cycling and uptake requiring orchardists to provide nutrients to promote healthy growth and yields. Regular soil and foliar nutrient testing to monitor for excesses or deficiencies can provide growers with a roadmap for orchard nutrition and should guide fertilizer inputs in addition to visual observations of tree growth and yields. Before applying any fertilizer, however, growers should also consider any potential barriers to uptake due to poor soil conditions including high or low soil moisture, temperature and compaction resulting in limited root growth and nutrient uptake (Dupont, et al. 2020). For more information on soil health, promoting healthy roots and soil biota's role in nutrient cycling visit WSU Tree Fruit Soil & Nutrition: treefruit.wsu.edu/orchard-management/soils-nutrition/.

Soil and Leaf Analyses

Soil analyses are useful for determining mineral nutrient availability in soil before orchard establishment. For existing orchards, a soil test every three years provides useful information for interpreting leaf analysis results and modifying fertilization programs. For example, if soil test indicate sufficient levels of a given nutrient that is deficient in foliar tests, this would suggest that poor nutrient uptake by the trees is the issue and could be due to poor root growth or soil pH.

Leaf analysis indicates the concentration of nutrients that are actually present in the tree foliage. If leaf samples are taken correctly and the results are interpreted properly, they provide a good tool for developing an effective fertilization program.

Leaf samples should be collected about 60 to 70 days after petal fall and after terminal buds have set, which generally corresponds to late July or early August. Undamaged leaves about twelve nodes downward from the terminal end of shoots will provide the most representative sample. Each sample should consist of about 100 leaves collected from several trees in the sample area. Do not mix leaves from different varieties, soil conditions, tree vigor, or crop load. Record observations on terminal shoot length, thickness, crop load, and fruit size, because these will enable meaningful interpretation of the observed nutrient concentrations in tree leaves. Choose a trusted lab with experience analyzing foliar samples from tree fruits and follow their instructions for preparing and sending samples.

Standard adequacy ranges for foliar nutrient contents.

Nutrient	Crop	Desired Level
Nitrogen	Young pome fruits	2.4 - 2.6%
	Mature pome fruits	1.8 - 2.6%
	Cherries, plum, prune	2.2 - 3.4%
	Peach, apricot, nectarine	2.5 - 3.5%
Phosphorus	All crops	0.1 - 0.5%
Potassium	All crops	1.4 - 1.8%
Calcium	All crops	1.3 - 2.0%
Magnesium	Pome fruits	0.4 - 0.5%
	Stone fruits	0.4 - 0.6%
Boron	Pome fruits	35 - 50 ppm
	Stone fruits	30 - 40 ppm
Zinc	All crops	30 - 50 ppm
Copper	All crops	7 - 12 ppm
Manganese	All crops	50 - 150 ppm
Iron	All crops	50+ ppm

Macronutrients: N, P, K

Fruit trees need to maintain an appropriate balance between vegetative growth and fruit growth. Too much vegetative growth may reduce fruit set and yield the following year and increases pruning labor. This balance is partially influenced by the availability of nitrogen (N), phosphorus (P), and potassium (K). Nitrogen, P, and K are used by plants for structure, nutrient transport, and movement of water, which are among

many other important functions. A lack of macro-nutrients or a nutrient imbalance may result in decreases in both vegetative growth as well as fruit yield. Also, fruit ripening and quality can be negatively affected when nutrient deficiencies are present. Generally, leaf tissue nutrient content is a good basis for determining plant needs.

Nitrogen (N)

Nitrogen deficiency can be detected visually. Trees will have little to no new shoot growth. Deficient leaves are pale green to yellow. Symptoms first appear in older leaves because N moves from older tissue into actively growing younger leaves. Leaves from deficient trees tend to drop earlier in the fall. Fruit set might be light, and mature fruits can be smaller and mature somewhat earlier than usual.

Sufficient annual vegetative growth ranges of important fruits. Growth ranges for trees are measured in inches.

Tree Fruit	Young Tree	Mature Tree
Apple	10 – 20	4 – 10
Pear	20 – 30	12 – 18
Peach	10 – 24	8 – 15
Cherry	10 – 20	8 – 15

Excess nitrogen can also cause problems. Fruit will color poorly and lose firmness in storage. Leaves will remain dark green into fall, and leaf drop will be delayed. As a result, the tree's process of entering winter dormancy will also be delayed, increasing susceptibility to possible winter injury. Fire blight, a common disease in the Intermountain West, spreads faster in vigorous growth.

Nitrogen applications are ideally applied in spring. Summer applications should be made at least six weeks prior to fruit ripening to ensure optimum fruit quality at harvest. Typical nitrogen needs are between 0.01 to 0.04 lbs N per tree, per year of age with an annual limit of 0.3 lbs N per tree. The amount that needs to be applied to reach this range will depend on soil texture, soil organic matter content, and leaf tissue content at the start of the growing season, among other indicators. Vegetative growth is the primary indicator for nitrogen requirements. Depending on the crop, new growth in younger trees should be between 10 and 30 inches per year, and in older trees it should be 4 to 18 inches. However, vegetative growth can also be limited by water so growers should consider irrigation management when evaluating nitrogen status in terms of vegetative growth.

Phosphorus (P)

The level of phosphorus and potassium in the soil does not change as rapidly as that of nitrogen, so their management is monitored more effectively by soil testing (at a depth of 1 foot and 2 feet, within the tree row) and periodic tissue sampling.

Phosphorus is critical to root growth and function and the proper cycling of energy in the plant. Phosphorus deficiency affects older leaves first, turning them small and bluish green on the margins. Other symptoms might include reduced flowering, a decrease in fruit quality, and delayed fruit maturity. Excess phosphorus can cause imbalances in the uptake of zinc and iron.

Phosphorus is not very mobile in the soil, so it should be applied within the root zone before planting a new orchard, or during renovation of orchard sections. Mid-season adjustment of phosphorus levels in soils is generally not practical, so providing adequate levels at the beginning of the season is the best strategy for management. When soil phosphorus is low annual adjustment of phosphorus nutrition is recommended to maintain sufficient levels in soil. Foliar sampling should be performed regularly to make sure adjustments are adequate.

Potassium (K)

Potassium is critical in the water relations of plants and in the assimilation and cell-to-cell transfer of other nutrients, particularly calcium, which is important for fruit quality, particularly in pome fruits. Levels of potassium in Intermountain West soils are regulated by the weathering of clay minerals and are generally sufficient without fertilizer application. However, on sandy or gravelly soils low in clay content, potassium deficiencies may be expressed by calcium or other micronutrient imbalances in the plant. The primary deficiency symptom is yellowing and bronzing of

the margins of older leaves. In-season adjustment of potassium nutrition is possible with foliar sprays of potassium chloride or potassium sulfate solutions, or injection of these materials into the irrigation water.

Micronutrients

Tree deficiencies of zinc, iron, copper, manganese, calcium, magnesium, and boron are common in high pH soils (pH>7.7) of the Intermountain West. These nutrients, with the exception of Zn, can be successfully corrected with soil amendments and temporarily with foliar applications. Zinc is often tightly bound in the soil and is best corrected through foliar sprays using either zinc sulfate or chelated zinc. Fruit trees showing severe deficiency symptoms may respond temporarily to some of these other nutrients applied as sprays. However, these sprays should only be used in conjunction with soil applications of the same nutrient. The sprays will provide temporary relief until the soil-applied nutrient can be translocated throughout the tree.

Chronic micro-nutrient deficiencies, typical on peaches on alkaline soils, can most times be corrected by reducing the soil pH through acidification of irrigation water and/or application of elemental sulfur to the soil. Adjusting soil pH, however, can be costly and difficult especially in soils with a high buffer capacity, indicated by high levels of calcium. Soil application of chelated micro-nutrients can correct these deficiencies from 1 to 3 years depending on soil pH. Several areas of Intermountain West soils are typically deficient in boron regardless of soil pH.

CAUTION: In particular for trace elements (Cu, Zn, Mn and B) growers should be careful to not over apply these nutrients as they can be phytotoxic in excess. Nutrient sprays can cause phytotoxic injury to foliage and tree if not applied correctly in the correct amounts and at the right time. To avoid potential injury, verify the nutrient deficiency through tissue analyses or visual observations. Use caution when using a concentrate sprayer because of potential injury. Avoid fertigation to reduce risk of phytotoxicity if there is a leak in the system. Some (like zinc sulfate) can cause tree injury if applied within 3-5 days of an application of oil. Others (like Leffingwell products) may be generally compatible with most fungicides and insecticides if the pH of the spray mixture is adjusted so that it remains close to neutral (pH 6-7).

Boron

Boron is critical to pollination, fruit formation and shoot growth. Deficiency often presents as blossom blast, shoot die back, dwarfed leaves and deformed fruit. It can also mask symptoms of Zn deficiency. Leaf analysis results show some boron deficiencies in peaches and apples. However, pears are the fruit crop that most often shows boron deficiency including "blossom blast" or wilting of the flower buds in early spring. Boron deficiency is common in Intermountain West soils and trees.

Boron deficiency can be corrected through soil and foliar applications until deficiencies are corrected. Boron should be soil applied (2-5lbs/acre) in fall on heavier soils or in spring on coarser soils as it is very mobile in the soil and can easily leach. A single maintenance spray, applied each year at a low rate (0.5-1lb/100 gal), should supply enough boron to prevent the development of a deficiency when soil levels are sufficient. While the spray may be applied at any time, fall applications when leaves are still green or spring pre-bloom applications are recommended. Proper calibration of equipment is important when applying boron as the range between deficiency and toxicity is very small, risking over application. Monitor boron levels with foliar and soil testing to prevent over application and adjust rates accordingly.

Calcium

Calcium is vital to cell wall development and hence fruit quality and storability and can cause bitter pit and corking especially in certain cultivars of apple like Honeycrisp. Despite often high levels of calcium in soil, uptake and allocation of calcium within the plant and fruit may still be inadequate. For example, in a survey of Montana orchards calcium levels in the soil were high in 61% of orchards, but 73% of orchards still demonstrated low foliar calcium. Several factors affect Ca uptake and partitioning in the plant including root health, spring soil temperatures, interactions with other nutrients, crop load, tree vigor and irrigation.

Foliar sampling and physical evaluation of fruit should be used to determine if Ca fertilizers should be applied

in conjunction with addressing other potential barriers to uptake. Under average conditions, three sprays are suggested, and up to twelve when deficiency symptoms are severe. Calcium chloride is the most effective and inexpensive option for both conventional and organic growers. Rates of 2-4lbs/acre calcium chloride are recommended per acre for a total application of 15-50lbs/acre depending on orchard needs. The first spray should be applied about one week after petal fall (mid-June). Subsequent sprays should be applied through mid-August and spaced according to total number of sprays needed to meet desired application rate. Young and very vigorous trees or trees with large fruit which have a history of serious bitter pit, may require more sprays than older trees or cultivars less prone to storage issues. The more severe the history of bitter-pit, the more frequently calcium should be applied, however, growers should keep in mind other factors influencing Ca uptake and address those as well.

Magnesium (Mg)

Magnesium deficiency is observed as interveinal chlorosis in leaves. Most soils contain sufficient amounts of Mg and issues with uptake are either due to competition with K and Ca limiting uptake or saturated soils. If foliar samples indicate Mg is deficient, but soil tests show adequate levels, address irrigation or soil nutrient issues and apply foliar Mg in the form of Epsom salts to temporarily address Mg needs. If soil supply is low, use soil tests to inform application rates.

Manganese

Yellow leaves, with green veins and mid-ribs are symptoms of manganese deficiency. Manganese deficiencies are especially common in arid climates with high pH soils. Peach orchards located on highly alkaline soils are especially susceptible. This deficiency is often masked by zinc and iron deficiencies, the latter of which has similar symptoms. While it may not be visually detectable, a tissue analysis will identify the deficiency. The deficiency also can be induced by applying excessive amounts of iron chelate. Usually one foliar application of manganese sulfate at the labeled rate, applied when the first leaves are fully expanded, is sufficient to maintain an adequate level of manganese in the leaves.

Iron

Iron deficiency is usually indicated by pale, yellow or nearly white leaves and green veins. This symptom is referred to as chlorosis and often appears early in the season on new growth. Chlorosis can be caused by a variety of factors including poor root growth, cold wet spring soils, high soil pH, water high in bicarbonates and poorly drained or compacted soils.

Iron sulfate is not readily take up by trees, however, iron chelates usually give temporary correction of chlorosis. Peach trees tend to be less responsive than other fruits to iron amendments. Soil and foliar sprays of chelated iron can provide temporary relief but quickly become unavailable to plants. Iron chlorosis will persist if the cause is related to irrigation or soil physical properties. These issues should be addressed alongside applying fertilizers. While soil pH is difficult to change in calcareous soils common to the Intermountain West, using acid fertilizers containing sulfur, allowing soil to dry out between irrigation events and reducing compaction will improve iron uptake.

Zinc

Zinc deficiency symptoms are common in the Intermountain West and present as blind wood, stunted growth or little leaf syndrome. Soil applications of zinc have not proven effective as it often binds with phosphorus or on organic matter becoming inaccessible to plants. Where zinc levels are known to be low, annual foliar spray applications should be made to avoid deficiency symptoms. Once symptoms are detected, they should be treated as soon as possible to avoid further injury. Several precautions should be taken to avoid phytotoxicity when applying zinc.

CAUTIONS:

1. Verify need by tissue analysis or visual deficiency symptoms. Zinc sprays can cause severe injury to shoots, buds, fruit, and leaves. Adjust the rate, formulation, and time of application according to the kind of fruit, the season of the year, and the amount of zinc required.

2. Applications made within 3 days before or after an application of oil can cause injury. Longer periods may be required during cool weather. Application of zinc sulfate spray within five days of any oil-

containing spray may damage apples and should be avoided during that time.

3. Because of the problem of multiple applications of oil to pears in the spring, it may be necessary to apply zinc in the fall instead.
4. Do not use fall applications on apricot because of potential injury.
5. When using zinc sulfate crystals, be sure all crystals are dissolved before spraying because of potential injury.
6. Zinc sulfate is highly corrosive. The spray tank, pump, lines, and nozzles should be thoroughly rinsed and flushed after using.
7. Foliar application during or followed by damp weather may result in spray injury on some varieties of stone fruits.

Dormant Application: Higher rates of zinc can be applied in the spring before the buds are open than during the growing season. Sprays are more effective and appear to cause less injury when delayed as late in the spring as possible, but before buds scales open.
Fall Application: Zinc can be applied after the trees have begun to go dormant (usually after mid October), but while the leaves still remain green and active. Fall applications are usually less effective than spring dormant applications, but the former may be needed in cases of severe deficiency. With sweet cherry, both a fall and a dormant application may be necessary

Nutrition for Organic Orchards

In organic systems, soil fertility, crop nutrient status, and groundcover management are closely linked. As specified under the National Organic Program (NOP), "Organic producers must rely upon animal manures, compost (organic matter of animal and/or plant origin that has been decomposed by microorganisms), and cover crops to supply some, if not all, of the required nutrients for healthy crops." Demonstrated deficiency must be documented and approved by certifier to apply any of foliar sprays in organic orchards. For more information, see Chapter 5 "Organic Orchard Management."

Nutrient Sprays

These recommendations serve as a guide for growers for timing sprays. Follow labeled rates and timing on all products used. Refer to product label and test for compatibility with other products before tank mixing. See Ch. 5 Organic Orchard Management for organic fertilizer sources containing NPK.

Nutrient	Use Any of the Listed Combinations	Rate Per 100 Gal (Dilute)	Rate Per Acre	Remarks
DORMANT SPRAY - Apply in spring before buds open				
Zinc maintenance	zinc sulfate 36% crystals	1.5-3 lb	6-12 lb	Check label and see precautions in this chapter.
	zinc sulfate 0.5 lb/gal LC	0.5 gal	2 gal	
	Tech-Flo Zeta Zinc 22	1-4 pt	1 qt	
Zinc deficiency	zinc sulfate 36% crystals	10 lb	40 lb	Check label and see precautions in this chapter.
	zinc sulfate 1.2 lb/gal LC	3 gal	12 gal	
	Tech-Flo Zeta Zinc	1 qt	4 qt	
PRE-PINK OR PINK SPRAY				
Boron maintenance	Solubor DF	10 oz	3-4 lb	**Solubor:** see label for further details on rates and maximum levels.
	Borosol 10	8-32 fl oz	1-4 qt	
Boron deficiency	Solubor DF	1.25 lb	5 lb	**Solubor WP:** see label for further details on rates and maximum levels and precautions in this chapter.
	Borosol 10	8-32 fl oz	1-4 qt	
FOLIAGE SPRAY - After bloom and before harvest				
Boron maintenance	Solubor DF	10 oz	2.5 lb	**Solubor WP:** multiple applications at low rates are most effective; see label.
	Borosol 10	8 fl oz	1 qt	
Boron deficiency	Solubor DF	1.25 lb	5 lb	**Solubor WP:** best applied after harvest or before bloom on pears. See precautions in this chapter. Multiple applications at low rates are most effective; see label.
	Borosol 10	8-16 fl oz	1-4 qt	
Calcium (bitter-pit reduction)	calcium chloride	3-4 lb	12-16 lb	Make 3 to 5 applications as needed from mid-June to mid-August.
Iron deficiency	iron chelate	See label	See label	Follow manufacturer's directions. All chelates break down rapidly under ultra-violet (sun) light. Spray chelates in evening or on cloudy days. Check label and see precautions in this chapter.
Manganese deficiency	manganese sulfate	2 lb	8 lb	Apply as soon as leaves are well developed.
Zinc deficiency, non-bearing trees	zinc sulfate 36% crystals	1.5 lb	6-12 lb	Check label and see precautions in this chapter.
	zinc sulfate 1.2 lb/gal LC	0.5-1 gal	2-4 gal	
	Tech-flo Zeta Zinc	0.25-1 pt	1-4 pt	
Zinc deficiency, bearing trees	Tech-flo Zeta Zinc	0.25-1 pt.	1-4 pt.	Caution: certain varieties of plums, peaches, and apricots are susceptible to zinc excesses.
Magnesium deficiency	epsom salts (magnesium sulfate)	10-20 lb	40-80 lb	Apply in 3 sprays at 14 day intervals beginning at petal fall.

Nutrient Sprays, continued

Nutrient	Use Any of the Listed Combinations	Rate Per 100 Gal (Dilute)	Rate Per Acre	Remarks
POSTHARVEST - Fall application near leaf drop				
Nitrogen deficiency (apple only)	urea	0.5-2.5 lb	2-10 lb	Use only formulations containing 2% or less biuret because of injury risk to tree and fruit.
Boron maintenance	Solubor 20.5WP	0.5 lb	2.5 lb	Check label and precautions in this chapter.
	Borosol 10	8 fl. oz	1-4 qt	
Boron deficiency	Solubor 20.5WP	1 lb	5 lb	Check label and precautions in this chapter.
	Borosol 10	1-2 pt.	1-4 qt	
Copper deficiency	copper sulfate 53%	1 lb	8-15 lb	
	Kocide 101 (50%)	1 lb	4 lb	
	Kocide DF (40%)	1.2 lb	4.8 lb	
Nitrogen supplement	urea	2.5-5 lb	10-20 lb	**Apples only.** May damage other fruit crops. Apply before leaf drop.
Zinc maintenance	zinc sulfate 36%	1.5-3 lb	7-8 lb	**Not on apricots.** Check label and see precautions in this chapter.
	Tech-flo Zeta Zinc	0.25 qt	1 qt	
Zinc deficiency	zinc sulfate 36%	2.5-5 lb	10-20 lb	**Not on apricots.** Check label and see precautions in this chapter.
	Tech-flo Zeta Zinc	1 qt	4 qt	

CHAPTER 12 ORCHARD IRRIGATION

Proper irrigation is essential to maintaining a healthy and productive orchard. In nearly all areas of the Intermountain West, irrigation is required as precipitation does not provide enough water for fruit trees. Over-irrigation slows root growth, increases iron chlorosis in alkaline soils, and leaches mobile nutrients like nitrogen, sulfur, and boron out of the root zone, leading to nutrient deficiencies. Over-irrigation can also induce excessive vegetative vigor and reduce fruit size. Excessive soil moisture also provides an environment ideal for crown and collar rots.

Conversely, applying insufficient irrigation can harm tree health as well. Too little water results in drought stress and reduced fruit size and quality. Water is also needed to make nutrients available for uptake, so dry soils are often limited in available nutrients even when they are present. To insure proper irrigation, begin with selecting irrigation systems suitable to their orchards and use available irrigation scheduling tools that account for temperature, rainfall, and crop growth stage to apply irrigation based on actual crop needs.

Irrigation System Design

Irrigation system design should take into account water availability and quality, orchard slope, size and soil texture, as well as tree and rootstock selection to maximize yield, fruit quality, tree health, and water conservation. While flood and over-head irrigation may still be used in some Intermountain West orchards, these systems are less efficient, can spread diseases and often lead to overwatering. Micro and drip irrigation systems are preferred for their efficiency and versatility. With careful design they can be used in a variety of orchards. Important considerations when designing a system include filtration systems to prevent clogging, size of tubing and emitters, pressure regulation and distribution uniformity. For more specific information on designing an irrigation system for your orchard refer to CSU's bulletin, Micro-Sprinkler Irrigation for Orchards.

Irrigation Scheduling

Properly managing irrigation is analogous to managing money. In addition to knowing your current bank balance (soil water content), it is important to track both expenses (evapotranspiration) and income (rainfall and irrigation). Evapotranspiration is the amount of water used under various climate conditions at different crop growth stages to schedule irrigation. It is an important concept to understand and when properly applied provides the most accurate method of irrigating for tree needs. Several online tools and apps are available to help calculate evapotranspiration based on weather. In addition, soil moisture sensors can help growers monitor soil moisture. Other less accurate methods, such as only monitoring soil moisture by feel or using a set amount of water based on average estimated water use for a crop across the whole season, can be useful but typically result in over-irrigation or in some cases under-irrigation depending on climate, growth stage and the skills of the grower. If the later method is used, growers should adjust scheduling based on in season precipitation and fluctuating temperatures to account for changes in evapotranspiration when possible.

Understanding How Much Water is in Your Soil Bank

Bank Balance (Soil Water Content)

How big is my bank account? – Water holding capacity

- *Field Capacity* is the amount of water that can be held in the soil after excess water has percolated out due to gravity.
- *Permanent Wilting Point* is the point at which the water remaining in the soil is not available for uptake by plant roots. When the soil water content reaches this point, plants die.
- *Available Water* is the amount of water held in the soil between field capacity and permanent wilting point. (Fig. 12.1.)

- *Allowable Depletion* (readily available) is the point where plants begin to experience drought stress. For most fruit trees, the amount of allowable depletion, or the readily available water represents about 50% of the total available water in the soil. (Fig 12.2.)
- *Rooting Zone* is the soil volume that roots can access based on rootstock, cultivar, soil depth, texture, restrictive layers and management practices.

The goal of a well-managed irrigation program is to maintain soil moisture between field capacity and the allowable depletion, or in other words, to make sure that there is always readily available water.

The amount of readily available water is related to the effective rooting depth of the plant, and the water holding capacity of the soil. The effective rooting depth depends on soil conditions, variety and rootstock (rooting zone). Although tree roots can grow to several yards deep, nearly all of the roots of a mature tree are typically in the top 2 to 3 feet (Atkinson, 1980). The water holding capacity within that rooting depth is related to soil texture, with coarser soils (sands) holding less water than fine textured soils such as silts and clays (see Table 12.1.). A deep sandy loam soil at field capacity at an effective rooting depth of three feet, for example, would contain 3.6-4.5 inches of available water, half of which (1.8 to 2.25 inches) is readily available water. Assuming that the tree roots extend 3 feet out from the trunk, the rooting zone could hold 64-79 gallons of available water at field capacity.

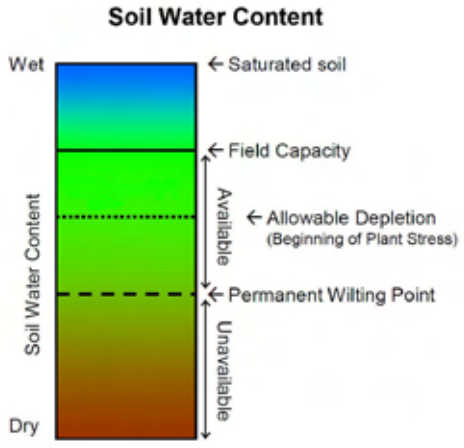


Fig. 12.1. Soil water content from saturated to dry. Optimal levels for plant growth are between field capacity and allowable depletion.

What's in the bank? -- Measuring Soil Moisture

In order to assess soil water content, one needs to monitor soil moisture at several depths, from just below the sod layer or cultivation depth (4 to 6 inches), to about 70 percent of effective rooting depth (2 feet). One of the more cost effective and reliable methods for measuring soil moisture is by electrical resistance block, such as the Watermark sensor (Irrometer Co., Riverside CA). These blocks are permanently installed in the soil, and wires from the sensors are attached to a handheld unit that measures electrical resistance. Resistance measurements are then related to soil water potential, which is an indicator of how hard the plant roots have to "pull" to obtain water from the soil. The handheld unit reports soil moisture content in centibars, where values close to zero indicate a wet soil and high values represent dry soil. The relationship between soil water potential and available water differs by soil type. The maximum range of the sensor is 200 centibars, which covers the range of allowable depletion in most soils. The sensors are less effective in coarse sandy soils,

Table 12.1. Available water holding capacity for different soil textures, in inches of water per foot of soil. Available water is the amount of water in the soil between field capacity and permanent wilting point. Readily available water is approximately 50% of available.*

Soil Texture	Available (*inch/foot*)	Readily available* (inches)	
		2 ft root depth	3 ft root depth
Sands and fine sands	0.5 - 0.75	0.5 - 0.75	0.75 - 1.13
Loamy sand	0.8 - 1.0	0.8 - 1.0	1.2 - 1.5
Sandy loam	1.2 - 1.5	1.2 - 1.5	1.8 - 2.25
Loam	1.9 - 2.0	1.9 - 2.0	2.85 - 3.0
Silt loam, silt	2.0	2.0	3.0
Silty clay loam	1.9 - 2.0	1.9 - 2.0	2.85 - 3.0
Sandy clay loam, clay loam	1.7 - 2.0	1.7 - 2.0	2.6 - 3.0

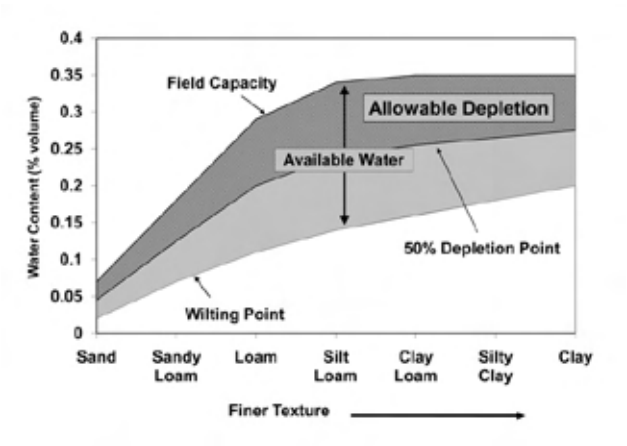


Fig. 12.2. The amount of allowable depletion, or the readily available water, represents about 50 percent of the total available water.

and will overestimate soil water potential in saline soils. Remember that allowable depletion is 50% of available water, which roughly corresponds to soil water potentials of 50 centibars for a loamy sand soil, and 90 centibars for a loam (Table 12.2, 50% depletion threshold values for each soil texture).

Growers may also estimate soil moisture by feel. This is a skill that takes some practice, but can be used to estimate soil moisture with in about 5 percent. Soil samples must be taken at various intervals in the full rooting zone of the crop based on soil texture, depth and stratification. Each sample is examined based on a set of criteria including can it form a ball, how strong is that ball, does the soil stain hands and fingers, and is water visible. For more information on using this method to estimate soil moisture visit the NRCS's guidelines for estimating soil moisture at: wcc.nrcs.usda.gov/ftpref/wntsc/waterMgt/irrigation/EstimatingSoilMoisture.pdf.

Table 12.2. Recommended Watermark sensor values at which to irrigate.

Soil Type	Sensor Reading at 50% depletion of soil water (centibars)
Loamy sand	40 - 50
Sandy loam	50 - 70
Loam	60 - 90
Silt loam, silt	70 - 90
Clay loam or clay	90 - 120

Expenses – Evapotranspiration

Water is lost from the orchard through surface runoff, deep percolation (moving below the root zone), evaporation from the soil surface, and transpiration through the leaves of the plant. Of these, the biggest losses are typically due to evaporation and transpiration, collectively known as "evapotranspiration" or ET. Deep percolation from excess irrigation can be another large loss, but is easily avoided by using available irrigation monitoring tools. Estimates of ET are based on weather data, including air temperature, sunshine, relative humidity and wind speed. Some weather stations are programmed to calculate and report the ET estimates for alfalfa as a reference crop (ETref or ETr).

Typical weekly ETr values are shown in Table 12.3. Calculated ETr can be determined by accessing weather data from a nearby weather station in Utah at: climate.usu.edu/traps, in Colorado at: coagmet.colostate.edu, or in Idaho and Montana at: usbr.gov/pn/agrimet/wyreport.

The ET of your crop can be determined by multiplying the ET_r by a correction factor or crop coefficient (K_{crop}) that is specific to your crop and its stage of development . In general, as the trees leaf out and increase the numbers of leaves in the canopy (where most water is lost by transpiration), the crop coefficient goes up.

$$ET_{crop} = ET_r \times K_{crop}$$

The K_{crop} for peach is shown in Fig. 12.3. At full bloom (Growth Stage = 0), a peach orchard is using about 20% of the amount of water used by the alfalfa reference crop. Water use increases gradually as the

Table 12.3. Typical weekly alfalfa reference evapotranspiration (ET_r) values for locations in **Utah**.

Location	May	June	July	Aug.
Logan	1.38	1.83	1.94	1.68
Ogden	1.48	1.98	2.10	1.80
Spanish Fork	1.48	1.94	2.08	1.74
Santaquin	1.47	1.92	2.03	1.67
Moab	1.63	2.08	2.19	1.87
Cedar City	1.57	1.95	2.04	1.74
St. George	1.95	2.40	2.53	2.02

Calculated from consumptive water use tables (Hill, 1994)

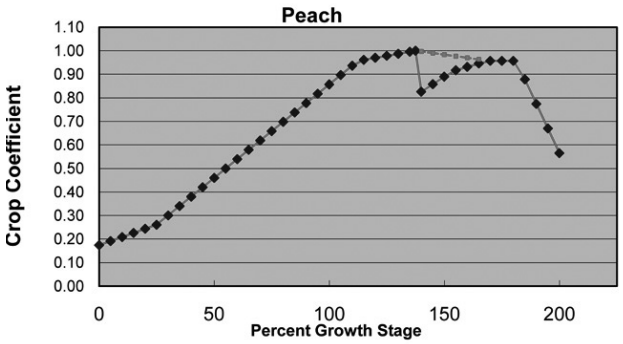


Fig. 12.3. Crop coefficients for peach, based on an alfalfa reference ET. Adapted from Johnson et al. (2000). Full bloom = 0, full canopy = 110; fruit harvest = 140; leaf drop = 200.

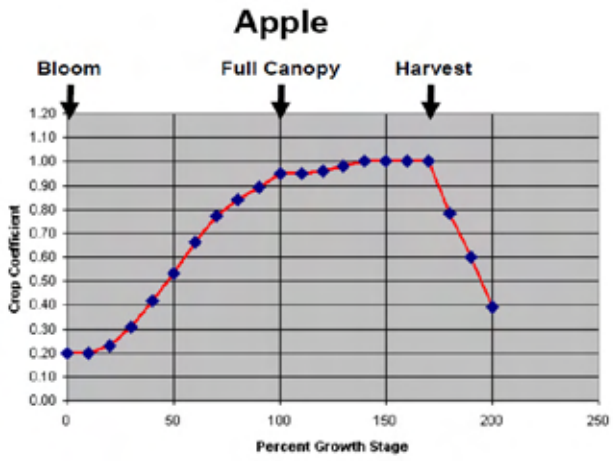


Fig. 12.4. Crop coefficients for apples, based on an alfalfa reference crop.

canopy develops until the full canopy is established (growth stage = 110) when water use is 95% of a reference alfalfa crop. Water use increases slightly during fruit ripening, then drops below 90% after fruit harvest (growth stage = 140). Water use increases again during the late season then declines during leaf senescence.

The K_{crop} for apples is shown in Fig. 12.4. At full bloom (Growth Stage = 0), an apple orchard is using about 20% of the amount of water used by the alfalfa reference crop. Water use increases dramatically until the full canopy is established (growth stage = 100) when water use is 95% of a reference alfalfa crop. Water use increases slightly during the second phase of fruit growth (mid-season to harvest) when water use is at 100% of the reference alfalfa crop. After harvest (growth stage = 170), water use quickly decreases.

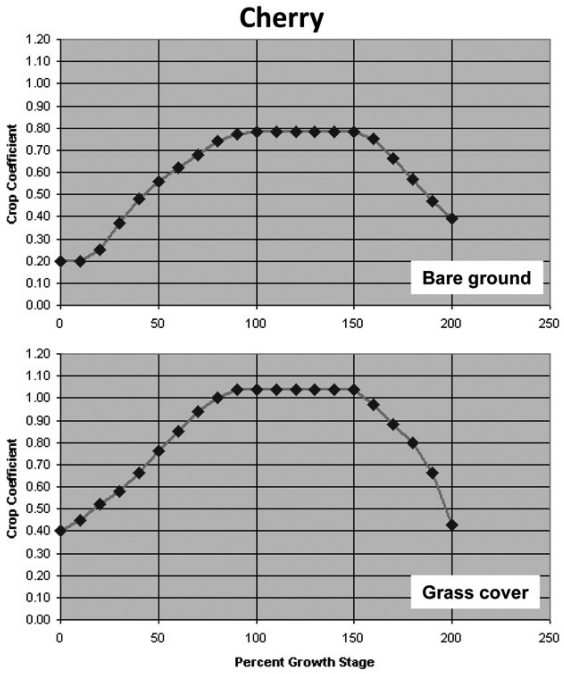


Fig. 12.5. Crop coefficients for sweet cherry with clean cultivated or grass cover row middles. (Tart cherry is similar.)

The K_{crop} for sweet cherry is shown in Fig. 12.5 and differs depending on whether or not the alleys have grass or are clean cultivated. At bud break (Growth Stage = 0), a cherry orchard with grass between rows is using about 40% of the amount of water used by the alfalfa reference crop, compared to 20% under clean cultivation. Water use increases until full bloom and fruit set (growth stage = 100) when water use is 105% of a reference alfalfa crop with grass cover and 80% without. By leaf senescence in the fall (growth stage = 200), water use has decreased to 40% of the reference crop.

Income – Irrigation and Rainfall

In the Intermountain West, rainfall contributes a small fraction of the in-season water requirements of the crop. Therefore, regular irrigation is needed to supply orchard water needs. This irrigation water can be supplied by flood, furrow, impact sprinklers, drip lines or micro-sprinklers.

Whichever irrigation system you utilize, it is important to calibrate your system so that you know precisely how much water is being applied. With sprinklers and micro-sprinklers, the simplest way to do this is to place

catch cans in multiple locations in your planting and collect water for a set period of time. The amount of water collected over time will give you an application rate (inches or gallons per hour), and differences in water collected among the catch cans will tell you how uniform the application is within your planting.

When trying to determine application uniformity, it is best to measure output at both ends of your irrigation system. Also, if your planting is on a slope, you should measure output at the highest and lowest points of your field. Elevation differences and the distance the water travels through the irrigation lines both affect water pressure, and consequently the flow rate at the nozzle. If you have trickle irrigation, you can place catch cans under the emitters and determine flow rate for each emitter. Flow rate from each emitter and emitter spacing can be used to calculate rate per area.

The efficiency of your system is a measure of how much you have to over water the wettest spots in the orchard to get adequate water to the dry spots. Efficiency is related to the uniformity of application and to the amount of evaporation that occurs before the water can move into the soil. A well-designed micro-sprinkler or drip system can be 70 to 90% efficient. Overhead sprinkler systems are typically 60 to 75% efficient, while flood and furrow irrigation is typically 30 to 50% efficient.

Tools: Several apps that estimate water use and help schedule irrigation have been developed that will run on a smartphone, tablet, or laptop. Washington State University's Irrigation Scheduler Mobile (Peters and Hill) is designed for orchards and is simple and user-friendly. It connects to networks in ID, MT, CO, and WY among other Western states. The app (with an account) can be accessed at weather.wsu.edu.

Case Study

Following is an example of how to calculate water needs for a mature peach orchard just prior to fruit harvest. The orchard is on a deep sandy loam soil with row middles planted to grass cover.

Water use (Expenses)

- ET_r values are 2.10 inches per week (weather station data).
- Crop coefficient is 0.98 (Growth stage = 130, from Figure 12.3).
- $ET_{crop} = ET_r \times K_{crop}$
- ET_{crop} = 2.10 inches/week × 0.98 = 2.06 inches/week

Soil storage capacity (potential bank balance)

- The total storage capacity for readily available water over the 2 foot effective rooting depth is 1.5 inches (Sandy Loam Soil, Table 12.1).
- 1.5 inches ÷ 2.06 inches per week = 0.73 weeks or 5.1 days between irrigations.
- Restated, soil moisture in the root zone will go from capacity to plant stress levels in 5.1 days. To recharge the soil profile, you will need to add 1.5 inches of water.

Irrigation efficiency

- To apply the necessary volume of water you must factor in your system's efficiency. For drip systems efficiency is assumed to be 95%, less for other types of systems. Using the example above you need to apply 1.6 inches of water per application. For micro-sprinklers with an efficiency closer to 80% you would apply 1.9 inches (i.e. 1.5 inches divided by 0.8).

Irrigation duration

- To determine the duration of an irrigation event you need to know the application rate of your system. You can determine the application rate for your specific system using online calculators such as WSU Irrigation Calculator. The calculator uses the emitter flow rate, distance between emitters and lines to determine the application rate of your system. Using the provided example, if the application rate is determined to be 0.262 in/hr you would need to run your irrigation system for 6.1 hours to apply 1.6 inches of water.

While this example uses a sandy loam soil, storage capacity will decrease in sandier soils. The result is less storage capacity and the need for more frequent, shorter duration, irrigation sessions. Conversely, in heavier soils, irrigation frequency will decrease, but growers should monitor for adequate water infiltration and adjust irrigation sessions to avoid surface pooling of water.

Summary

Good irrigation management requires:

1. An understanding of the soil-plant-water relationship.
2. A properly designed and maintained irrigation system, and a knowledge of the efficiency of the system.
3. Proper timing based on:
   a. Soil water holding capacity.
   b. Weather and its effects on crop demand.
   c. Stage of crop growth.

Each of these components requires a commitment to proper management. Proper irrigation management will provide the most efficient use of water, and will optimize orchard yields in balance with long term orchard health and productivity.

Additional Resources

AgriMet Crop Coefficients, Pacific Northwest Regional office of the Bureau of Reclamation, U.S. Department of the Interior.

Atkinson, D. 1980. The distribution and effectiveness of the roots of tree crops. Horticultural Reviews 2:424-490.

Faust, M. 1989. Physiology of Temperate Zone Fruit Trees. Wiley and Sons, New York.

Irrigation Scheduling Techniques. Water Conservation Fact sheet. No. 577.100-1. British Columbia Ministry of Agriculture and Food. March 1997.

Johnson, R.S., J. Ayars, T. Trout, R. Mead and C. Phene. 2000. Crop coefficients for mature peach trees are well correlated with midday canopy light interception. Acta Hort. 557:455-460.

CHAPTER 13 COLD EFFECTS ON FRUIT and BUD PHENOLOGY

Freeze/frost events can damage fruit buds and young fruit. The level of damage is directly related to cold intensity and duration as well as bud developmental stage. Data obtained from research done in Washington has been used to develop critical temperature charts that relate bud developmental stage with cold injury (see the end of this chapter). Evaluating injury can help determine subsequent management practices. A hand lens or dissecting microscope is required for good evaluation.

Bud Structure

Fruit crops differ in bud structure and arrangement on the shoots. Apricots, peaches, and nectarines have simple flower buds with a single flower within each flower bud. In peaches and nectarines, buds are arranged in pairs (rarely in three's) on last season's shoots with a single vegetative bud between the flower buds. Apricots, like cherries and plums, may have single to multiple flower buds on the last season's shoots or clusters of simple buds on short branches, called spurs. Apple, pear, cherry, and plum have flower buds with multiple flowers within a single bud. Apple and pear buds are positioned as single buds on spurs or along last year's shoots; cherry and plum buds have single to multiple flowers buds in clusters on the shoots or on short spurs.

Collecting and Cutting Buds and Fruit for Evaluation

Evaluation of bud and fruit damage begins with collection of shoots with flower buds. The target is around 100 buds for evaluation, collected on shoots from differing heights within the tree and locations within an orchard block. Varieties should be kept separated and bundled with flagging tape and a label. These are then brought back from the orchard, the base of the shoots placed into a bucket (or a can) with water, and allowed to warm up at 70°F for a minimum of 2 hours to allow the damaged tissue to darken due to oxidation of phenolic compounds released by the injury. Discoloration intensifies within injured tissues with time, so four hours is better than 2 hours for detection purposes.

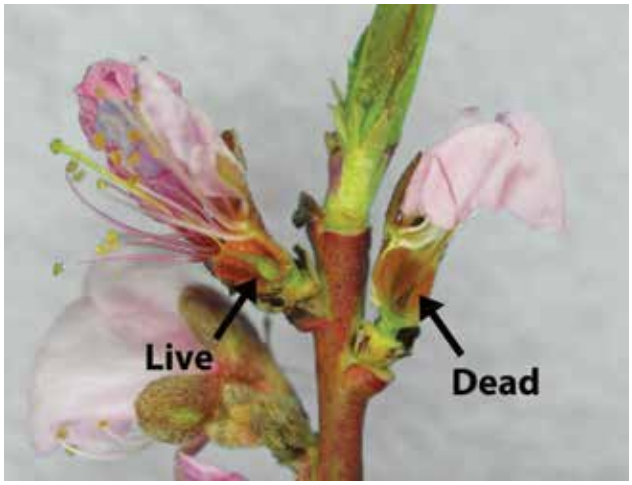
Buds are then cut and examined for brown to black discoloration of the fruit pistil (young fruit within the flower). A general rule of thumb is that sweet cherries need about 50% of the buds produced the previous summer in order to have a full crop; all the other tree fruits (apple, pear, apricot, peach, nectarine, and plum) need only about 10% for a full crop.

The cutting process requires a very sharp razor blade; single edge blades work well because they are stiffer and easier to control for cutting. They are quite inexpensive and can be discarded when the cutting edge becomes dull or damaged.

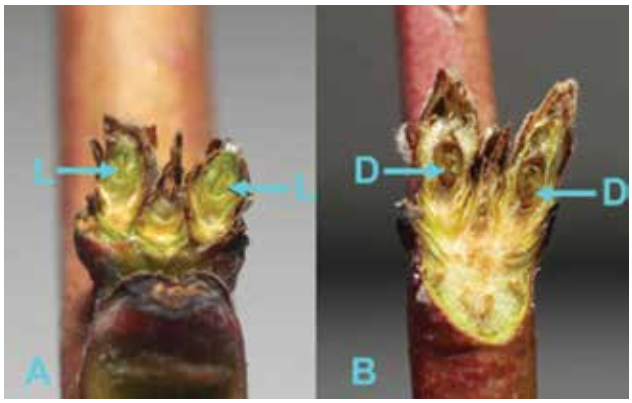
Apricot, Peach, Nectarine

Apricot, peach, and nectarine buds are easiest to cut by starting at the base of the bud (or flower) and cutting on a vertical diagonal. Buds in later stages of development (near bloom) often are best evaluated by simply cutting the petal corolla vertically to expose the entire pistil to view for evaluation. Buds killed within the past day or two will have pistils that are the same size or only slightly smaller than live pistils while buds killed several weeks previously will have a very small pistil with a much darker discoloration. Pistils often develop discoloration within hours at room temperature after being killed; apricot pistils often turn a blackish brown.

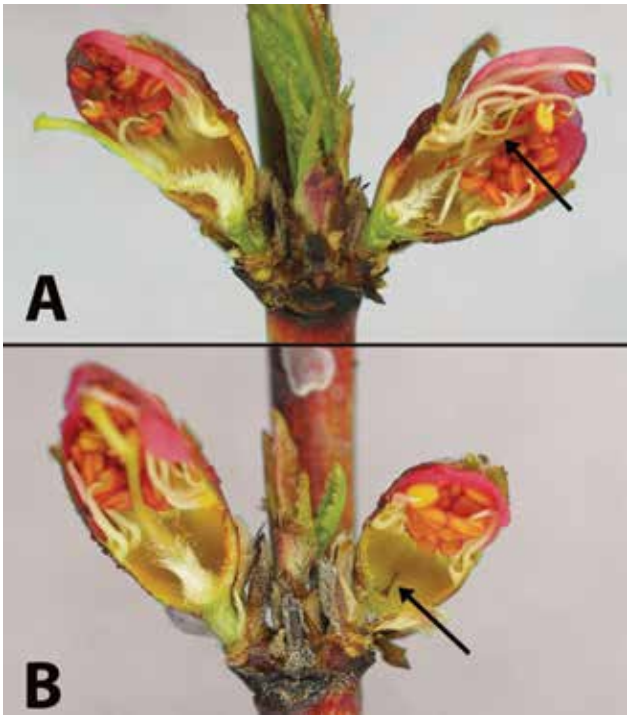
When evaluating damage of young fruit, the cut should be made horizontally through the fruit about 1/3 the distance from the stem end to the stylar end in order to cut through the embryo structure called the funiculus, which is a connection to the exterior fruit tissue. A vertical cut can also be used if one cuts through the suture (fruit crease) to the back of the fruit, but that often is more difficult. Damage to the funiculus often kills the embryo within the young fruit (causing fruit dropping in mid-June) or stops development. For peach and nectarine, this can be seen at harvest, when the frost occurred at shuck-fall.



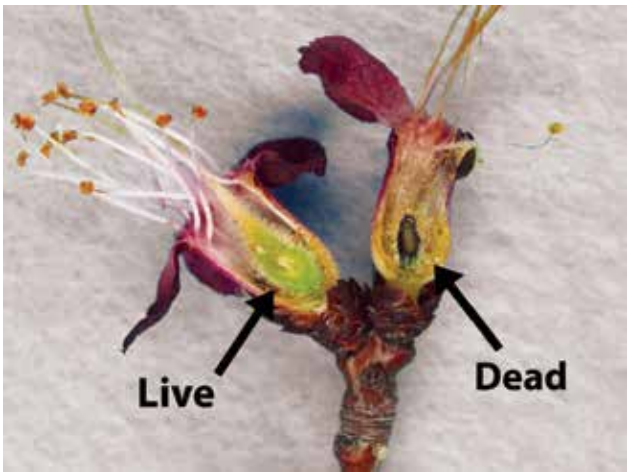
Fantasia **nectarine** buds, cut longitudinally to show the pistil, one live and one dead. (photo by HJ Larsen)



Berenda Sun **peach** buds (first swell stage) cut vertically to show pistils. A. Both buds alive. B. Both buds dead. (photo by HJ Larsen)



Berenda Sun **peach** buds (first pink stage) cut vertically to expose the pistil for freeze injury evaluation. Arrows: damaged or dead pistil (right side each photo). A. Right bud shows pistil damaged by freeze the prior night; note brownish discoloration of pistil. B. Right bud shows pistil killed by freeze 2 - 3 weeks prior to evaluation. Note smaller size and darker brown color of the older freeze-killed pistil in B than in A. (photos by HJ Larsen)

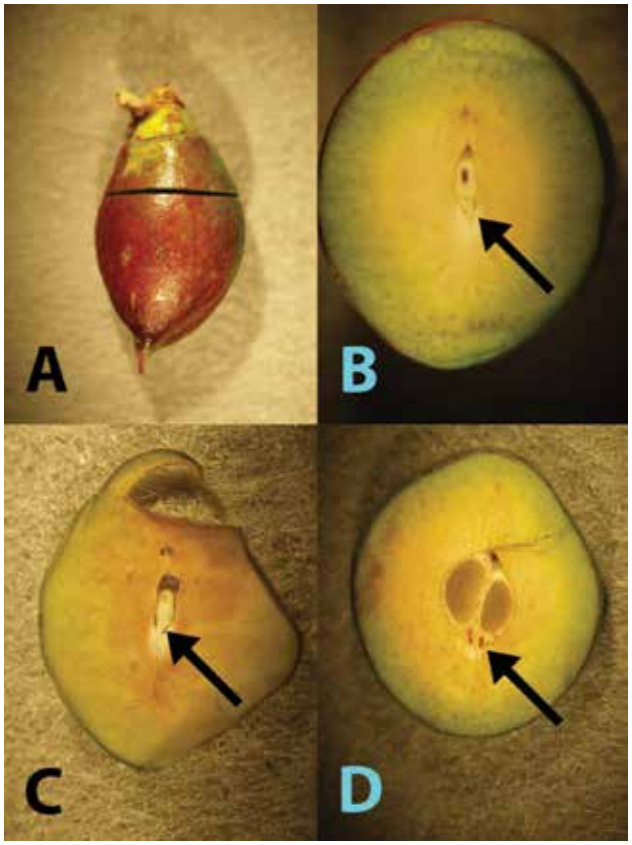


Apricot buds (full bloom stage) cut vertically to expose the pistil for freeze damage evaluation. Note the blackened pistil on the right, killed by the prior night freeze (photo by HJ Larsen).

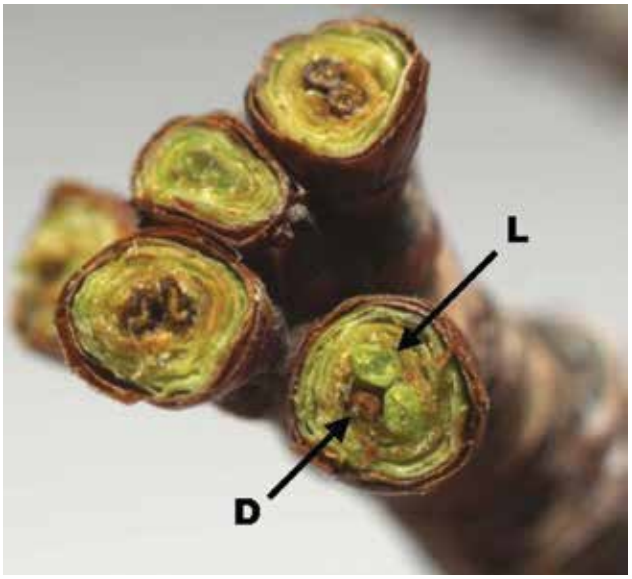
Sweet Cherry, Plum, Apple, Pear

Sweet cherry, plum, apple, and pear buds are multiple-flower buds (more than one flower inside each bud). Plums typically have two flowers per bud, cherries usually have two to five, and apples and pears typically have six or more. But both plums and cherries can have only a single flower within a bud if some flower initials are killed by winter injury.

A horizontal cut through these multiple-flower buds will cut through several of the flowers they contain. However, because the flowers within these buds often have differing timing for bloom, it is difficult to see all the flowers at one time. Often the most advanced flower will be the highest (furthest from the base of the bud) and the least advanced flower be the lowest (closest to the base of the bud). The earlier in bud development that the evaluation is done, the greater the possibility of seeing all the flowers within the bud. At



Young **nectarine** cut to show embryo attachment (funiculus, arrows) to the fruit tissue. A. Cut orientation and location. B. Young embryo with undamaged funiculus. C. Thin section to emphasize embryo and undamaged funiculus). D. Twin embryos with damage within each funiculus; note the brown discoloration. (photos by HJ Larsen)



Bing **sweet cherry** buds (multiple-flower buds) cut horizontally across the bud for flower viability evaluation. Arrows: D = dead flowers (dark brown color), L = live flower. (photo by HJ Larsen)

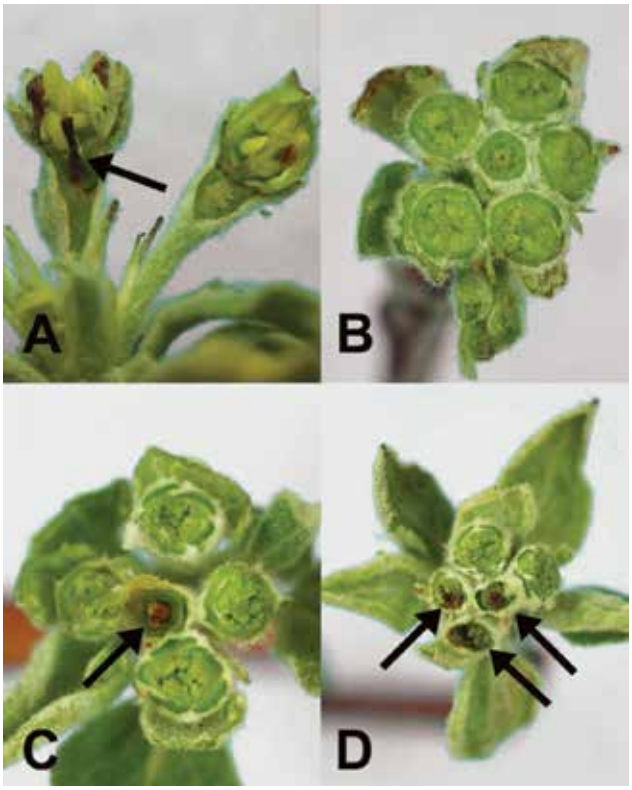
Sweet cherry flowers killed by frost at bloom, cut vertically to expose the blackened pistil. (photo by HJ Larsen)

or near bloom, one needs to use more angled vertical cuts to reveal the pistils.

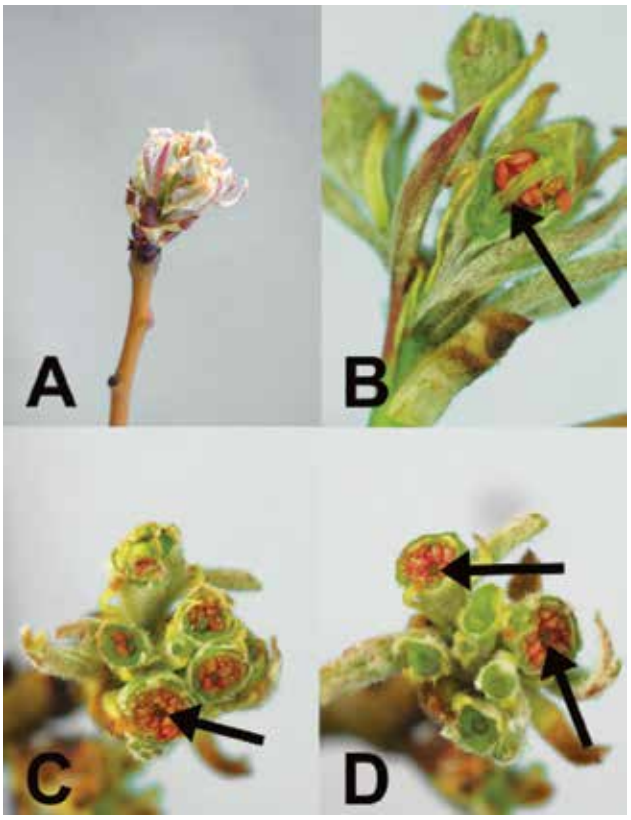
Apple and pear buds, like plum, tend to have differing timing for opening of the flowers within the fruit bud. In apples, the "king bloom" is the first to open and typically has five "side bloom" flowers forming a ring around it. Because it is earliest, it typically will be positioned toward the top of the bud when one makes a horizontal cut through the flower bud.

When flower structures are damaged by frost or freezing temperatures, injured tissues of the style and ovary will darken through formation of phenolic compounds in response to injury. Cross-sectional cuts through the flower will reveal these darkened flower structures for by making sequential cuts beginning at the upper top of the bud and proceeding toward the base of the bud. Because the style (the central portion of the pistil) is so much longer than the stigma (top portion of the pistil), it is typically the structure seen in the cross-sectional cuts through the upper portion of the flower where the petals are found. Browning of this structure after a frost event is a good indication that the flower has been killed and will not become a successful fruit.

In pears, the spread in flower stage of development is even greater as they approach bloom. However, the flowers tend to develop from the base of the shoot toward the top. This makes cold injury damage evaluation even more dependent of multiple cuts through the developing buds. As with apple, damage to and discoloration of the stylar tissue within the blossom following exposure to freezing temperatures often is



Apple buds cut to show cold injury damage; arrows show killed pistil tissues. A. Longitudinal section (left flower killed). B - D: Cross-sections of flower buds. B. Six live flowers (King bloom in center); C: King bloom pistil killed, side blooms still alive; D: King bloom and two side blooms killed, two top side blooms alive.



Pear buds. A. Pear bud showing the multiple-flowers bud type. B. Longitudinal section showing pistil compound style (arrow points to stylar bundle leading to fused ovary receptacle). C & D. Cross-section cut through the multiple flowers; C is higher level cut, D is next cut lower; arrows in C & D point to stylar clusters with tissue browning that could indicate cold damage and death of the stylar tissues. (photos by HJ Larsen)

associated with death of the flower. Pear has a tendency to develop late flowers at the tips of shoots (these are commonly termed "rat-tail bloom"). These late flowers can escape earlier frost damage and set fruit, but the fruit usually is substantially smaller and lower in quality.

Forcing Buds to Evaluate Injury

Finally, bud viability can also be assessed by forcing buds to bloom indoors. Cut some shoots with flower buds on them, place them promptly into water and keep them at room temperature for several weeks. Re-cut the shoot ends every 5 days, so that the vascular tissue will continue absorbing water.

Most tree fruits accumulate around 400 Growing Degree Hours (GDH) per day when held at 70°F, and need between 4,000 and 7,000 GDH to reach bloom. Thus, viable buds should bloom within 10 to 16 days when incubated in water at 70°F. Apricots, peaches, and plums often complete chill requirements between late December and mid-January in the Intermountain West. Cherries, apples, and pears often complete their chill requirements between late January and late February.

Types of Frost Injury

Very late frost events after petal-fall can cause injury to young fruit tissues and impact fruit quality and appearance. Sweet cherry fruit exposed to cold can be killed outright. Injury to young peach fruit can result in fruit that never sizes beyond the size of a walnut. This can readily be seen as non-damaged fruit approaches ripeness. Frost injury to apple and pear fruit kills the surface cells and tissues, causing a pronounced scabby pattern on the fruit surface that

Late frost injury to young fruit. A. Sweet cherry: d = killed young cherry fruit. B. Peach: h = healthy, maturing fruit; d = damaged, non-maturing fruit. C. Apple with frost ring. D. Pears with frost ring. (photos by HJ Larsen)

is termed "frost ring". Such affected fruit, although edible, are not salable and often are removed by hand thinning if possible.

Researchers working on cryopreservation of fruit buds have noted that buds that are frozen before they have cold acclimated (i.e., Sept., Oct., or early Nov.), often had oxidative browning of the vascular tissues leading to the buds. Buds with such damage could not be successfully grafted for subsequent germplasm recovery. This type of injury can occur from a late fall or early winter freeze, especially where mild temperatures precede a freeze event, but not after mid-winter when these tissues are very cold hardy. Buds damaged in this manner may open, but subsequently fall off in late spring/early summer as water stress becomes an issue. Consequently, fruit bud protection efforts against cold injury may need to include late fall/early winter, especially if a rapid drop to potentially damaging temperatures is forecasted to follow prolonged warm weather that slows cold acclimation by the buds.

Tree Fruit Growth Stages and Critical Temperatures – APPLE

Typical temperatures in Fahrenheit, at which 10% and 90% injury after 30 minutes exposure, is provided under each bud stage image.

To have a full crop of cherries requires well over 50% bud survival in most years, while apples, pears, and peaches may only need 10-15% bud survival.

	Silver Tip	Green Tip	Half-inch Green
10% kill	15	18	23
90% kill	2	10	15

	Tight Cluster	First Pink (Pink)	Full Pink (Open Cluster)
10% kill	27	28	28
90% kill	21	24	25

	First Bloom (King Bloom)	Full Bloom	Post-bloom
10% kill	28	28	28
90% kill	25	25	25

Tree Fruit Growth Stages and Critical Temperatures – PEAR

	Swollen Bud (Scale Separation)	Bud Burst	Green Cluster (Tight Cluster)
10% kill	15	20	24
90% kill	0	6	15

	White Bud (First White)	Full White	First Bloom (King Blossom)
10% kill	25	26	27
90% kill	19	22	23

	Full Bloom	Petal Fall (Post Bloom)
10% kill	28	28
90% kill	24	24

Tree Fruit Growth Stages and Critical Temperatures – CHERRY

Swollen Bud (First Swell)

Green Tip (Bud Burst)

Tight Cluster

	Sweet Cherry	Tart Cherry	Sweet Cherry	Tart Cherry	Sweet Cherry	Tart Cherry
10% kill	17	15	25	26	26	26
90% kill	5	0	14	22	17	24

White Bud (First White, Popcorn)

First Bloom

Full Bloom

	Sweet Cherry	Tart Cherry	Sweet Cherry	Tart Cherry	Sweet Cherry	Tart Cherry
10% kill	27	28	28	28	28	28
90% kill	24	24	25	24	25	25

Petal Fall (Post Bloom)

	Sweet Cherry	Tart Cherry
10% kill	28	28
90% kill	25	25

Tree Fruit Growth Stages and Critical Temperatures – PEACH/NECTARINE

	Swollen Bud (First Swell)	Calyx Green	1/4" green (Calyx Red)
10% kill	18	21	23
90% kill	1	5	9

	Pink (First Pink)	First Bloom	Full Bloom
10% kill	25	26	27
90% kill	15	21	24

	Post Bloom (Petal Fall)	Shuck Split
10% kill	28	28
90% kill	25	25

Tree Fruit Growth Stages and Critical Temperatures – APRICOT

	First Swell (Bud Swell)	Tip Separation (Swollen Bud)	First White
10% kill	15	20	24
90% kill	---	0	14

	First Bloom	Full Bloom	In the Shuck (Petal Fall)
10% kill	25	27	27
90% kill	19	22	24

	Shuck Split (Post Bloom)
10% kill	28
90% kill	25

Tree Fruit Growth Stages and Critical Temperatures – PLUM

	Swollen Bud	Bud Burst	Green Cluster
10% kill	14	20	24
90% kill	0	7	16

	White Bud	Bloom	Petal Fall
10% kill	26	28	28
90% kill	22	33	33

CHAPTER 14 PESTICIDE INFORMATION

Pesticide Regulation, Safety, and Storage

Emergency Information

The poison control hotline for every U.S. state is

(800) 222-1222.

In Utah, the poison control center is the Utah Poison Control Hotline in Salt Lake City, and in Colorado, Idaho, and Montana, it is the Rocky Mountain Poison and Drug Center in Denver. The hotline is staffed 24/7 to provide treatment recommendations and referral to an emergency medical facility.

Restricted Use Pesticides and Obtaining a Pesticide Applicator License

The Environmental Protection Agency classifies certain pesticides, or uses of pesticides, as restricted if they could cause harm to humans or to the environment unless it is applied by applicators who have the knowledge to use these pesticides safely. These are called Restricted Use Pesticides, and they are available for purchase and use only by certified pesticide applicators or persons under their direct supervision.

NOTE: ***All restricted use pesticides included in the spray tables in this guide are followed by a small R (ᴿ).***

The EPA defines two categories of pesticide applicators: private and commercial. A private applicator is a person who uses (or supervises the use of) restricted use pesticides on agricultural lands owned or rented by that individual or his/her employer. The private applicator may not apply restricted use pesticides on another person's property if he/she is to receive monetary compensation. A commercial applicator is defined as any person who uses or supervises the use of any pesticides for monetary compensation. Both categories require an applicator's license; however, the testing and recertification differ among the two.

In Utah, applicants can pick up study materials at the Utah Department of Agriculture and Food in Salt Lake City and any UDAF District Field Office, or find pesticide education materials on the UDAF website. Make an appointment to take the exam, and allow 2 hours.

- *Private applicators*' exams (general and agriculture) are open-book and the fee is $20 and the license lasts 3 years. To recertify, you can re-take the exams or obtain 6 total CEU units.
- *Commercial applicators*' exams cost $65, and the license lasts three years. Business owners must also obtain a license. The applicant must have 70% to pass. To recertify, you can re-take the exams or obtain 24 total CEU units.

Utah Department of Agriculture and Food
Division of Plant Industry
PO Box 146500, 4315 South 2700 West
TSOB South Bldg, Floor 2
Taylorsville, UT 84129
(801) 982-2252
ag.utah.gov/farmers/plants-industry/pesticides

In Colorado:

- Applicants for *private applicator* license must pass the exam, and then request the license through the website or by phone, which costs $75 and is active for 3 years. To recertify, either retake the exam or earn 7 CEU credits.

- *Commercial applicator* certification is required for all businesses plus employees that are applying restricted-use pesticides. Exams cost $31.50 each and the license costs $100 and lasts 3 years. To recertify, either retake the exams or earn the appropriate number of credits.

The Colorado Department of Agriculture
Division of Plant Industry
305 Interlocken Parkway
Broomfield, CO 80021
(303) 869-9000
ag.colorado.gov/plants/pesticides

In Idaho:

- Applicants can pick up study materials at the Idaho State Department of Agriculture (ISDA) in Boise or at any ISDA regional office. Contact your local office to find out when the next available exam is offered in your area. Exams are $10 per attempt. Pre-license trainings are offered by University of Idaho Extension and ISDA throughout Idaho. For registration information contact University of Idaho, (208) 459-6365.

- *Private applicators'* exams (general and agriculture) are closed-book and the fee is $10. The applicant must pass with 70% or higher, and the license lasts 2 years. To recertify, you can re-take the exams or obtain 6 total CEU units.

- *Commercial applicators'* exams cost $120, and the license lasts two years. The applicant must have 70% to pass the exam. To recertify, you can re-take the exams or obtain 15 total CEU units over the course of two years.

  Idaho State Department of Agriculture
  Pesticide Licensing
  P.O. Box 7249, Boise, ID 83707
  2270 Old Penitentiary Road
  Boise, ID 83712
  (208) 332-8500
  agri.idaho.gov/main/pesticides

In Montana:

Applicants can contact the Montana Department of Agriculture at agr.mt.gov/Pesticide-License-Program for study materials, to find available exam times, and to inquire about pre-license trainings.

- *Private applicators* must either pass a graded written exam from a local office of the Montana State University (MSU) Extension Service or attend a training course provided by MSU Extension Service and take an ungraded written exam. The fee for the private applicator license is $60 and the license is effective for five years. To recertify, the applicator must acquire 6 CEU units in five years by attending approved training courses.

- *Commercial applicators'* licenses cost $85 per year, $25 per operator for the first 2 operators, and $10 per operator for each additional operator. All applicants must meet liability requirements for commercial applicators and have at least 80% in both the core and category-specific section exams to obtain a license. Annual license renewal.

Pesticide Record-keeping

Federal laws requires that private and commercial applicators maintain pesticide records for all applications of restricted use products for at least two years. The laws are enforced through the state departments of agriculture. Applicators can develop their own format for record-keeping. Spray dates must be recorded within 14 days after the application is made, and must include:

1. Name and address of property owner
2. Location of treatment site, if different from above, crop treated, and size of area
3. Target pest
4. Exact date of application
5. Brand name and EPA registration number of pesticide used
6. Total amount of product applied
7. Name and license number of the applicator

Because Worker Protection Standards require worker notification of all pesticide applications, it is recommended that comparable records be kept of all pesticide applications. This will also enable the grower to complete a listing of pesticides used at the time of harvest. Packing sheds and processors are increasingly requiring pesticide usage lists.

EPA Worker Protection Standard

EPA's Worker Protection Standard (WPS) for agricultural pesticides is a regulation aimed at reducing the risk of pesticide poisonings and injuries among agricultural workers and pesticide handlers. The WPS offers protections to agricultural workers and pesticide handlers. The WPS contains requirements for pesticide safety training, notification of pesticide applications, use of PPE, REIs after pesticide application, decontamination supplies, and emergency medical assistance.

Avoiding Drift, Runoff, Spills

Pesticides that enter the environment can cause injury to humans, animals, and non-target plants. Whenever sprays are necessary, only apply when weather conditions are appropriate, application equipment is properly calibrated, and pesticide formulation, droplet size, and adjuvants are used to minimize drift and runoff.

State Groundwater and Pesticide Programs

Approximately half of the groundwater withdrawn from wells is used for agriculture. Many people depend on groundwater as a source of drinking water. Many states have enacted a Groundwater/ Pesticide State Management Plan. The plan outlines steps towards protecting groundwater from pesticide contamination and response to a pesticide detection in groundwater.

If a pesticide has been detected in groundwater, then a groundwater monitoring plan will be implemented in the area to determine the extent and, if possible, the source of pesticide contamination. The state agriculture agency will work with the landowner to prevent further groundwater contamination. A number of different farming practices, called Best Management Practices (BMPs), and simple devices can significantly reduce the possibility of pesticides entering the system. BMPs will be required by the EPA as a condition of future use of the pesticides.

The EPA has identified five broad-spectrum herbicides to monitor, due to their high potential to leach into groundwater and to be a possible detriment to public health, safety, and the environment. The pesticides are: alachlor, atrazine, cyanazine, metolachlor, and simazine. Each has been detected in groundwater in several states, with some detections exceeding drinking water standards.

Pesticide Storage and Disposal

In general, pesticides should always be stored in a safe location. The storage facility should be kept locked so that children and other unauthorized people cannot enter and be exposed to pesticide hazards. All pesticides should be kept in their original containers, closed tightly, and with their original labels. If the label has come off or is coming off, paste or tape it back on. All pesticides should be protected from excessive heat, and liquid pesticides should be stored in an area protected from freezing.

Growers are urged to review their annual pesticide needs and stocks on hand well in advance of the growing season to prepare for disposal of unused product. Pesticide purchases should be based on the amount projected for use within any given season. Empty containers should be triple-rinsed and drained; they often can then be disposed of through regular trash collection, but be sure to check the label and local regulations.

Never dispose of pesticides or containers by dumping them into the sewer, sink, or toilet. Municipal water treatment practices remove little of the pesticides, and such careless disposal can contaminate waterways and is subject to penalties. The best means to dispose of such pesticides is to use them up according to their labeled instructions.

Utah, Idaho, Colorado, and Montana departments of agriculture occasionally hold pesticide disposal drop-offs. In Idaho, Agri-Plas collects and recycles containers. More information can be found at agriplasinc.wordpress.com. In Montana, the disposal fee is free for the first 200 pounds and $1 per pound with a minimum charge of $5.

EPCRA & The Fruit Grower

The Emergency Planning and Community Right-to-know Act was enacted in 1986 and requires that any facility that stores chemicals identified by the EPA as “Extremely Hazardous Substances” (EHS) provide a report when storage or accidental spill of an EHS occurs over a given threshold. The report is used in local community emergency planning and to provide local governments and residents access to information about specific chemicals.

Fruit growers should be aware of this reporting requirement because some of the EHS materials on the list are used as orchard pesticides. The table on the next page lists those pesticides where storage amounts and threshold spill level require reporting.
The storage limit of an EHS pesticide is called the

Orchard-use pesticides from the EPA's List of Extremely Hazardous Substances.

Chemical Name	Threshold Planning Quantity (lbs a.i.)	Reportable Quantity (lbs a.i.)	Formulated Amounts Containing 1 lb a.i.
phosmet (Imidan)	10	1	2 lb Imidan 50WP
oxamyl (Vydate)	100	1	2 qt Vydate 2L
dimethoate (Dimethoate 4EC)	500	10	---
methomyl (Lannate)	500	100	---

Threshold Planning Quantity (TPQ), given in amount of active ingredient. The limit for an accidental spill is referred to as the Reportable Quantity (RQ).

When a farm facility exceeds a storage limit (TPQ), or has an accidental spill (RQ), the information must be reported within 60 days (Tier 1 report). In addition, an annual report (Tier II report) is also due every March 1 only if a Tier 1 report has been filed. EPA offers reporting software.

The farm facility is responsible for distributing reports to the state, local emergency planning committee, and local fire departments. To determine exactly where and how to distribute reports, contact the following:

Utah:

Utah Division of Env. Response and Remediation
195 North 1950 West
P. O. Box 144840
Salt Lake City, Utah 84114-4840
deq.utah.gov/division-environmental-response-remediation
(programs/services, Tier II)

Colorado:

Colorado Dept of Public Health & Environment
SARA Title III -- Tier II Reports, OEIS - B2
4300 Cherry Creek Drive South
Denver, Colorado 80246-1530
(303) 692-2000
cdphe.colorado.gov/environmental-agriculture-program/discharge-spill-and-noncompliance-reporting-and-monitoring

Idaho:

University of Idaho Environmental Health & Safety
875 Perimeter Drive
Moscow, ID 83844
(208) 885-6111
uidaho.edu/dfa/administrative-operations/ehs

Montana:

Montana Department of Agriculture
Leonard Berry, Compliance Program Manager
302 N Roberts
Helena, MT 59601
(406) 444-6982
agr.mt.gov/Pesticide-Compliance-Enforcement

Pesticide Use

Reduced-Risk Pesticides

EPA's Conventional Reduced Risk Pesticide Program registers certain pesticides as "reduced risk." These are pesticides that pose less risk to human health and the environment than existing conventional alternatives. Biological and antimicrobial pesticides are handled through separate registration processes.

Products given the Reduced Risk decision have been compared with existing alternatives currently registered on that use site. These are products that have:

- low impact on human health
- lower toxicity to non-target organisms (birds, fish, plants)
- low potential for groundwater contamination
- low use rates
- low pest resistance potential

- compatibility with Integrated Pest Management (IPM) practices

NOTE: ***Reduced risk pesticides included in the spray tables in this guide are under the "Reduced risk/Organic" headings within each pest.***

Use of Adjuvants

Spray adjuvants are materials added to pesticides in order to enhance their effectiveness. Many insecticides and some fungicides are formulated by the manufacturers with their own adjuvants. Because of the breadth of conditions growers encounter in Utah and Colorado, additional adjuvants may further enhance the effectiveness of the product. However, select with care, considering all the factors that may affect spray performance. Use of the wrong adjuvant for the conditions can decrease product effectiveness. Many pesticides will state the type of adjuvant that can be used.

There are many types of adjuvants, including surfactants (ionic or nonionic wetting agents/spreaders that improve wetting of foliage), stickers, and emulsifiers, and agents that buffer, defoam, control drift, penetrate soil, filter UV, and more. Each type of adjuvant differs in the way it interacts with spray chemicals and water quality, and weather conditions further affect their potential use. Thus, no one adjuvant can or should be used under all conditions.

Remember that amount and type of the adjuvant needed will vary with the hardness and pH of the water. Use just enough spreader-sticker to break the surface tension and spread the spray uniformly over the leafy surfaces; excessive amounts of surfactants will increase spray runoff. Do not use spreader-stickers with growth regulators (unless specifically called for on the label).

Adjusting for Water pH

The pH of water used to prepare spray solutions is very important. Water in many locations in Utah and Colorado is alkaline, ranging in pH from 7.4 to 8.5. The use of alkaline water for spray solution preparation can rapidly decompose many insecticides and decrease their activity. The following procedure is strongly recommended:

1. Check the pH of your water supply.
2. Read labels to determine whether water pH is important for that material.
3. If necessary, adjust water pH before adding any chemical or pesticide that is sensitive to pH. pH adjusters include Buffercide, Buffer-X, Unifilm-B, and LI 700 Acidiphactant.
4. Apply spray solutions as soon as possible after mixing in the spray tank. Avoid leaving mixed spray solutions in the spray tank overnight.

Sprayer Calibration

Calibration is important so that the amount of spray you think you are applying for a known area is accurate. A sprayer may be used one way to spray insecticides, and another way to spray herbicides. Calibration should be done with a sprayer that will be used for a particular application, in the same manner that the pesticide will be applied. How to calibrate and calculate how much material to use:

1. Put a known volume (V) of water in the sprayer. Spray the water out in the same manner the pesticide will be applied, then determine the area in square feet (A), that was sprayed.
2. To calculate the area in acres that are sprayed by V, divide A by 43,560. For example, if V=1 gallon, and the spray covered 1,075 sq. ft., then the area treated by 1 gallon is 1,075÷43,560 or 0.025 acre.
3. Next, mix only enough spray to cover the area. If you need to spray 2,000 square feet and it takes 1 gallon to cover 1,075 square feet, dividing 2,000 by 1,075 gives you the number of gallons of spray that should be in the tank. In this case, 1.86 gallons are needed to cover the 2,000 square foot area.
4. To calculate the amount of pesticide required for each gallon of spray, multiply the rate per acre on the pesticide label by the area you determined in step two above. In this example the area was 0.025 acre. If the rate per acre is 6 oz, the amount of pesticide for each gallon is 0.025 × 6, or 0.15 oz/gallon. Use the conversion factors in the table below to convert the amount into a unit that you can measure with your equipment.

Preparation of Small Spray Quantities

Rates for applying pesticides are shown on labels as rate per volume (usually 100 gallons of water) or rate per area, (usually acre or 1000 sq. ft.) Mixing directions for small quantities of pesticide vary with the scenario.

If the rate is by volume, adjust the amount of pesticide to the volume of water you mix. The table below gives various mixing rates. If the rate is by *final spray concentration*, you do not have to calibrate the sprayer, but you must read the label to know how much spray material to apply. If the rate is amount per area (usually acre, but sometimes 1000 sq. ft.), your sprayer must be calibrated.

For measuring amounts of solid form pesticides such as wettable powders, dry flowables, etc., us a scale to ensure the correct weight. For measuring liquids, use a graduated medicine spoon or a syringe, which are available from your physician, veterinary supply, farm supply, or pharmacy. Graduated spoons and syringes used for a pesticide must not be used for anything other than that product.

Conversion Factors for Weight or Volume

Wettable powders (W) and dry flowable (DF) formulations[1]
1 lb = 453.6 grams
1 oz = 28.4 grams
Liquids
¼ teaspoon (tsp) = 1.25 ml
½ tsp = 2.5 ml
¾ tsp = 3.75 ml
1 tsp = 5 ml
1 ½ tsp = 7.5 ml
1 tablespoon (tbs) = 15 ml
1 gal = 4 qt = 8 pt = 16 c = 128 fl oz = 256 tbs = 768 tsp
1 fl. oz. = 2 tbs = 6 tsp = 30 ml

[1]Dry materials should be weighed to provide a more exact conversion.

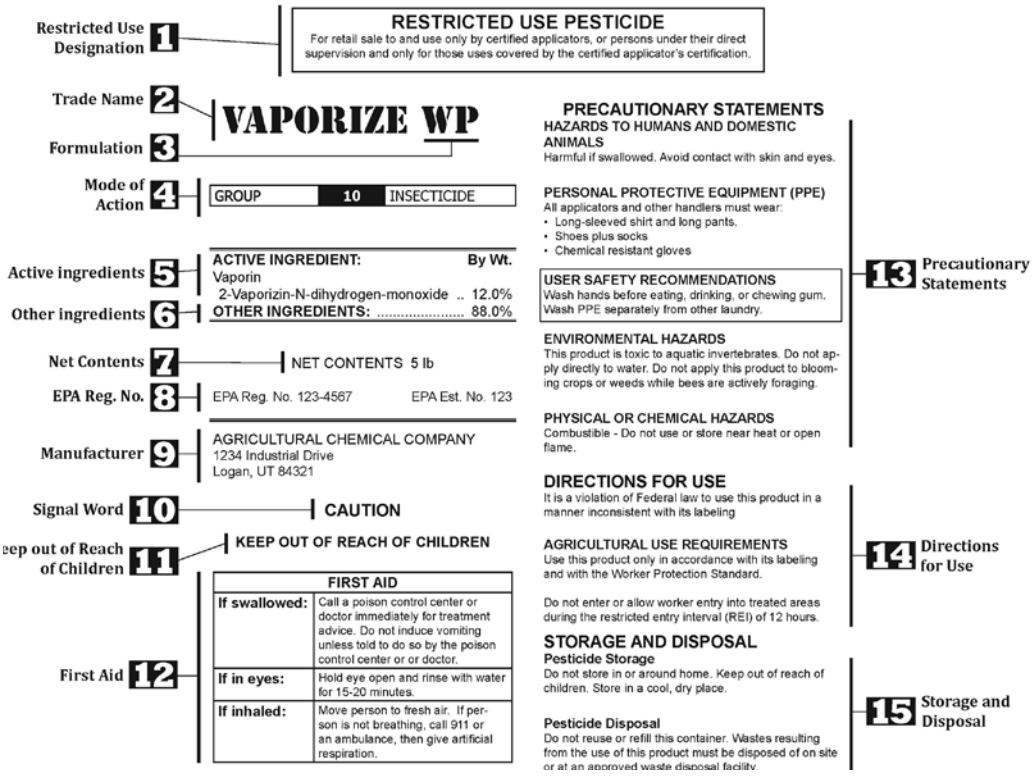
Conversion values for preparation of 1, 3, and 5 gallons of spray from the rate per 100 gallons.[1]

	Amount per:			
Material	100 gal	5 gal	3 gal	1 gal
Dry: Wettable Powders, & Dry Flowables	2 lb (907.2 g)	45.4 g or 1.659 oz	27.2 g or 0.95 oz	9.1 g or 0.32 oz
	1 lb (453.6 g)	22.7 g or 0.79 oz	13.6 g or 0.48 oz	4.5 g or 0.16 oz
	8 oz. (226.8 g)	11.3 g or 0.39 oz	6.8 g or 0.24 oz	2.3 g or 0.08 oz
	4 oz. (113.4 g)	5.7 g or 0.2 oz	3.4 g or 0.11 oz	1.1 g or 0.04 oz
	2 oz. (66.7 g)	2.8 g or 0.06 oz	1.7 g or 0.05 oz	0.6 g or 0.02 oz
Liquids: Liquid or Emulsifiable Concentrates, & Liquid Flowables	1 gallon (3,840 ml)	192 ml, or 12 tbs + 2 tsp + 2.0 ml	115 ml, or 7 tbs + 2 tsp	38.4 ml, or 2 tbs +1 tsp + 0.9 ml
	1 qt (960 ml)	48 ml, or 3 tbs + ½ tsp + 0.5 ml	28.8 ml, or 1 tbs+2 ¾ tsp+0.5 ml	9.6 ml, or ¾ tsp + 1.05 ml
	1 pint (480 ml)	24 ml, or 1 tbs+1 ¾ tsp+0.25 ml	14.4 ml, or 2 ¾ tsp + 0.65 ml	4.8 ml, or ¾ tsp + 1.05 ml
	1 cup (8 fl oz=16 tbs=240 ml)	12 ml, or 2 ½ tsp	7.2 ml	2.4 ml
	4 fluid oz (120 ml) or 8 tbs	6 ml, or 1 tsp + 1.0 ml	3.6 ml	1.2 ml
	2 fluid oz (60 ml) or 4 tbs	3 ml, or ½ tsp + 0.5 ml	1.8 ml	0.6 ml
	1 fluid ounce (30 ml) or 2 tbs	1.5 ml	0.9 ml	0.3 ml

[1]The measurements in tablespoons and teaspoons are approximate. The use of an electronic scale and syringe will be much more accurate.

Understanding the Pesticide Label

Information on pesticide labels represents the research, development, and registration procedures that a pesticide must undergo before reaching the market. The EPA requires a manufacturer to submit data from nearly 150 tests prior to the product's approval for use. Understanding the material you are using, how it is applied, and in what rate, is important for human and environmental safety, and is required by law.



Product Information

1 Classification

When a pesticide is classified as restricted, the label will state "Restricted Use Pesticide" at the top of the front panel. These products require an applicators license to purchase and apply.

2 Trade Name/Brand Name

This is the name of the product that the manufacturer has created, such as "Sunspray," "Warrior," etc.

3 Formulation

- **emulsifiable concentrate (EC)**: an oil-based liquid plus an emulsifier that, when mixed with water, forms a milky solution; moderate agitation; easy to handle and apply
- **flowable (or liquid) (F or L)**: a thick liquid where the active ingredient has been imbedded in an inert solid and ground to a fine powder; moderate agitation; easy to handle and apply
- **solution (S)**: the active ingredient mixes readily with liquid and does not separate
- **wettable powder (WP)**: dust-like formulation that does not dissolve in water and must be constantly agitated to remain in suspension
- **soluble powder (SP)**: powder formulation that readily forms a suspension in water; a rare formulation because few active ingredients are soluble in water
- **water dispersible granules (or dry flowables) (WDG or DF)**: small granules that, when mixed with water, disperse to fine particles; constant agitation required
- **water soluble packets (WSP)**: a wettable or soluble powder that has been pre-measured into a plastic bag that dissolves in the tank water

4 Mode of Action

This information is sometimes included on a label, and provides the pesticide classification number. This number is important to know because growers should rotate among classes to prevent resistance.

5 Active Ingredient

The active ingredient, or A.I., is the material that is working to kill the target pest. On a label, the percentage of the A.I. is provided. The A.I. is usually listed as a common name of the more complicated

chemical name. For example, the chemical name, 1-((6-Chloro-3-pyridinyl)methyl)-N-nitro-2-imidazolidinimine, is also known as imidacloprid.

6 Other/Inert Ingredients
These ingredients are sometimes added to the product to improve effectiveness (such as a surfactant).

7 Net Contents

8 EPA Registration Number
Every product has a unique registration number. This may or may not be on the front panel.

9 Manufacturer's Address
This may or may not be on the first panel.

Safety and Environmental Information

10 Signal Word
Each pesticide label has a "signal word".

- **Danger-Poison:** a red skull and crossbones means that the product can be fatal, or illness can occur if swallowed, absorbed, or inhaled.
- **Danger**: corrosive, and can cause irreversible eye damage or skin injury.
- **Warning**: moderately toxic, and can cause moderate eye or skin irritation.
- **Caution:** mildly toxic, but can cause slight eye or skin irritation.

11 Keep Out of Reach of Children
The front panel of every pesticide label must bear this statement.

12 First Aid *(May not be on front panel)*
This section recommends proper antidotes and treatment for medical personnel treating a victim. For this reason, always take the pesticide label with you if you need to visit an emergency medical facility. Products labeled DANGER also bear an 800 telephone number that physicians may call for further treatment advice.

13 Precautionary Statements
Hazards to Humans and Domestic Animals
This part of the label includes precautionary statements indicating specific hazards, routes of exposure, and precautions to be taken to avoid human and animal injury, based on the signal word. Protection for mouth, skin, eyes, or lungs are provided, and what specific action you need to take to avoid acute effects from exposure.

Personal protective equipment (PPE)
Specific instructions are included regarding the type of clothing that must be worn during the handling and mixing processes. The PPE listed is the minimum pesticide handling protection that should be worn.

User safety recommendations
This section is usually surrounded by a box, and includes information on proper washing after handling the pesticide.

Environmental hazards
An explanation is provided of potential hazards and the precautions needed to prevent injury or damage to non-target organisms or to the environment, especially preventing groundwater contamination.

Physical or chemical hazards
Explains hazards for fire, or other.

Use Information

14 Directions for Use
This section makes up the bulk of a pesticide labe. Products intended for use in agriculture will have an Agricultural Use Requirement box included in this section. It will state that the Worker Protection Standard applies to the product. Directions for use include:

- the crops to which the product may be applied
- the pests that the product targets
- amount to use
- method of application
- timing of application
- pre-harvest interval
- re-entry interval
- PPE requirements for early re-entry
- other limitations

15 Storage and Disposal
Storage information includes temperature and light requirements to prevent the breakdown of the material. This section also explains how to deal with the unused portion of the product and the container.

Extension
UtahStateUniversity

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EXTENSION

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The Title IX Coordinator is the Director of the Office of Title IX Programs and Gender Equity, 123 Student Services Building, Fort Collins, CO 80523-0160, (970) 491-1715, titleix@colostate.edu.

The Section 504 and ADA Coordinator is the Director of the Office of Equal Opportunity, 101 Student Services Building, Fort Collins, CO 80523-0160, (970) 491-5836, oeo@colostate.edu.

University of Idaho
Extension

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