INTERMOUNTAIN
Commercial Tree Fruit Production Guide

2018

A publication for commercial fruit producers of the Intermountain West

EXTENSION

UtahStateUniversity

University of Idaho Extension

Colorado State University Extension

MONTANA STATE UNIVERSITY | EXTENSION

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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 and socially sound pest management decision. IPM integrates as many suitable pest management options as possible.

The components of IPM are:

1. Knowledge of pest (identification, biology, life cycle)
2. Monitoring for pests and injury (see next section)
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 warning of potential 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 zigzag 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.

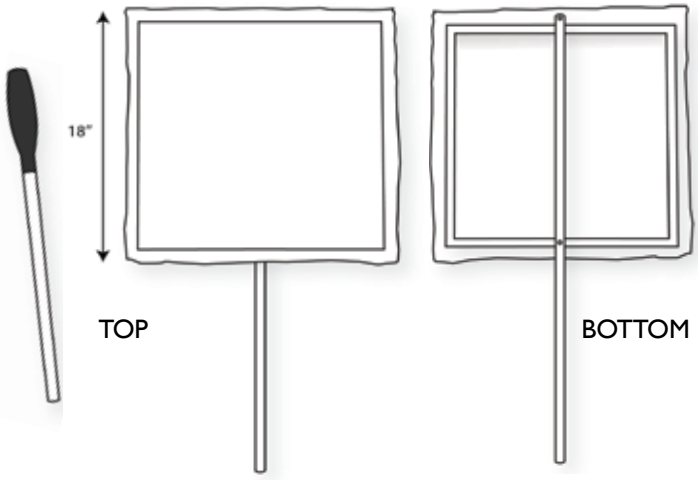
How to Monitor

1. 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.

2. Use pheromone traps for some pests, including **codling moth and peach twig borer**.

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

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

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

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).

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

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 full bloom	30 days (regular) 60 days (L2 or LL)
peach twig borer (PTB)	mid to late April	upper tree canopy	early to mid May	30 days (regular) 60 days (L2 or LL)
greater peachtree borer (GPTB)	peach shuck fall	lower tree canopy	late June to early July	30 days
obliquebanded leafroller (OBLR)	mid May	mid tree canopy	late May to mid June	30 days
western cherry fruit fly (WCFF)	green stage of fruit	southwest side of tree; mid-canopy	used for monitoring only	ammonium carbonate bait: 3 wk

used in insect phenology models (see the following section).

After biofix, check traps weekly and record the numbers 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 $1.20 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, 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.

3. 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 symptoms 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 (utahpests.usu.edu/uppdl) at 5305 Old Main Hill, Logan, UT 84322. The fee is $7, 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 $7-25 and must be accompanied by a form (970-491-6950, plantclinic.agsci.colostate.edu).

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, 121 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
West Linn, OR
503-342-8611
alphascents.com

ISCA Technologies
Riverside, CA
(951) 686-5008
iscatech.com

Great Lakes IPM
Vestaburg, MI
800-235-0285
greatlakesipm.com

Trece
Adair, OK
918-785-3061
trece.com

Pest Monitoring Toolkit

- 10x-30x magnification hand lens
- orange delta traps and codling moth, greater peachtree borer, and/or peach twig borer pheromone lures
- extra sticky liners for traps
- Pherocon AM yellow sticky traps plus external ammonium carbonate lure
- beating tray and padded stick
- vials of alcohol, tweezers, a small paintbrush, and plastic containers 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 Pest Biology sections.

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 physiological 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.

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

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):

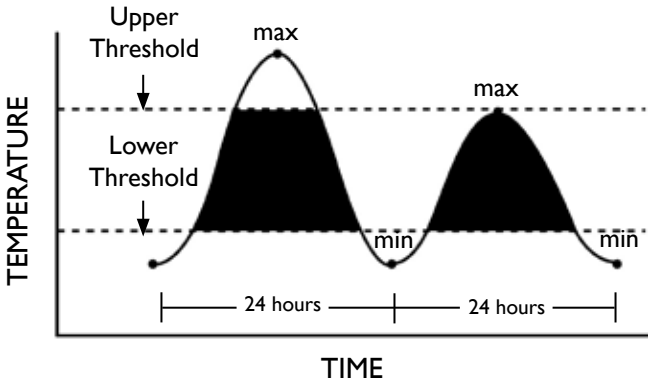
[(daily maximum temperature + daily minimum temperature)/2] – baseline temperature.

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.

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.

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 (which would be January 1 in the Intermountain West) 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).

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 weekly.
- 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/plant-clinic), MSU Ravalli County Extension (msuextension.org/ravalli), and MSU's Western Agricultural Research Center (agresearch.montana.edu/warc).

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
Box Elder 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. 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.

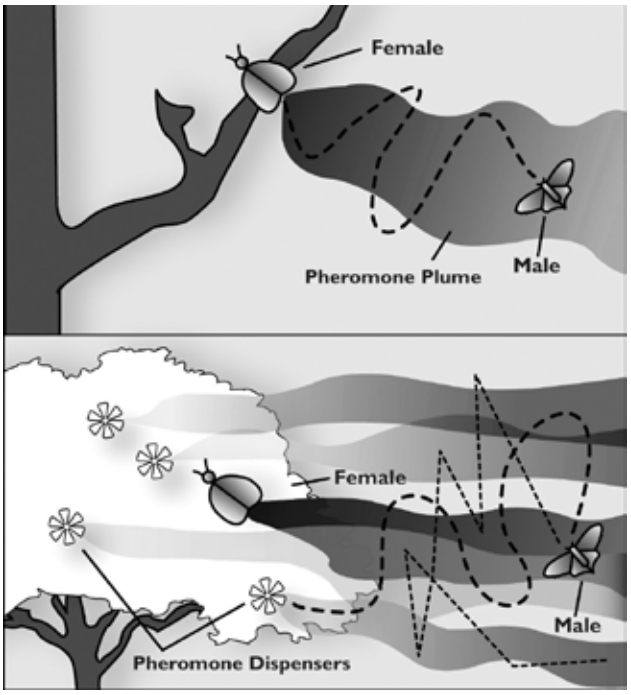
In the wild, male moths find female moths for mating by following the species-specific scent (called a pheromone), that females exude. Under MD, an orchard is saturated with that same female pheromone, "confusing" males and preventing them from finding females. Mating never occurs or is significantly 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, though available, has not proven effective.)

General MD guidelines:

- All dispensers last only one season.
- Hang them singly and evenly in the orchard canopy.
- 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.

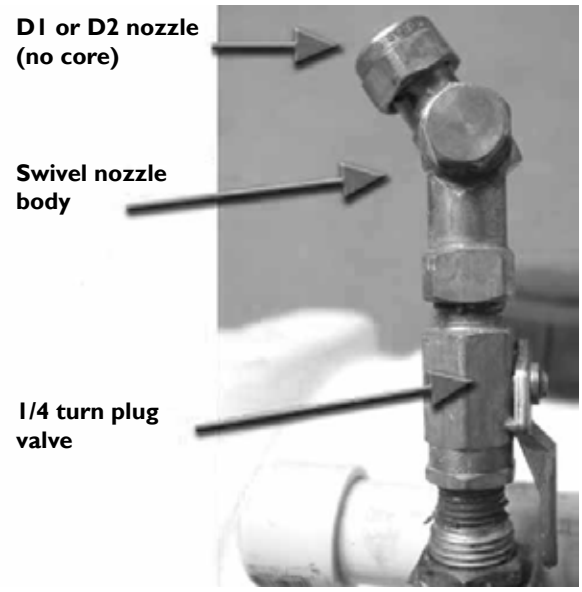
Brand	Type	Rate	Hang at:	Cost (approx)	Effectiveness	Notes
CODLING MOTH - APPLE, PEAR						
Isomate-CM Flex	hand-applied loops	200-400/ac	apple full bloom	$100/acre (at 400/ac rate)	very effective	hang high in tree
Checkmate CM-XL	hand-applied clips	200/acre	apple full bloom	$100/acre	somewhat effective	hang high in tree
Checkmate CM-O Puffer	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, consider treating after a cumulative capture of 6 moths	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/trap/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 an insecticide 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 outside 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, $350-$400 for 1 quart; Cropworx in Eckert, CO, 970-835-3335, or online at www.cropworx.net.

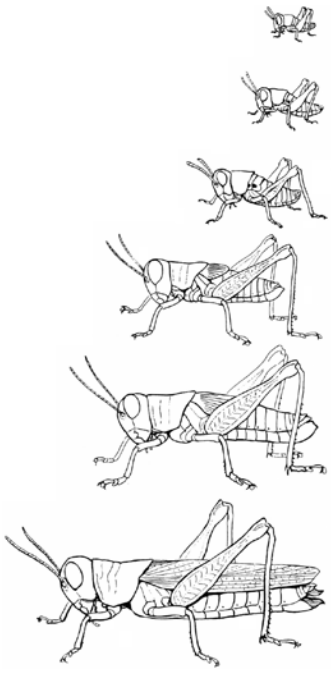
Some points to remember when using codling moth virus:

- 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 or *Nosema locustae* (a natural grasshopper pathogen) that must be consumed
   - 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

2. Dust (carbaryl):
   - easy to apply, but expensive
   - does not readily adhere to foliage and must be reapplied frequently

3. Sprays (malathion, carbaryl, diflubenzuron):
   - less expensive
   - adheres to plant material
   - malathion and carbaryl kill on contact, or when grasshoppers eat foliage
   - diflubenzuron must be ingested and 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 small 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 task. 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

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

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.

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 experimenting with the use 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, 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/

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

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.

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 (pest.ceris.purdue.edu) 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: utahpests.usu.edu/caps

Colorado: www.colorado.gov/pacific/agplants/pest-survey

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: pest.ceris.purdue.edu

CHAPTER 3 INSECT AND MITE BIOLOGY AND MONITORING

Aphids - Green Apple Aphid

HOSTS: 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.

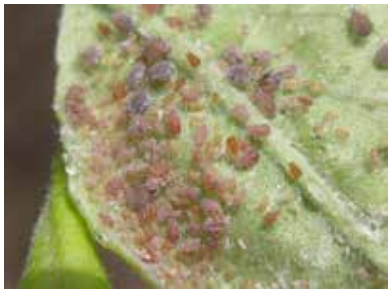
MONITORING: Look for shiny black eggs in early spring. If aphids are a problem later in the season, start after petal fall and select a random shoot on the major cultivar in the block and count the number of leaves that have one or more wingless aphids; repeat on 10-20 more shoots, and determine an average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

DEGREE DAY MODEL: none

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



HOSTS: 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.

DEGREE DAY MODEL: none

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

HOSTS: 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; 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.

DEGREE DAY MODEL: none

MGMT CONSIDERATIONS: 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

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.

DEGREE DAY MODEL: upper threshold: 82°F; lower threshold: 39°F; 274 degree days required for one generation.

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

Aphids - Black Cherry Aphid

HOSTS: 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.

DEGREE DAY MODEL: none

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

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.

DEGREE DAY MODEL: lower threshold: 44°F; adults active at 1450 degree days after March 1.

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

Brown Marmorated Stink Bug

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 can cause dark-colored lesions, pits, depressions and cat-facing 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.

DEGREE DAY MODEL: upper threshold: 91.4°F; lower threshold: 59°F

BMSB Life Stage	Degree Days
Pre-oviposition period	148
Egg hatch	126
Egg to adult	538

MGMT CONSIDERATIONS: In 2017, BMSB was found causing damage on backyard peaches in Utah. It has been trapped in commercial orchards in northern Utah, but no economic losses have been documented in any Intermountain West state. Treat with insecticides when active populations and initial crop damage are detected.

Cat-facing Insects

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. They 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.

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

TREATMENT THRESHOLD: No threshold determined.

DEGREE DAY MODEL: none

MGMT CONSIDERATIONS: Early-season feeding causes fruit distortion. Injury near harvest causes pits and sunken areas on fruits and lowers fruit quality and storability.

Codling Moth

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 (1x) 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 count 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	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

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.

DEGREE DAY MODEL: Lower threshold 47°F; summer generation adults are active beginning at 725 DD.

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.

Flatheaded Borers

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 May-July.

TREATMENT THRESHOLD: No threshold determined.

DEGREE DAY MODEL: none

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

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	Degree Days
adults begin flight (UT)	575-650
50% moths have flown	1290

MGMT CONSIDERATIONS: Peachtree borer can be difficult to control because of the protection given them once they have entered the tree. Mating disruption (1+ acres) or preventive trunk sprays covering the upper roots and 12-18" of lower trunk are the main control tactic.

Leaf Blister Mites

HOSTS: apple, pear

BIOLOGY: Pear-leaf and apple-leaf 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.

DEGREE DAY MODEL: none

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

Leafhoppers

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.

DEGREE DAY MODEL: none

MGMT CONSIDERATIONS: Nymphs are easier to control than adults.

Leafrollers

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.

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

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.

Peach Silver Mite

HOSTS: nectarine, peach

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 difficult. Starting in mid summer, check the leaves for the silvering symptom.

TREATMENT THRESHOLD: No threshold determined.

DEGREE DAY MODEL: none

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

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	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 Psylla

HOSTS: 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.

DEGREE DAY MODEL: lower threshold: 41°F

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)

HOSTS: cherry, pear

BIOLOGY: Overwinters as a pupa 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.

DEGREE DAY MODEL: none

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

Root Borers

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

BIOLOGY: Prionus root borer (*next page, top right*) and ten-lined June beetle grubs (*bottom right*)

feed on roots and crowns of cherry and peach. They can be a problem in sandy soils, and in new orchard sites.

SYMPTOMS/DAMAGE: General tree decline with few other above ground symptoms. Extensive feeding throughout roots and within crown wood.

MONITORING: Ground bucket traps baited with prionic acid pheromone lures will attract male prionus beetles.

TREATMENT THRESHOLD: No threshold determined.

DEGREE DAY MODEL: none

MGMT CONSIDERATIONS: Soil application of a systemic insecticide 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. Entomopathogenic nematodes and fungi can be effective on June beetle larvae. Mass trapping with a pheromone lure can help to reduce prionus populations.

Root Weevils

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.

DEGREE DAY MODEL: none

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.

Rust Mites

HOSTS: apple, pear

BIOLOGY: Rust mites are microscopic mites in the eriophyid group. Adults overwinter under leaf bud scales of pear and apple, and emerge with new leaf growth in the spring.

SYMPTOMS/DAMAGE: Russeted fruit; pear leaves are sensitive to rust mites, becoming bronzed or scorched.

MONITORING: Use a hand lens to inspect leaves starting in mid-spring.

TREATMENT THRESHOLD: No threshold determined.

DEGREE DAY MODEL: none

MGMT CONSIDERATIONS: In apple, rust mites can be beneficial in that they may serve as alternative prey for predatory mites that also help suppress spider mites. In pear, lower populations can be tolerated as pear leaves are sensitive to injury.

San Jose Scale

HOSTS: apple, pear, cherry, peach, nectarine

BIOLOGY: San Jose scale is an armored scale that

overwinters as a mix of nymphs and adults. 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.

Spider Mites

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).

DEGREE DAY MODEL: none

MGMT CONSIDERATIONS: In addition to plant-feeding mites, there are predatory mites that feed on spider mites. Predatory mites can provide effective biological control if they aren't harmed by pesticides. 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)

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.

DEGREE DAY MODEL: none

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

Thrips, Western Flower

HOSTS: apple, nectarine

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.

MONITORING: Shake flower clusters vigorously into a cup or jar. Test 5 clusters on 5 trees per 10 acres.

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

DEGREE DAY MODEL: none

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

Walnut Husk Fly

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.

TREATMENT THRESHOLD: No threshold determined.

DEGREE DAY MODEL: none

MGMT CONSIDERATIONS: Treat by 7-10 days after the first adult flies are caught or beginning in late July.

Western Cherry Fruit Fly

HOSTS: 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.

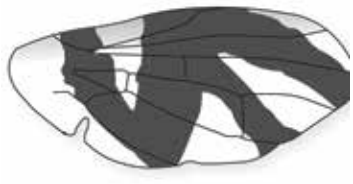
TREATMENT THRESHOLD: No threshold determined.

DEGREE DAY MODEL: lower threshold: 41°F

MGMT CONSIDERATIONS: To prevent egg-laying in fruits, treat by 5-7 days after the first flies are detected, when fruits develop a salmon blush color, or when 900 degree days has passed since March 1. Proper timing of insecticides is important.

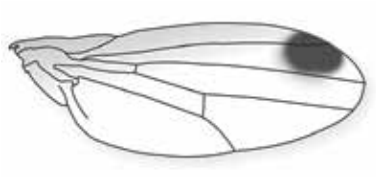
Comparison of Fruit Fly Wings

Apple Maggot



Walnut Husk Fly

Spotted Wing Drosophila



Western Cherry Fruit Fly

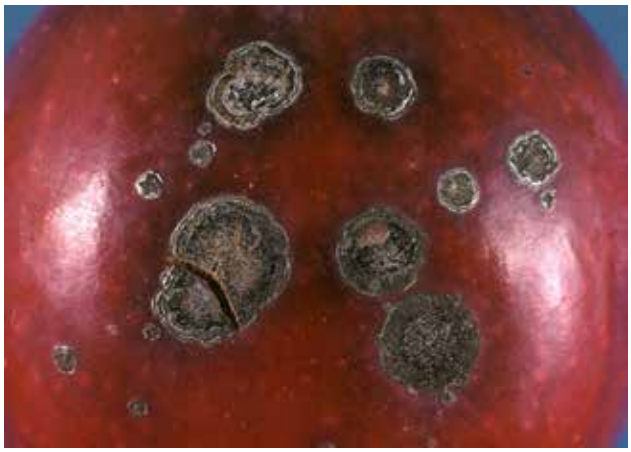
CHAPTER 4 DISEASE BIOLOGY AND MONITORING

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 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.

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

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

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.

to fall. Rainy 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.

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

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

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*.

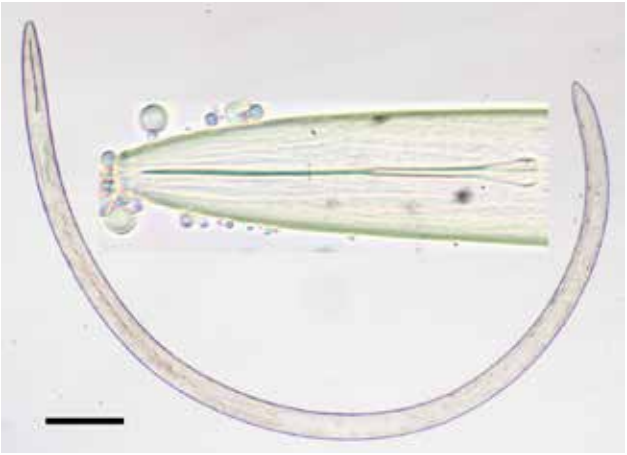
Dagger Nematode (*Xiphinema* spp.)

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



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

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); 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.

REFERENCES:

Pokharel, R. R. and H. J. Larsen. 2007. The importance and management of phytoparasitic nematodes in western Colorado orchards. Journal of Nematology 39(1): 96.

Pokharel, R. and H. J. Larsen. 2008. Plant parasitic nematodes associated with fruit crops in western Colorado. Western Colorado Research Center, Colorado State University. Annual report, TR 07-08: 22-28.

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.

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.

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.

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.

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.

- 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:

- ***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.

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

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.*

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

Organic Certification

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.

Soil, nutrient, pest, and weed management are all interrelated on organic farms and must be managed in concert for success. 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 (attra.ncat.org/organic.html).

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. During this time, growers will likely assume greater operating expenses, without earning organic price premiums.

Accredited Certification Agencies and Other Resources

- **Utah**: ag.utah.gov/plants-pests/organic-certifications
- **Colorado**: www.colorado.gov/pacific/agplants/organic-resources
- **Idaho**: agri.idaho.gov/main/about/about-isda/ag-inspections/organic-certification-program
- **Montana**: agr.mt.gov/Organic-Program
- National Organic Program: www.ams.usda.gov/nop
- OMRI (Organic Materials Review Institute): www.omri.org
- Organic Farming Research Foundation: www.ofrf.org
- Organic Trade Association: www.ota.com
- Organic Crop Improvement Association: www.ocia.org
- Western Sustainable Agriculture Research and Education Program: westernsare.org

Organic Orchard Design

Orchard design and cultivar selection have a long-term impact on pest control. While apple trees are resilient and can usually survive for decades without human intervention, year-round migration of pests from wild or unmanaged apple trees almost guarantee pest damage to unsprayed fruit. Surveys

have shown that more than 95% of the fruit on wild or abandoned apple trees are usually damaged or infested.

Some specific organic pest control methods are more effective when there are fewer orchard edges bordering natural areas or unmanaged orchards. For example, pheromone mating disruption is much less effective in apple orchards where mated female codling moths, oriental fruit moths, or apple maggots can easily fly into the orchard from surrounding areas. In some situations, growers may want to selectively remove unmanaged trees that are closely related or a host for other pests of the fruit crop. For example, apple pests may move from crabapple trees, hawthorns, cedar, juniper, mountain ash, cotoneaster, and quince. To minimize migration of pests, these species would need to be removed within a minimum of a half-mile of the orchard.

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.

Pest Management Concerns

Beneficial insects are an excellent tool in an organic production program but cannot be counted on as a stand-alone method of control. Any pest management program needs to be a multi-faceted plan of action. A well balanced "toolbox" for an organic pest management program may include beneficial insects, bat boxes, insect-specific bacteria or viruses, mating disruption, tangle foot, apple bags, baits, traps, and less toxic organic pesticides.

Vertebrate pests such as mice and voles can become a serious problem in orchards during the winter where surrounding hedgerows, brambles, or fields provide an ideal rodent habitat during the summer months. 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. Many species of fruit-eating birds also thrive in hedgerows or woods, and fruit damage by birds in late summer tends to be more problematic where they have an ideal habitat around orchards.

Replanting certain fruit trees into land previously planted with fruit trees often results in stunted trees and reduced yields. This disease syndrome, known as replant disease, has nonspecific causes that often differ from one site to another. Multiple biotic and abiotic factors are involved in replant disease. Organic growers can potentially minimize the negative effects of apple replant disease by avoiding the old tree rows of the previous orchard when planting new trees. Additionally, several rootstock selections are more resistant to replant disease.

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 apple replant disease include allowing a fallow period before planting, soil pH adjustment, minimizing soil compaction, improving soil drainage, correcting nutrient deficiencies, and providing supplemental irrigation immediately after nursery trees are planted in the orchard.

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."

Naturally derived soil amendments have variable nutrient levels depending upon the sources from which they were derived. Therefore, nutrient availability from composts and cover crops will be specific for the soil type and crop demand in each orchard.

Besides supplying nutrients, soil amendments can 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.

The soil can be further improved by through tillage and cultivation practices that maintain or improve the physical, chemical, and biological condition of soil, and minimize erosion.

Under NOP regulations, many commercial fertilizers are permitted, but for most nutrients 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.

Cover Crops

Preplant cover cropping can improve soil conditions, and provides nutrients and organic matter. Other benefits of cover crops include reducing soil erosion, attracting beneficial insects, and improving site aesthetics, which are especially important in U-Pick orchards.

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. Organic growers can also maintain cover crops or permanent grass covers in bearing orchards to suppress weeds.

Compost

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.

Fertilizers

Any material, including fertilizers, that is used in a certified organic system must be approved under NOP regulations by your certifier. 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. 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

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
Fertibor (boron)	White, odorless, powder that is not flammable, combustible, or explosive, and has low acute oral and dermal toxicity.	
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

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) Agri-Flex (Syngenta)	Epi-Mek 0.15 EC (Syngenta) Reaper 0.15 EC (Loveland) Zoro (Cheminova)
carbaryl	Sevin 4F (Novasource)	Carbaryl 4L (Loveland; Drexel)	Sevin SL (Bayer)
beta-cyfluthrin	Baythroid XL (Bayer)	Leverage 360 (Bayer)	Sultrus (Helena)
esfenvalerate	Asana XL (Valent)	S-FenvaloStar (LG Life)	Zyrate (Rotam)
imidacloprid	Admire Pro (Bayer)	Alias 2F, 4F (Makhteshim) Couraze 1.6F, 2F, 4 (Cheminova) Dominion 2L (Controle Sol. Inc.) Kilter (Nufarm) Macho 2 FL (Albaugh) Malice 75 WSP (Loveland) 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)	Besiege (Syngenta) Cobalt (Dow) Drexel L-C (Drexel) Grizzly Too, Z (Winfield) Kilter (Nufarm) Lambda T, T2 (Helena)	Lambda-Cy (United Phosphorus) LambdaStar (LG Life) Lamcap (Syngenta) Paradigm (Makhteshim) Province (Tenkoz) Silencer 1 EC (Makhteshim)
permethrin	Pounce 25 WP (FMC) Ambush 25 W (Amvac)	Arctic 3.2 EC (Winfield) Astro (FMC) Fastac CS (BASF) Gladiator (FMC) Mustang (FMC)	Perm-Up 3.2 EC (United Phosphorus) Permastar AG (LG Life) Tengard SFR (United Phosphorus)

Restricted Entry and Pre-Harvest Intervals

Formulation Name (Active Ingredient Name)	Type	REI (hrs)	PHI (days)						
			apple	pear	cherry	peach	nectar-ine	apricot	plum
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) [foliar]	I	12	7	7	7	0	0	0	7
Agri-Flex (thiamethoxam/ abamectin)	I	12	35	35	---	---	---	---	---
Agri-Mek SC (abamectin)	I	12	28	28	21	21	21	21	21
Agri-Mycin 17 (streptomycin)	F	12	50[b]	30[b]	---	---	---	---	---
Aim EC (carfentrazone)	H	12	3	3	3	3	3	3	3
Aliette WDG (aluminum tris)	F	12	14	14	NL[a]	NL[a]	NL[a]	NL[a]	NL[a]
Alion (indaziflam)	H	24	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
Apollo SC (clofentezine)	I	12	45[ef]	21[ef]	21[ef]	21[ef]	21[ef]	21[ef]	---
Asana XL (esfenvalerate)	I	12	21	28	14	14	14	14	14
Assail 30SG/70 WP (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
Azatrol EC (azadirachtin)	I	4	NL	NL	NL	NL	NL	NL	NL
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
Bexar (tolfenpyrad)	I	---	---	14[df]	14[df]	14[df]	14[df]	14[df]	14[df]
Biobit HP (*Bacillus thuringenesis*)	I	4	0	0	0	0	0	---	0
BlightBan A506 (*Pseudomonas fluorescens*)	F	4	0[f]	0[f]	0[f]	0[f]	0[f]	0[f]	---
Blossom Protect (*Aureobasidium pullulans*)	F	4	0[bf]	0[bf]	---	---	---	---	---
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	---	---	---	---	---
Calypso 4 F (thiacloprid)	I	12	30[f]	30[f]	14[f]	14[f]	14[f]	14[f]	14[f]
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

I = insecticide
F = fungicide
H = herbicide

NL = no time listed
--- = not labeled for that crop

a = non-bearing trees only
b = pre-bloom only
c = do not apply after shuck split

d = not registered in Colorado
e = not registered in Idaho
f = not registered in Montana

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
Casoron 4G (dichlobenil)	H	12	0	0	0	---	---	---	---
Centaur WDG (buprofezin)	I	12	14[df]	14[df]	14[df]	14[df]	14[df]	14[df]	14[df]
Champ Dry Prill, Champ Formula 2, Champ WG (copper hydroxide)	F	48	0[b]	0[b]	0[b]	21	21	0[b]	0[b]
Chateau SW (flumioxazin)	H	12	60	60	60	60	60	60	60
Closer SC (sulfoxaflor)	I	12	7	7	7	7	7	7	7
C-O-C-S WDG (copper oxychloride)	F	48	0[f]	0[f]	0[f]	0[f]	0[f]	0[f]	0[f]
Cueva (copper octanoate)	F	4	0	0	0	0	0	0	0
Cuprofix (copper sulfate)	F	48	0	0	0	0	0	0	0
Cyd-X (*Cydia pomonella* granulosis virus)	I	4	0	0	---	---	---	---	---
Danitol 2.4 EC (fenpropathrin)	I	24	14	14	3	3	3	3	3
Delegate WG (spinetoram)	I	4	7	7	7	1	1	14	1
Diazinon 50W (diazinon)	I	4 days	21	21	21	21	21	21	21
Dimethoate 4EC (dimethoate)	I	10-14 days	---	28	21[d]	---	---	---	---
Dimilin 2L (diflubenzuron)	I	12	---	14	---	14	14	14	14
Dipel DF (*Bacillus thuringiensis*)	I	4	0	0	0	0	0	0	0
Elevate 50WDG (fenhexamid)	F	12	---	0	0	0	0	0	0
Endigo ZC (thiamethoxam/ lambda-cyhalothrin)	I	24	35	35	14	14	14	14	14
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
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]
Gem 500 SC (trifloxystrobin)	F	12	---	---	1	1	1	1	1
GF-120 NF (spinosad)	I	4	0	0	0	0	0	0	0
Gladiator (abamectin/zeta-cypermethrin)	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	12	NL	NL	28	14	28	28	28
Grandevo (*Chromobacterium subtsugae*)	I	4	0	0	0	0	0	0	0

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e = not registered in Idaho
f = not registered in Montana

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
Imidan 70-W (phosmet)	I	7 days cherry-3	7	7	7 (tarts only)	14	14	14	14
Indar 2F (fenbuconazole)	F	12	14	---	0	0	0	0	0
Inspire Super (difenoconazole/ cyprodinil)	F	12	14	14	2	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
Kanemite 15 SC (acequinocyl)	I	12	14	14[b]	7	---	---	---	---
Karmex DF (diuron)	H	12	0[e]	NL[e]	---	8 mo.	---	---	---
Kasumin 2L (kasugamycin)	F	12	90	90	---	---	---	---	---
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
Kumulus DF (sulfur)	F	24	0[d]	0[d]	0[d]	0[d]	0[d]	0[d]	0[d]
Lannate LV, Lannate SP (methomyl)	I	2-4 days	14	---	---	4	1	---	---
Leverage 360 (imidacloprid/ cyfluthrin)	I	12	7	7	7	7	7	7	7
Luna Experience (fluopyram/ tebuconazole)	F	12	---	---	0	0	0	0	0
Luna Sensation (fluopyram/ trifloxystrobin)	F	12	14	---	1	1	1	---	---
Malathion 57 EC (malathion)	I	12-24	---	1	3	7	7	6	---
Matrix SG (rimsulfuron)	H	4	7	7	14	14	14	14	14
Merivon Xemium (pyraclostrobin/ fluxapyroxad)	F	12	0	0	0	0	0	0	0
Microthiol Disperss (sulfur)	F	24	0	0	0	0	0	0	0
Milstop (potassium bicarbonate)	F	1	0	0	---	0	---	0	0
M-Pede (potassium salts of fatty acids)	I	12	0	0	0 (tarts only)	0	0	0	0
Mycoshield (oxytetracycline)	F	12	60	60	---	21	21	---	---
Nealta (cyflumetofen)	I	12	7	7	---	---	---	---	---
NemaSeek (*Heterorhabditis bacteriophora*)	I	---	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	0[f]	0[f]	0[f]	21[f]	21[f]	0[f]	0[f]
Onager (hexythiazox)	I	12	28	28	7	7	7	7	7
Ph-D (polyoxin D zinc salt)	F	4	0	0	0	0	0	0	0
Phostrol (salts of phosphorous acid)	F	4	0	0	0	0	0	0	0
Phyton 27 AG (copper sulfate pentahydrate)	F	48	0	0	0	0	0	0	0
Poast (sethoxydim)	H	12	14	14	25	25	25	25	25

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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
Pounce 25 WP (permethrin)	I	12	NL[bf]	NL[bf]	3[f]	14[f]	14[f]	---	---
Princep 4L (simazine)	H	12	150	NL	NL (tarts only)	---	---	---	---
Pristine (boscalid/pyraclostrobin)	F	12	0	0	0	0	0	0	0
Proclaim (emamectin benzoate)	I	12	14	14	---	---	---	---	---
Procure 480SC (triflumizole)	F	12	14	14	1	---	---	---	---
PropiMax EC (propiconazole)	F	12	---	---	0	0	0	0	0
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 (azoxystrobin/ difenoconazole)	F	12	---	---	0	0	0	0	0
Quash (metconazole)	F	12	---	---	14	14	14	14	14
Quilt Xcel (azoxystrobin/ propiconazole)	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 (*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]
Rhyme (flutriafol)	F	12	14[e]	14[e]	7[e]	7[e]	7[e]	7[e]	7[e]
Ridomil Gold SL (mefenoxam)	F	48	NL	---	NL	NL	NL	NL	NL
Rimon 0.83EC (novaluron)	I	12	14	---	---	8	8	8	8
Savey 50 DF (hexythiazox)	I	12	28	28	28	28	28	28	28
Scythe 4.2E (pelargonic acid)	H	12	NL	NL	NL	NL	NL	NL	NL
Serenade ASO, Serenade MAX (*Bacillus subtilis*)	F	4	0	0	0	0	0	0	0
Sevin 4F (carbaryl)	I	12	3	3	3	3	3	3	3
Sinbar WDG (terbacil)	H	12	60	NL[a]	NL[a]	60	NL[a]	NL[a]	NL[a]
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	60	60	60	60	60	60
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
Success (spinosad)	I	4	7[f]	7[f]	7[f]	1[f]	1[f]	14[f]	7[f]
Sulfur 6L (sulfur)	F	24	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
Tersus (pyrethrins)	I	12	0	0	0	0	0	0	0
Tilt (propiconazole)	F	12	---	---	0	0	0	0	0

I = insecticide
F = fungicide
H = herbicide

NL = no time listed
--- = not labeled for that crop

a = non-bearing trees only
b = pre-bloom only
c = do not apply after shuck split

d = not registered in Colorado
e = not registered in Idaho
f = not registered in Montana

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
Topguard (flutriafol)	F	12	0	14	7	7	7	7	7
Topsin M WSB (thiophanate-methyl)	F	48	1	1	1	1	1	1	1
Ultor/Movento (spirotetramat)	I	24	7	7	7	7	7	7	7
Vangard WG (cyprodinil)	F	12	0	0	2 (tart 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
Vivando (metrafenone)	F	12	---	---	7	7	7	7	---
Voliam Flexi (thiamethoxam/ chlorantraniliprole)	I	12	35	35	14	14	14	14	14
Voliam Xpress (lambda-cyhalothrin /chlorantraniliprole)	I	24	21	21	14	14	14	14	14
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	---

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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
Acramite 50WS (bifenazate)	++	+	---	+	---	++
Actara (thiamethoxam)	++++	+++	+++	+	+++	+++
Admire Pro (imidacloprid)	++++	+++	+++	+	+++	++
Agri-Flex (thiamethoxam/abamectin)	++++	+	---	+++	+++	+++
Agri-Mek SC (abamectin)	+++	+	---	++++	---	+
Altacor (chlorantraniliprole)	+	+	+	+	++	++++
Apollo SC (clofentezine)	+	+	---	+	++	+
Asana XL (esfenvalerate)	++++	++++	++++	++++	++	++++
Assail (acetamiprid)	++	+++	++++	++++	++	+++
Avaunt (indoxacarb)	++	++++	++++	+	++++	+
Aza-Direct (azadirachtin)	++	+	+	+	---	+
AzaGuard (azadirachtin)	++	+	+	+	---	+
Azatin O (azadirachtin)	+	+	---	+	---	---
Azatrol EC (azadirachtin)	+	+	+	+	+	+
Bacillus thuringiensis	+	+	---	+	+	+
Baythroid XL (beta-cyfluthrin)	++++	++++	++++	++++	++	++++
Belay (clothianidin)	++++	++	---	+	++	++++
Beleaf 50 SG (flonicamid)	+	---	---	+	---	---
Biobit HP (*Bacillus thuringenesis*)	+	+	---	+	+	+
Brigade 2EC (bifenthrin)	++++	---	---	---	---	---
Calypso 4 F (thiacloprid)	++	+++	++++	+	++	+++
Captan 80 WDG (captan)	++++	---	---	++	---	++
Captiva Prime (canola oil/garlic oil)	+	++	---	++	---	---
Centaur WDG (buprofezin)	+	++	---	+	---	---
Closer SC (sulfoxaflor)	++++	---	---	---	---	---
C-O-C-S WDG (copper oxychloride)	+	---	---	---	---	---
Cyd-X (CM granulosis virus)	+	+	+	+	+	+
Danitol 2.4 EC (fenpropathrin)	++++	++++	++++	++++	++	++++
Delegate WG (spinetoram)	++	+	+	++++	+++	++++
Diazinon 50W (diazinon)	++++	+++	++++	+	+++	+++
Dimethoate 4EC (dimethoate)	++++	+++	---	+++	---	++++
Dimilin 2L (diflubenzuron)	+	++	---	---	---	++++
Dipel DF (*Bacillus thuringiensis*)	+	+	---	+	+	+
Elevate 50 WDG (fenhexamid)	+	---	---	---	---	---
Endigo ZC (thiamethoxam/lambda-cyhalothrin)	++++	++	++++	++	+++	++++
Entrust (spinosad)	+++	+++	---	+	+++	+
Envidor 2 SC (spirodiclofen)	++++	++	---	++	---	+

++++ = Most Hazardous - Do not apply to blooming crops or weeds
+++ = Hazardous – Apply only during late evening
++ = Moderately Hazardous – Apply only during late evening or early morning
+ = Reasonably Safe – Can be applied at any time
--- = No information available

Pesticide Toxicity to Pollinators and Beneficials, continued

Formulation Name (Active Ingredient Name)	honey-bees	lady beetles	parasitoid wasps	predatory mites	syrphid flies	lace-wings
Esteem 35 WP (pyriproxyfen)	+	+++	+++	+	---	+++
Exirel (cyantraniliprole)	+++	++++	++	+	+	++++
GF-120 NF (spinosad)	+++	+	---	+	---	---
Gladiator (abamectin/zeta-cypermethrin)	++++	---	---	---	---	---
Grandevo (*Chromobacterium subtsugae*)	++++	+	+	+	+	+
Horticultural oil	++	+	---	---	---	+
Imidan 70-W (phosmet)	++++	+++	++++	+	---	++
Intrepid 2F (methoxyfenozide)	+	+	+	+	+	+
Kanemite 15 SC (acequinocyl)	+	+	---	+	---	---
Kasumin (kasugamycin)	+++	---	---	---	---	---
Kumulus (sulfur)	+	---	---	++	---	++
Lannate LV, Lannate SP (methomyl)	++++	++++	++++	++++	---	+++
Leverage 360 (imidacloprid/cyfluthrin)	++++	++++	++++	++++	+++	++++
Malathion 57 EC (malathion)	+++	+++	+++	---	---	++++
Microthiol Disperss (sulfur)	+	---	---	++	---	++
M-Pede (potassium salts of fatty acids)	++	---	---	++	---	++
Nexter (pyridaben)	++	+++	---	+++	---	++
Nu-Cop 50 DF (copper hydroxide)	++	---	---	---	---	---
Onager (hexythiazox)	+	+	---	+	++	+
Phyton 27 AG (copper sulfate pentahydrate)	+	---	---	---	---	---
Pounce 25 WP (permethrin)	++++	++++	---	++++	---	++++
Proclaim (emamectin benzoate)	++++	+	---	---	---	+
Procure (triflumizole)	+	---	---	---	---	---
PropiMax EC (propiconazole)	++	---	---	---	---	---
Quadris Top (azoxystrobin/ difenoconazole)	+	---	---	---	---	---
Rimon 0.83EC (novaluron)	++++	++++	+++	++++	---	++++
Savey 50 DF (hexythiazox)	+	+	---	+	++	+
Sevin (carbaryl)	++++	+++	++++	+++	++++	+++
Sivanto prime (flupyradifurone)	+	+	++	++	---	+
Success (spinosad)	++	+++	---	+++	+++	+
Sulfur, wettable	+	---	---	++	---	++
Sulfur 6L (sulfur)	+	---	---	++	---	++
Surround WP (kaolin clay)	+	+	---	++	---	---
Ultor (spirotetramat)	+	---	---	+++	---	---
Vendex 50WP (fenbutatin-oxide)	+	+	---	++	---	+++
Venerate XC (*Burkholderia* spp. strain)	++	---	---	---	---	---

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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)	+	---	---	+++	---	+++

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Insecticide Classes

Main Group and *Primary Site of Action*	Chemical Sub-group or primary Active Ingredient	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, thiacloprid, 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 - Clofentezine, Hexythiazox	clofentezine, 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*	20A - Acequinocyl	acequinocyl
	20D - Bifenazate	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 *Energy metabolism*	25A - Beta-ketonitrile derivatives	cyflumetofen
28: Ryanodine receptor modulators *Nerve and muscle action*	28 - Diamides	chlorantraniliprole, cyantraniliprole

Fungicide Classes

Main Group and *Primary Site of Action*	Chemical Sub-group or primary Active Ingredient	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
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.

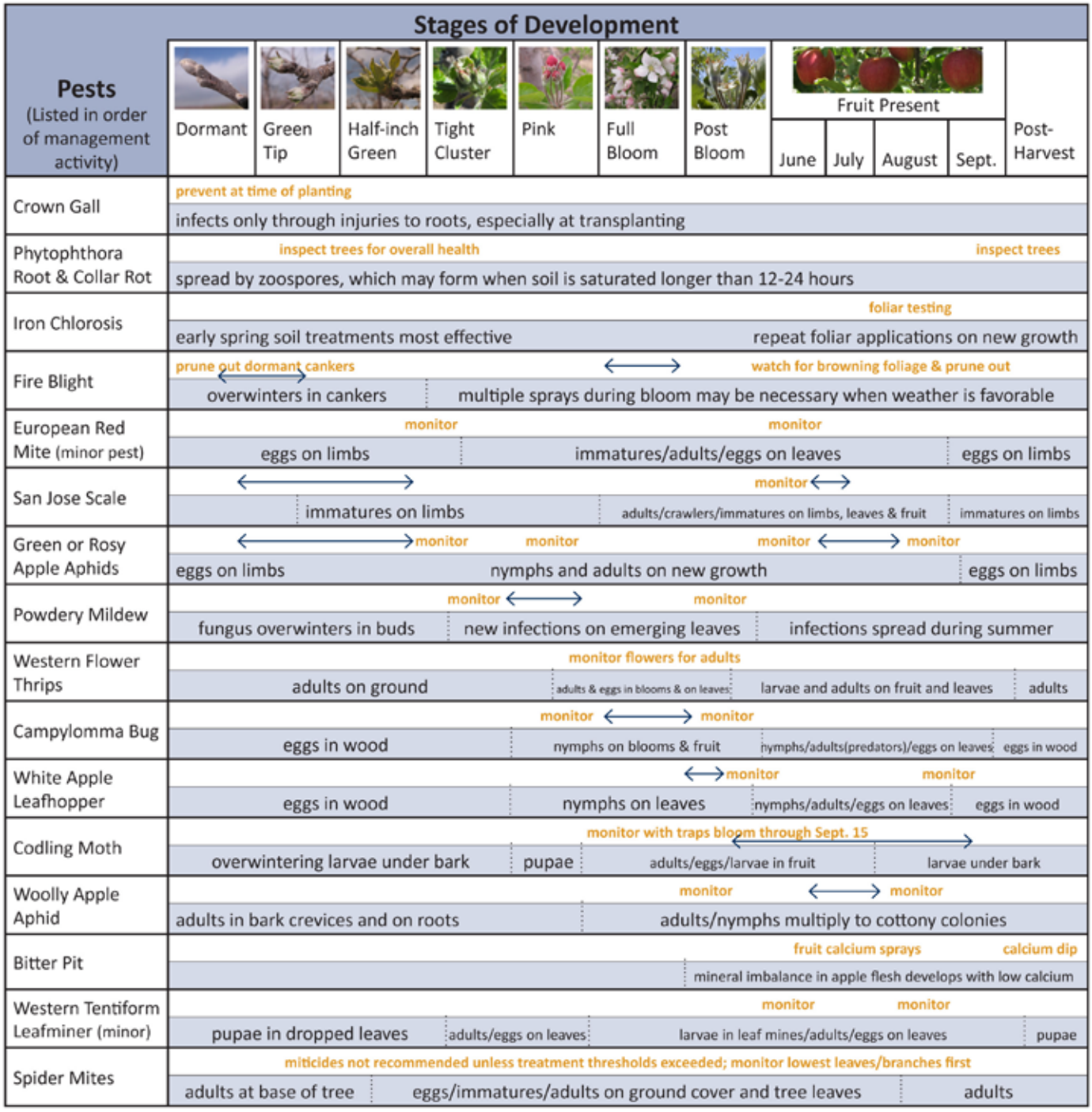
H**orticultural oil** - can cause injury if applied when temperatures read 85°F within 4 hours of application. Injury may also occur at temperatures under 40°F.

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



APPLE Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff.	MOA	Comments
GREEN TIP TO HALF-INCH GREEN (Delayed Dormant)						
Aphid Eggs (Green apple and Rosy apple aphids)	*Conventional:*					2% horticultural oil plus insecticide is more effective at killing overwintering eggs.
	Diazinon 50W[R] (diazinon) + 2% oil	---	1-1.5 lb	4	1	
	Reduced Risk/Organic:					
	Beleaf 50 SG (flonicamid)	2-2.8 oz	---	3	9	
	Horticultural oil[O] (many brands)	2%	2 gal	3	NC	**Diazinon:** max 1 application/yr.
	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)	2 qt	0.5 pt	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 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		
European Red Mite and Brown Mite *(these pests rarely need treatment)*	*Conventional*:					
	Gladiator[R] (abamectin/zeta-cypermethrin)	19 oz	4.75 oz	4	3/6	
	Reduced Risk/Organic:					
	Captiva Prime[O] (canola oil/garlic oil)	1-2 pt	---	2-3	NC	
	Horticultural oil[O] (many brands)	2%	2 gal	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/rate unknown
Number shown after pesticide name is number of days product lasts (only applies to certain pests).

APPLE Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff.	MOA	Comments
GREEN TIP TO HALF-INCH GREEN (Delayed Dormant) (continued)						
Fire Blight	*Conventional:*					**Champ Formula 2, Champ WG:** use on yellow varieties may cause discoloration. Max 1 application/yr. **Kocide:** the addition of 1 to 3 lb of hydrated lime per pound of Kocide may reduce crop injury. **Phyton:** max 1 application up to green tip.
	Champ Dry Prill, Champ Formula 2, Kocide (copper hydroxide)	See label	---	3	M1	
	Champ WG (copper hydroxide)	8-12 lb	---	3	M1	
	Phyton 27 AG (copper sulfate pentahydrate)	---	20-40 oz	3	M1	
	Reduced Risk/Organic:					
	Badge X2[O] (coppers)	3.5-7 lb	---	3	M1	
	C-O-C-S WDG (copper oxychloride)	8-11.7 lb	---	2	M1	
	Cueva[O] (copper octanoate)	---	---	3	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	Horticultural oil[O] (many brands) + one of the following:	2%	2 gal	4	NC	**Captiva:** use alone (do not mix with horticultural oil). **Centaur WDG:** max 1 application/yr. **Esteem:** max 2 applications/yr.
	Conventional:					
	Asana XL[R] (esfenvalerate) (7-14)	5-14.5 oz	2-5.8 oz	3	3	
	Centaur WDG (buprofezin) (7)	35-46 oz	---	2	16	
	Diazinon 50W[R] (diazinon) (14)	1 lb	---	4	1	
	Reduced Risk/Organic:					
	Captiva Prime[O] (canola oil/garlic oil)	1-2 pt	---	2-3	NC	
	Esteem 35 WP (pyriproxyfen) (14)	4-5 oz	---	3-4	7	
	Venerate[O] (*Burkholderia* spp. strain)	4-8 qt	---	2	NC	

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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APPLE Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff.	MOA	Comments
FIRST PINK						
Apple Scab *(this pest rarely needs treatment in commercial orchards)*	*Conventional:*					**Flint:** max 4 applications/yr.
	Procure 480SC (triflumizole)	8-16 oz	---	4	3	
	Rally 40WSP (myclobutanil)	5-8 oz	---	4	3	
	Vangard WG (cyprodinil)	5 oz	---	4	9	
	Reduced Risk/Organic:					
	Flint (trifloxystrobin)	2.5 oz	---	3-4	11	
	Kumulus DF[O], Microthiol Disperss[O], Sulfur 6L (sulfur)	See label	See label	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. **Indar 2F, Merivon, Pristine, Sovran:** max 4 applications/yr. **Topguard:** max 4 applications/yr; do NOT add adjuvant.
	Indar 2F (fenbuconazole) (7-10)	6-8 oz	---	4	3	
	Inspire Super (difenoconazole/cyprodinil) (7-10)	12 oz	---	4	3/9	
	Luna Sensation (fluopyram/trifloxystrobin) (7-14)	5-5.8 oz	---	3-4	7/11	
	Merivon Xemium (pyraclostrobin/fluxapyroxad) (7-10)	4-5.5 oz	---	4	7/11	
	Procure 480SC (triflumizole) (7-14)	8-16 oz	---	4	3	
	Rally 40WSP (myclobutanil) (10-14)	5-10 oz	---	4	3	
	Rhyme (flutriafol) (10)	4-6 oz	---	4	3	
	Sovran (kresoxim-methyl) (7-10)	4-6.4 oz	---	3	11	
	Topguard (flutriafol) (7)	10-14 oz	---	4	3	
	Topsin M WSB (thiophanate-methyl) (5-10)	0.75-1 lb	0.25 lb	2-3	1	

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APPLE Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff.	MOA	Comments
FIRST PINK (continued)						
POWDERY MILDEW (continued)						
Powdery Mildew	*Reduced Risk/Organic:*					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.
	Flint (trifloxystrobin) (7-10)	2-2.5 oz	---	4	11	
	Fontelis (penthiopyrad) (7-21)	16-20 oz	---	3	7	
	Kaligreen[O], MilStop[O] (potassium bicarbonate) (14)	See label	---	3	NC	
	Kumulus DF[O], Microthiol Disperss[O], Sulfur 6L (sulfur)	See label	See label	4	M2	
	Lime-sulfur[O] (10-14)	See label	---	3	M2	
	Ph-D (polyoxin D zinc salt) (10-14)	6.2 oz	---	3	19	
	Pristine (boscalid/pyraclostrobin) (7-10)	14-18.5 oz	---	3	7/11	
	Regalia[O] (*Reynoutria sachalinensis*) (7-10)	1-4 qt	---	---	NC	
	Serenade ASO[O] (*Bacillus subtilis*) (7)	2-4 qt	---	2	44	
	Serenade MAX[O] (*B. subtilis* strain) (7-10)	1-3 lb	---	2	44	
	Sonata[O] (*Bacillus pumilis* strain) (7-14)	2-4 qt	---	2	44	

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 first pink and continue at 7-14 day intervals 2-3 times or as needed
- infections may continue through the summer in humid conditions

Cultural:
- overwinters in buds and infects new leaves

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff.	MOA	Comments
PINK TO PETAL FALL						
Campylomma	*Conventional:*					One application at pink stage is more effective than at petal fall. **Assail:** apply at night or while bees are not working in blooms. Max 4 applications/yr. **Assail:** max 2 applications/acre/yr.
	Actara (thiamethoxam)	4.5 oz	---	3-4	4	
	Diazinon 50W (diazinon)	2-4 lb	---	3-4	1	
	Reduced Risk/Organic:					
	Assail 30SG, 70 WP (acetamiprid) (7-14)	See label	---	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

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APPLE Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff.	MOA	Comments
PINK TO PETAL FALL (continued)						
Western Flower Thrips *(May be a problem on yellow, pink, and green varieties.)*	*Reduced Risk/Organic:*					**Entrust:** max 4 applications/yr.
	Delegate WG (spinetoram)	4.5-7 oz	---	4	5	
	Entrust^{O} (spinosad)	2-3 oz	0.67-1 oz	4	5	
	Grandevo^{O} (*Chromobacterium subtsugae*)	3 lb	---	2-3	NC	
	Success (spinosad)	6-10 oz	---	4	5	

Pest Biology:
- overwinter as adults in on the ground and move to trees during bloom
- they 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)	1-2 units	---	4	NC	
	Checkmate CM-XL^{O} (mating disruption)	120-200	---	3	NC	
	Isomate-CM Flex^{O} (mating disruption)	200-400	---	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 17 (streptomycin) (3-4)	24-48 oz	4-8 oz	3-4	25	
	Kasumin 2L (kasugamycin) (3-4)	64 oz	---	3	24	
	Mycoshield (oxytetracycline) (2-3)	---	1 lb	2-3	41	
	Reduced Risk/Organic:					**Agri-Mycin 17:** where there is resistance, use only once per year mixed with oxytetracycline.
	Actigard 50WG (acibenzolar-S-methyl)	1-2 oz	---	2	NC	
	BlightBan^{O} A506 (*Pseudomonas fluorescens*)	See label	---	1-2	NC	
	Blossom Protect^{O} (*Aureobasidium pullulans*)	1.25 lb	---	3	NC	
	Cueva^{O} (copper octanoate)	14 oz	---	2	MI	
	Serenade MAX^{O} (*Bacillus subtilis* strain)	2-3 lb	---	2	44	

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APPLE Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff.	MOA	Comments
BLOOM (continued)						
FIRE BLIGHT (continued)						
Comments, continued:						
	Biologicals: products must be on flowers before infection. Apply at 10, 40, 70 and 90% open flowers.					
	Cueva: a soluble copper that is less phytotoxic; may cause russeting in some varieties. Max 10 applications per year.					
	Kasumin 2L: max 4 applications/yr.; alternate after 2 applications.					
	Mycoshield: max 6 applications/yr.					
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:*					**Admire Pro:** do not apply when bees are active.
	Actara (thiamethoxam) (10)	2-3 lb	---	3	4	
	Admire Pro foliar (imidacloprid) (10)	2.8 oz	---	4	4	
	Agri-Flex[R] (abamectin/thiamethoxam) (10)	5.5-8.5 oz	1.5-2 oz	4	4/6	**Agri-Flex:** max 2 applic./yr. Must be mixed with oil; can russet light-skinned fruit varieties.
	Lannate LV[R], Lannate SP[R] (methomyl) (7)	See label	---	2-3	1	
	Leverage 360[R] (cyfluthrin/imidacloprid) (14)	2.4-2.8 oz	---	4	3/4	
	Voliam Flexi (thiamethoxam/ chlorantraniliprole) (10)	6-7 oz	---	3	4/28	
	Reduced Risk/Organic:					**Assail:** max 4 applications/yr; use with oil.
	Assail 30SG, 70 WP (acetamiprid) (12)	See label	---	3-4	4	
	Aza-Direct[O], AzaGuard[O], Azatin O[O], Azatrol EC[O] (azadirachtin)	See label	---	2	UN	**Beleaf:** max 3 applications/yr.
	Beleaf 50 SG (flonicamid) (7)	2-2.8 oz	---	3	9	
	Captiva Prime[O] (canola oil/garlic oil)	1-2 pt	---	2-3	NC	
	Horticultural oil[O] (many brands)	1%	1 gal	2-3	NC	
	M-Pede[O] (potassium salts of fatty acids) (7-14)	See label	1-2 gal	2-3	28	
	Sivanto prime (flupyradifurone) (10)	7-14 oz	---	4	4	
	Ultor/Movento (spirotetramat) (14)	8-14 oz	---	4	23	
Comments, continued:						
	Lannates: do not use on early Macintosh and Wealthy varieties; max 5 applications per year.					
	Leverage 360: max 2 applications per year.					
	Ultor/Movento: must be tank-mixed with a spray adjuvant/additive; max 40 oz/acre per year.					
	Sivanto: max 20 oz/acre per year.					
	Voliam Flexi: max 4 applications/yr.					

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APPLE Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff.	MOA	Comments
PETAL FALL (continued)						
APHIDS (continued)						
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
Borer (Shothole, Flatheaded) *(minor pests in Intermountain West)*	*Conventional:*					**Warrior, Voliam Xpress:** only use if absolutely necessary. Pyrethroids are harmful to beneficials.
	Asana XL[R] (esfenvalerate) (7-14)	5-14.5 oz	2-5.8 oz	3	3	
	Endigo ZC[R] (thiamethoxam/lambda-cyhalothrin) (10)	5-6 oz	---	3	3/4	
	Voliam Xpress[R] (lambda-cyhalothrin/chlorantraniliprole) (10)	6-12 oz	---	3	3/28	
	Warrior II[R] (lambda-cyhalothrin) (5)	1.3-2.6 oz	---	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
Crown Rot *(Phytophthora)*	*Conventional*:					**Aliette, Fosphite, Phostrol:** apply as foliar spray as a protectant; will not "cure" already infected trees. Repeat 2-4 times per as necessary (every 60 days). Do not apply to dormant trees.
	Aliette WDG (aluminum tris) (30)	2.5-5.0 lb	0.5-1.0 lb	2	33	
	Reduced Risk/Organic:					
	Fosphite (salts of phosphorous acid)	---	1-3 qt	2	33	
	Phostrol (phosphorous acid)	2.5-5.0 pt	---	2	33	
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

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APPLE Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff.	MOA	Comments
PETAL FALL (continued)						
Fruitworm (Speckled Green Fruitworm) *(this pest rarely needs treatment)*	*Conventional:*					**Bt products:** must be applied when larvae are less than 1/2 inch.
	Danitol 2.4 EC[R] (fenpropathrin) (10)	16-21 oz	---	4	3	
	Gladiator[R] (abamectin/zeta-cypermethrin) (21)	19 oz	4.75 oz	4	3/6	
	Imidan 70-W (phosmet) (14-21)	3.5-5.7 lb	0.75-1 lb	2-3	1	**Danitol:** max 2 applications/yr.
	Leverage 360[R] (cyfluthrin/imidacloprid) (14)	2.4-2.8 oz	---	3-4	3/4	
	Voliam Flexi (thiamethoxam/ chlorantraniliprole) (14)	4-7 oz	---	4	4/28	**Delegate WG:** max 4 applic./yr.
and/or	*Reduced Risk/Organic:*					
	Altacor (chlorantraniliprole) (14)	2.5-4.0 oz	---	4	28	
Obliquebanded Leafroller	Aza-Direct[O], AzaGuard[O], Azatin O[O], Azatrol EC[O] (azadirachtin) (7)	See label	---	3	UN	**Entrust, Success:** max 4 applications/ yr. Toxic to bees for 3 hours after application.
(leafrollers are sporadic on apple and rarely need treatment)	Biobit HP, Dipel DF[O], XenTari[O] (*Bacillus thuringiensis* sub. *kurstaki*) (5-7)	See label	---	3-4	11	
	Delegate WG (spinetoram) (14)	4.5-7 oz	---	4	5	**Exirel:** max 3 applications/yr.
	Entrust[O], Success (spinosad) (7)	See label	---	3	5	
	Exirel (cyantraniliprole) (14)	10-17 oz	---	3-4	28	**Imidan:** max 22 lb/acre per year.
	Intrepid 2F (methoxyfenozide) (14)	8-16 oz	---	4	18	**Intrepid:** max 3 applications/yr.
						Leverage: max 2 applications/yr.
						Voliam: max 16 oz/acre/yr.

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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Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff.	MOA	Comments
PETAL FALL (continued)						
Lygus and Stink Bugs, including Brown Marmorated Stink Bug *(BMSB is not yet an economic pest in the Intermountain West)*	*Conventional:*					**Beleaf:** max 3 applications/yr. **Danitol, Leverage 360:** max 2 applications/yr.
	Danitol 2.4 EC[R] (fenpropathrin)	16-21.3 oz	---	3	3	
	Endigo ZC[R] (thiamethoxam/lambda-cyhalothrin)	5-6 oz	---	4	3/4	
	Gladiator[R] (abamectin/zeta-cypermethrin)	19 oz	4.75 oz	4	3/6	
	Leverage 360[R] (cyfluthrin/imidacloprid)	2.4-2.8 oz	---	3	3/4	
	Reduced Risk/Organic:					
	Beleaf 50 SG (flonicamid)	2-2.8 oz	---	4	9	

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:*					**Assail:** use with oil. Max 4 applications/yr. **Avaunt:** max 4 applications/yr. **Centaur WDG:** max 1 applic./yr. **Danitol, Leverage 360, Surround WP:** max 2 applic./yr. **Sevin 4F:** max 8 applications/yr. **Sivanto:** max 28 oz/acre per year.
	Avaunt (indoxacarb)	5-6 oz	---	3-4	22	
	Centaur WDG (buprofezin)	9-12 oz	---	3	16	
	Danitol 2.4 EC[R] (fenpropathrin)	11-21 oz	---	3	3	
	Leverage 360[R] (cyfluthrin/imidacloprid)	2.4-2.8 oz	---	3	3/4	
	Sevin 4F (carbaryl)	0.5-1.5 qt	---	4	1	
	Reduced Risk/Organic:					
	Assail 30SG, 70 WP (acetamiprid)	See label	---	3	4	
	Aza-Direct[O], AzaGuard[O], Azatin O[O], Azatrol EC[O] (azadirachtin)	See label	---	2	UN	
	Grandevo[O] (*Chromobacterium subtsugae*)	1-3 lb	---	2	NC	
	M-Pede[O] (potassium salts of fatty acids)	See label	1-2 gal	2-3	28	
	Sivanto prime (flupyradifurone)	7-14 oz	---	4	4	
	Surround WP[O] (kaolin clay)	25-50 lb	25-50 lb	1	NC	

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

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Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff.	MOA	Comments
PETAL FALL (continued)						
Woolly Apple Aphid and/or **San Jose Scale**	*Reduced Risk/Organic:* Ultor/Movento (spirotetramat)	8-14 oz	---	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

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff.	MOA	Comments
FRUIT PRESENT						
Aphids (Green Apple and Rosy Apple Aphids)	*Conventional:*					**Actara:** max 16.5 oz/acre per year. **Admire Pro:** max 14 oz/acre per year. **Assail:** max 4 applications/yr; use with oil for best results. **Calypso 4 F, Closer SC:** after petal fall only. **Horticultural oil**: use when temps are between 50 and 85°F.
	Actara (thiamethoxam) (10)	4.5-5.5 oz	---	3	4	
	Admire Pro (imidacloprid) (foliar) (10)	2.8 oz	---	4	4	
	Calypso 4 F (thiacloprid) (7)	2-4 oz	---	3	4	
	Closer SC (sulfoxaflor)	1.5-2.75 oz	---	4	4	
	Lannate LV[R] (methomyl) (7)	1.5-3 pt	---	4	1	
	Leverage 360[R] (cyfluthrin/imidacloprid) (14)	2.4-2.8 oz	---	4	3/4	
	Voliam Flexi (thiamethoxam/ chlorantraniliprole) (10)	6-7 oz	---	3	4/28	
	Voliam Xpress[R] (lambda-cyhalothrin/ chlorantraniliprole) (10)	6-12 oz	---	3	3/28	
	Reduced Risk/Organic:					
	Assail 30SG, 70 WP (acetamiprid) (12)	See label	---	3-4	4	
	Aza-Direct[O], AzaGuard[O], Azatin O[O], Azatrol EC[O] (azadirachtin) (7)	See label	---	2	UN	
	Captiva Prime[O] (canola oil/garlic oil) (5)	1-2 pt	---	2-3	NC	
	Horticultural oil[O] (many brands)	1%	1 gal			
	M-Pede[O] (potassium salts of fatty acids) (7)	See label	1-2 gal	2-3	28	
	Ultor/Movento (spirotetramat) (14)	8-14 oz	---	4	23	

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APPLE Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff.	MOA	Comments
FRUIT PRESENT (continued)						
APHIDS (continued)						
Comments, continued						
	Lannate LV: do not use on Early Macintosh or Wealthy varieties. Max 5 applic./yr.					
	Leverage 360: max 2 applic./yr.					
	Voliams: max 4 applications/yr.					
	Ultor/Movento: works best if applied at petal fall. Must be tank-mixed with a spray adjuvant/additive.					

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

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. **Delegate WG:** max 28 oz/acre per year. **Imidan:** max 8 applications/yr. **Leverage 360:** max 2 applications/yr.
	Actara (thiamethoxam) (10)	4.5-5.5 oz	---	3	4	
	Admire Pro (imidacloprid) (10)	2.8 oz	---	3	4	
	Asana XL[R] (esfenvalerate) (14)	5-14.5 oz	2-5.8 oz	2	3	
	Gladiator[R] (abamectin/zeta-cypermethrin) (21)	14-19 oz	3.5-4.7 oz	3	3/6	
	Imidan 70-W (phosmet) (14)	3.5-5.7 lb	0.75-1 lb	3	1	
	Leverage 360[R] (cyfluthrin/imidacloprid) (14)	2.4-2.8 oz	---	4	3/4	
	Sevin 4F (carbaryl) (14)	2-3 qt	---	3	1	
	Voliam Xpress[R] (lambda-cyhalothrin/ chlorantraniliprole) (10)	6-12 oz	---	4	3/28	
	Warrior II[R] (lambda-cyhalothrin) (21)	1.3-2.6 oz	---	3	3	
	Reduced Risk/Organic:					
	Altacor (chlorantraniliprole) (14)	3.0-4.5 oz	---	2	28	
	Assail 30SG, 70 WP (acetamiprid) (14)	See label	---	3	4	
	Delegate WG (spinetoram) (14)	4.5-7.0 oz	---	3	5	
	Entrust[O] (spinosad) (10)	2-3 oz	---	2	5	
	GF-120 NF[O] (spinosad + bait) (7-14)	10-20 oz	---	2-4	5	
	Success (spinosad) (7)	4-8 oz	1.3-2.7 oz	2	5	

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 red sticky sphere 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

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/rate unknown

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APPLE Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff.	MOA	Comments
FRUIT PRESENT (continued)						
Codling Moth	*Conventional:*					Keep fruit protected through September 15.
	Asana XL[R] (esfenvalerate) (14)	5-14.5 oz	2-5.8 oz	2	3	
	Danitol 2.4 EC[R] (fenpropathrin) (10)	16-21 oz	---	2	3	
	Endigo ZC[R] (thiamethoxam/lambda-cyhalothrin) (14)	5-6 oz	---	2-3	3/4	**Assail:** max 4 applications/yr; use with oil.
	Imidan 70-W (phosmet) (21)	2-5.75 lb	0.75-1 lb	3-4	1	
	Leverage 360[R] (cyfluthrin/imidacloprid) (14)	2.4-2.8 oz	---	2	3/4	
	Proclaim[R] (emamectin benzoate) (7-14)	3.2-4.8 oz	0.8-1.2 oz	3	6	**Bt products:** must be applied when larvae are less than 1/2 inch.
	Rimon 0.83EC (novaluron) (14)	20-50 oz	---	3-4	15	
	Sevin 4F (carbaryl) (14)	1-3 qt	---		1	
	Voliam Flexi (thiamethoxam/chlorantraniliprole) (14)	4-7 oz	---	4	4/28	**Danitol, Leverage 360:** max 2 applications/yr.
	Voliam Xpress[R] (lambda-cyhalothrin/chlorantraniliprole) (14)	6-12 oz	---	4	3/28	
	Warrior II[R] (lambda-cyhalothrin) (14)	1.3-2.6 oz	---	3	3	**Esteem:** max 2 applications/yr; use with oil.
	Reduced Risk/Organic:					
	Altacor (chlorantraniliprole) (14)	3.0-4.5 oz	---	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) (12)	See label	---	3-4	4	
	Biobit HP, Dipel DF[O], XenTari[O] (*Bacillus thuringiensis* sub. *kurstaki*) (7)	See label	---	3-4	11	
	Cyd-X[O] (*Cydia pomonella* granulosis virus) (7)	1-6 oz	---	2	NC	
	Delegate WG (spinetoram) (14)	6-7 oz	---	3-4	5	**Proclaim:** use with horticultural oil.
	Entrust[O] (spinosad) (7)	2-3 oz	0.67-1 oz	2-3	5	
	Esteem 35 WP (pyriproxyfen) (14)	4-5 oz	---	3	7	
	Exirel (cyantraniliprole) (14-21)	---	10-17 oz	4	28	
	Horticultural oil[O] (many brands)	1-1.5%	1-1.5 gal	1-2	NC	
	Success (spinosad) (7)	6-10 oz	---	3-4	5	

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 and other structures from orchards where larvae can overwinter

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APPLE Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff.	MOA	Comments
FRUIT PRESENT (continued)						
European Red Mite and Brown Mite *(these pests rarely need treatment in commercial orchards)*	*Conventional:*					**Apollo SC:** max 1 application/yr. **Envidor, Nexter, Savey:** max 1 application/yr. **Kanemite:** max 2 applications/yr. **Onager:** max 1 application/yr; works best on eggs. **Vydate:** max 4 applications/yr. **Zeal:** works best on eggs and nymphs; max 1 application/yr.
	Apollo SC (clofentezine)	4-8 oz	---	4	10	
	Envidor 2 SC (spirodiclofen)	16-18 oz	---	4	23	
	Gladiator[R] (abamectin/zeta-cypermethrin)	19 oz	4.75 oz	4	3/6	
	Nexter (pyridaben)	6.6-10 oz	---	3	21	
	Onager (hexythiazox)	12-24 oz	---	4	10	
	Savey 50 DF (hexythiazox)	3-6 oz	---	4	10	
	Vydate L[R] (oxamyl)	2-4 pt	---	4	1	
	Reduced Risk/Organic:					
	Horticultural oil[O] (many brands)	1-1.5%	1-1.5 gal	2-3	NC	
	Kanemite 15 SC (acequinocyl)	21-31 oz	---	4	20	
	Zeal (etoxazole)	2-3 oz	---	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

Grasshoppers	*Conventional*:					**NOLO Bait:** most effective on nymphs. Do not use if rain w/in 8 hours. **Sevin 4F:** use higher rate for mature grasshoppers. Bait form available.
	Sevin 4F (carbaryl)	0.5-1.5 qt	---	2-3	1	
	Reduced Risk/Organic:					
	NOLO Bait[O] (*Nosema locustae*)	1 lb	---	3	NC	

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.

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APPLE Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff.	MOA	Comments
FRUIT PRESENT (continued)						
San Jose Scale	*Conventional:*					**Assail:** max 4 applications/yr. **Centaur WDG:** max 1 application/yr. **Diazinon:** max 2 applications/yr. **Leverage 360, Esteem:** max 2 applications/yr.
	Centaur WDG (buprofezin)	34.5 oz	---	4	16	
	Closer SC (sulfoxaflor)	5.75 oz	---	3	4	
	Diazinon 50W[R] (diazinon)	---	1 lb	3	1	
	Imidan 70-W (phosmet)	3.5-5.7 lb	0.75-1 lb	1	1	
	Leverage 360[R] (cyfluthrin/imidacloprid)	2.4-2.8 oz	---	2	3/4	
	Reduced Risk/Organic:					
	Assail 30SG, 70 WP (acetamiprid)	3.4 oz	---	3	4	
	Aza-Direct[O], AzaGuard[O], Azatin O[O], Azatrol EC[O] (azadirachtin)	See label	---	1	UN	
	Esteem 35 WP (pyriproxyfen) + 1% hort. oil[O] (many brands)	4-5 oz	---	4	7	
	Sivanto prime (flupyradifurone)	10.5-14 oz	---	4	4	
	Venerate[O] (*Burkholderia* sp. strain)	4-8 qt	---	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		
Spider Mites	*Conventional:*					**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. **Envidor, Onager:** max 1 applic./yr. **Kanemite:** max 2 applications/yr. **Nealta:** max 2 applic./yr. Apply at first sign of mites. **Nexter:** max 1 application/yr. **Savey:** max 1 application/yr. **Zeal:** max 1 application/yr. Apply at first sign of mites.
	Agri-Flex[R] (abamectin/thiamethoxam/)	5.5-8.5 oz	1.5-2 oz	4	4/6	
	Envidor 2 SC (spirodiclofen)	16-18 oz	---	4	23	
	Nealta (cyflumetofen)	13.7 oz	---	4	NC	
	Nexter (pyridaben)	6.6-10 oz	---	2-3	21	
	Onager (hexythiazox)	12-24 oz	---	4	10	
	Savey 50 DF (hexythiazox)	3-6 oz	---	4	10	
	Reduced Risk/Organic:					
	Acramite 50WS (bifenazate)	0.75-1 lb	---	4	UN	
	Captiva prime[O] (canola oil/garlic oil)	1-2 pt	---	2-3	NC	
	Kanemite 15 SC (acequinocyl)	21-31 oz	---	3	20	
	M-Pede[O] (potassium salts of fatty acids)	See label	1-2 gal	2-3	28	
	Zeal (etoxazole)	2-3 oz	---	3-4	10	

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APPLE Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff.	MOA	Comments
FRUIT PRESENT (continued)						
SPIDER MITES (continued)						
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
Stink Bugs, including Brown Marmorated Stink Bug *(BMSB is not yet an economic pest in the Intermountain West)*	*Conventional*:					**Beleaf:** max 3 applications/yr. **Danitol:** max 2 applications/yr. **Lannate LV:** do not use on Early Macintosh and Wealthy varieties. Max 5 applications/yr. **Leverage 360:** max 2 applications/yr.
	Asana XL[R] (esfenvalerate) (14)	5-14.5 oz	2-5.8 oz	2	3	
	Closer SC (sulfoxaflor) (14)	2.8-5.8 oz	---	3	4	
	Danitol 2.4 EC[R] (fenpropathrin) (14)	16-21 oz	---	2	3	
	Gladiator[R] (abamectin/zeta-cypermethrin) (14)	14-19 oz	3.5-4.7 oz	3	3/6	
	Lannate LV[R] (methomyl) (14)	1.5-3 pt	---	4	1	
	Leverage 360[R] (cyfluthrin/imidacloprid) (14)	2.4-2.8 oz	---	3	3/4	
	Sevin 4F (carbaryl) (14)	1.5-3 qt	---	3	1	
	Warrior II[R] (lambda-cyhalothrin) (21)	1.3-2.6 oz	---	4	3	
	Reduced Risk/Organic:					
	Belay (clothianidin) (14)	4-6 oz	---	2	4	
	Beleaf 50 SG (flonicamid) (14)	2-2.8 oz	---	3	9	
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:*					**Avaunt:** max 4 applications/yr. **Calypso 4 F:** after petal fall only; 30-day PHI. **Centaur WDG:** max 1 applic./yr. **Danitol, Leverage 360:** max 2 applications/yr.
	Admire Pro (imidacloprid) (10)	1.4-2.8 oz	---	4	4	
	Avaunt (indoxacarb) (10)	5-6 oz	---	3-4	22	
	Calypso 4 F (thiacloprid) (10)	2-4 oz	0.5-1 oz	4	4	
	Centaur WDG (buprofezin) (14)	9-12 oz	---	3	16	
	Danitol 2.4 EC[R] (fenpropathrin) (10)	10-21.3 oz	---	3	3	
	Leverage 360[R] (cyfluthrin/imidacloprid) (14)	2.4-2.8 oz	---	4	3/4	
	Voliam Flexi (thiamethoxam/ chlorantraniliprole) (14)	4-7 oz	---	4	4/28	

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APPLE Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff.	MOA	Comments
FRUIT PRESENT (continued)						
WHITE APPLE LEAFHOPPER (continued)						
White Apple Leafhopper	*Reduced Risk/Organic:*					**Assail:** max 4 applications/yr.
	Assail 30SG, 70 WP (acetamiprid) (14)	2.5-4.0 oz	---	3	4	
	Aza-Direct^{O}, AzaGuard^{O}, Azatin O^{O}, Azatrol EC^{O} (azadirachtin) (7)	See label	---	2	UN	
	Captiva Prime^{O} (canola oil/garlic oil) (3-5)	1-2 pt	---	2-3	NC	
	Grandevo^{O} (*Chromobacterium subtsugae*) (7)	1-3 lb	---	2	NC	
	M-Pede^{O} (potassium salts of fatty acids) (7)	See label	1-2 gal	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.
	Diazinon 50W^{R} (diazinon)	---	1 lb	4	1	
	Reduced Risk/Organic:					
	Assail 30SG, 70 WP (acetamiprid)	2.5-4.0 oz	---	2-3	4	
	Beleaf 50 SG (flonicamid)	2-2.8 oz	---	2-3	9	**Beleaf:** max 3 applications/yr.
	Captiva Prime^{O} (canola oil/garlic oil)	1-2 pt	---	2-3	NC	
	Horticultural oil^{O} (many brands)	1-1.5%	---	2-3	NC	**Diazinon:** highly toxic to bees. Max 2 applications/yr.
	M-Pede^{O} (potassium salts of fatty acids)	See label	1-2 gal	2-3	NC	

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	Products	Rate (per acre)	Rate (per 100 g)	Eff.	MOA	Comments
EARLY FALL						
Pearleaf Blister Mite and Rust Mites	*Conventional:*					**Agri-Mek SC:** max 2 applications/ yr.
	Agri-Mek SC[R] (abamectin)	10-20 oz	2.5-5 oz	4	6	
	Sevin 4F (carbaryl)	1.5-3 qt	---	3	1	
(these pests rarely need treatment in commercial orchards)	*Reduced Risk/Organic:*					
	Captiva Prime[O] (canola oil/garlic oil)	1-2 pt	---	2-3	NC	
	Kumulus DF[O], Microthiol Disperss[O], Sulfur 6L (sulfur)	See label	See label	3	M2	
	Lime-sulfur + horticultural oil[O] (many brands)	See label	See label	4	M2	
	M-Pede[O] (potassium salts of fatty acids)	See label	1-2 gal	1-2	28	

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

Pests (Listed in order of management activity)	Stages of Development												
	 Dormant	 Swollen Bud	 Green Cluster	 White Bud	 First Bloom	 Full Bloom	 Petal Fall	 Post Bloom/Summer: June	July	August	Sept.	Post-Harvest
Crown Gall (minor pest)	prevent at time of planting												
	infection through injuries to roots, especially at time of transplanting												
Zinc Deficiency (minor problem)											foliar testing		
	dormant sprays most effective							foliar sprays only marginally effective					
Iron Chlorosis											foliar testing		
	early spring soil treatments most effective							repeat foliar applications on new growth					
Pear Psylla	⟷ monitor							monitor ⟷ monitor					
	adults on limbs; egg-laying begins in March							nymphs/summer adults/eggs on leaves and fruit				winter adults	
Pear Decline (minor pest)	use decline-resistant rootstocks											remove diseased trees	
	phytoplasma carried and spread by pear psylla						good psylla control reduces decline symptoms						
Fire Blight	prune out dormant cankers ⟷			⟷ watch for browning foliage & prune out in dry weather									
	overwinters in cankers			multiple sprays during bloom may be necessary when weather is favorable									
Rust Mite and Blister Mite (minor)	⟷							monitor			monitor ⟷		
	adults under buds			eggs/immatures/adults in buds, on leaves, and fruit								adults	
European Red Mite (minor pest)	⟷			monitor				monitor					
	eggs on limbs			immatures/adults/eggs on leaves								eggs on limbs	
San Jose Scale (minor pest)	⟷							monitor ⟷					
	immatures on limbs						adults/crawlers/immaturs on limbs, leaves, and fruit					immatures on limbs	
Codling Moth								monitor with traps bloom through Sept. 15 ⟷					
	larvae under bark			pupae under bark				adults/eggs/larvae in fruit				immatures on limbs	
Cherry (Pear) Slug (minor pest)											monitor ⟷ monitor		
	pupae in soil							adults/eggs/larvae on leaves				pupae in soil	
Spider Mites								miticides not recommended unless treatment thresholds exceeded					
	adults at base of tree			eggs/immatures/adults on ground cover and tree leaves								adults	

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.

PEAR Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff.	MOA	Comments
DORMANT						
Fire Blight	*Conventional*:					**Champ Formula 2, Champ WG:** use on yellow varieties may cause discoloration. Max 1 application/yr.
	Champ Dry Prill, Champ Formula 2, Kocide (copper hydroxide)	See label	---	3	M1	
	Champ WG (copper hydroxide)	8-12 lb	---	3	M1	
	Phyton 27 AG (copper sulfate pentahydrate)	---	20-40 oz	3	M1	**Kocide:** the addition of 1 to 3 lb of hydrated lime per pound of Kocide may reduce crop injury.
	Reduced Risk/Organic:					
	Badge X2[O] (coppers)	3.5-7 lb	---	3	M1	**Phyton:** max 1 applic. up to green tip.
	C-O-C-S WDG (copper oxychloride)	8-11.7 lb	---	2	M1	
	Cueva[O] (copper octanoate)	---	---	3	M1	
Pear Psylla	Horticultural oil[O] (many brands) + one of the following:	2%	2 gal			**Assail, Delegate WG:** max 4 applications/yr; use with adjuvant.
	Conventional:					
	Asana XL[R] (esfenvalerate)	5-14.5 oz	2-5.8 oz	3	3	**Esteem:** max 2 applications/yr.
	Gladiator[R] (abamectin/zeta-cypermethrin)	19 oz	---	4	3/6	
	Pounce 25 WP[R] (permethrin)	12.8-16 oz	---	3	3	**Lime-sulfur:** do not use with oil after the dormant stage.
	Warrior II[R] (lambda-cyhalothrin)	1.3-2.6 oz	---	3	3	
	Reduced Risk/Organic:					**Pounce:** pre-bloom only.
	Assail 30SG, 70 WP (acetamiprid)	See label	---	4	4	
	Delegate WG (spinetoram)	6-7 oz	---	4	5	**Sivanto:** max 20 oz/ acre per year.
	Esteem 35 WP (pyriproxyfen)	4-5 oz	---	3-4	7	
	Grandevo[O] (*Chromobacterium subtsugae*)	2-3 lb	---	---	NC	
	Lime-sulfur[O]	See label	---	3	M2	
	Sivanto prime (flupyradifurone) (10)	10.5-14 oz	---	---	4	

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

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

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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. **Sevin 4F:** do not apply during bloom or when weeds are blooming on orchard floor
	Nexter (pyridaben)	7-11 oz	---	4	21	
	Sevin 4F (carbaryl)	1.5-3 qt	---	3	1	
	Reduced Risk/Organic:					
	Captiva Prime[O] (canola oil/garlic oil)	1-2 pt	---	2-3	NC	
	Horticultural oil[O] (many brands)	2%	2 gal	4	NC	

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	Products	Rate (per acre)	Rate (per 100 g)	Eff.	MOA	Comments
PRE-BLOOM (White Bud - Full White)						
Powdery Mildew	*Conventional:*					**Biologicals** (Serenade, etc.) and **oils** must be applied before infection; they act as a protectant. **Flint, Merivon, Pristine, Sovran, Topsin:** max 4 applications/yr. **Merivon, Pristine:** do not use with oil. **Sovran:** drift may harm some cherry varieties. **Topguard:** max 4 applications/yr; do NOT add adjuvant.
	Inspire Super (difenoconazole/cyprodinil) (10-14)	12 oz	---	3	3/9	
	Merivon Xemium (pyraclostrobin/ fluxapyroxad) (7-10)	4-5.5 oz	---	4	7/11	
	Procure 480SC (triflumizole) (7-14)	8-16 oz	---	4	3	
	Sovran (kresoxim-methyl) (7-10)	4-6.4 oz	---	3	11	
	Topsin M WSB (thiophanate-methyl) (7-10)	1 lb	0.25 lb	3	1	
	Reduced Risk/Organic:					
	Flint (trifloxystrobin) (10-14)	2-2.5 oz	---	4	11	
	Kaligreen[O] (potassium bicarbonate) (7)	2.5-3 lb	---	3	NC	
	MilStop[O] (potassium bicarbonate) (7)	2-5 lb	2.5 lb	3	NC	
	Ph-D (polyoxin D zinc salt) (10-14)	6.2 oz	---	3	19	
	Pristine (boscalid/pyraclostrobin) (7-10)	15-18.5 oz	---	4	7/11	
	Regalia[O] (*Reynoutria sachalinensis*) (7)	1-4 qt	---	2	P5	
	Serenade MAX[O] (*Bacillus subtilis*) (7)	1-3 lb	---	2	44	
	Sonata[O] (*Bacillus pumilis* strain) (7)	2-4 qt	---	2	44	

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	Products	Rate (per acre)	Rate (per 100 g)	Eff.	MOA	Comments
BLOOM						
Codling Moth	*Reduced Risk/Organic*					Install **mating disruption** just before first moth flight (biofix), around full bloom of Red Delicious. Supplemental insecticides may be necessary; monitoring with traps is critical.
	Checkmate Puffer CM-O[o] (mating disruption)	1-2 units	---	4	NC	
	Checkmate CM-XL[o] (mating disruption)	120-200	---	2-3	NC	
	Isomate CM Flex[o] (mating disruption)	200-400		4	NC	
	Isomate C TT (mating disruption)	100-200	---	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)

Cultural:
- none

Fire Blight	*Conventional:*					**Actigard:** mix with antibiotic to improve efficacy. See label for info on painting existing cankers. **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. **Streptomycin:** where there is resistance, use only once per year mixed with oxytetracycline.
	Agri-Mycin 17 (streptomycin) (3-4)	24-48 oz	---	3-4	25	
	Kasumin 2L (kasugamycin) (3-4)	64 oz	---	3	24	
	Mycoshield (oxytetracycline) (2-3)	---	1 lb	2-3	41	
	Reduced Risk/Organic:					
	Actigard 50WG (acibenzolar-S-methyl)	1-2 oz	---	2	NC	
	BlightBan[o] A506 (*Pseudomonas fluorescens*)	See label	---	2	NC	
	Blossom Protect[o] (*Aureobasidium pullulans*)	1.25 lb	---	3	NC	
	Cueva[o] (copper octanoate)	---	1 gal	2	M1	
	Serenade MAX[o] (*Bacillus subtilis* strain)	2-3 lb	---	2	44	

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	Products	Rate (per acre)	Rate (per 100 g)	Eff.	MOA	Comments
PETAL FALL						
Crown Rot *(Phytophthora)* *(this disease is rarely a problem on pears)*	*Reduced Risk:*					**Fosphite, Phostrol, Aliette:** 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)	2.5-5 lb	0.5-1.0 lb	2	33	
	Fosphite (phosphorous acid)	---	1-3 qt	2	33	
	Phostrol (phosphorous acid)	2.5-5 pt	---	2	33	
Lygus and Stink Bugs, including Brown Marmorated Stink Bug *(BMSB is not yet an economic pest in the Intermountain West)*	*Conventional:*					**Beleaf:** max 8.4 oz/ acre per year. **Brigade 2EC:** wait 30 days between applications. **Danitol:** max 42.6 oz/ acre per year. **Gladiator:** max 38 oz/ acre per year.
	Asana XL[R] (esfenvalerate)	5-14.5 oz	2-5.8 oz	3	3	
	Brigade 2EC[R] (bifenthrin)	3-12.8 oz	---	4	3	
	Danitol 2.4 EC[R] (fenpropathrin)	16-21.3 oz	---	4	3	
	Endigo ZC[R] (thiamethoxam/lambda-cyhalothrin)	5-6 oz	---	4	3/4	
	Gladiator[R] (abamectin/zeta-cypermethrin)	19 oz	---	4	3/6	
	Reduced Risk/Organic:					
	Belay (clothianidin)	6 oz	---	2-3	4	
	Beleaf 50 SG (flonicamid)	2-2.8 oz	---	4	9	

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:
- often overwinter in alfalfa or other field crops and migrate to nearby fruit trees when crops are harvested; cause cat-facing injury to fruit

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

Cultural:
- remove weed host plants prior to fruit forming on trees
- do not mow nearby weeds or cover crops when fruit is present or the insects will move to fruit trees

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PEAR Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff.	MOA	Comments
PETAL FALL (continued)						
Oblique-banded Leafrollers *(leafrollers are sporadic in pear and rarely need treatment)*	*Conventional:*					**Altacor, Delegate WG, Voliam:** max 4 applications/yr. **Bt products:** must be applied when larvae are less than 1/2 inch. **Entrust:** max 9 oz/yr. **Leverage 360:** max 1 application/yr.
	Leverage 360[R] (cyfluthrin/imidacloprid) (14)	2.4-2.8 oz	---	3	3/4	
	Proclaim[R] (emamectin benzoate) (7-14)	3.2-4.8 oz	1-1.2 oz	3	6	
	Voliam Flexi (thiamethoxam/ chlorantraniliprole) (10-14)	4-7 oz	---	4	4/28	
	Voliam Xpress[R] (lambda-cyhalothrin/ chlorantraniliprole) (10-14)	6-12 oz	---	3	3/28	
	Reduced Risk/Organic:					
	Altacor (chlorantraniliprole) (10-14)	3.0-4.5 oz	---	4	28	
	Aza-Direct[O], AzaGuard[O], Azatin O[O], Azatrol EC[O] (azadirachtin) (7)	See label	---	2-3	UN	
	Biobit HP, Dipel DF[O], XenTari[O] (*Bacillus thuringiensis* sub. *kurstaki*) (7)	See label	---	3-4	11	
	Delegate WG (spinetoram) (14)	4.5-7.0 oz	---	4	5	
	Entrust[O] (spinosad) (7)	2-3 oz	0.7-1 oz	3	5	
	Exirel (cyantraniliprole) (14)	10-17 oz	---	4	28	
	Intrepid 2F (methoxyfenozide) (14)	8-16 oz	---	3-4	18	
	Success (spinosad) (7)	6-10 oz	---	3-4	5	

Pest Biology:
- fruittree 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	Products	Rate (per acre)	Rate (per 100 g)	Eff.	MOA	Comments
PETAL FALL (continued)						
Pear Psylla	*Conventional:*					**Actara:** highly toxic to bees.
	Actara (thiamethoxam)	5.5 oz	---	3-4	4	
	Admire Pro (imidacloprid)	7 oz	---	3-4	4	**Admire Pro, Agri-Mek SC, Centaur WDG, Esteem 35 WP:** max 2 applications/yr.
	Agri-Mek SC[R] (abamectin)	2.2-4.25 oz	---	3-4	6	
	Centaur WDG (buprofezin)	2.2-2.9 oz	---	3	16	
	Nexter (pyridaben)	7-10.7 oz	---	3-4	21	
	Voliam Flexi (thiamethoxam/ chlorantraniliprole)	7 oz	---	3	4/28	**Agri-Mek SC:** use with adjuvant, such as 1% oil.
	Reduced Risk/Organic:					
	Assail 30SG, 70 WP (acetamiprid)	1.7-3.4 oz	---	3-4	4	**Assail:** max 4 applications/yr; use with oil.
	Aza-Direct[O], AzaGuard[O], Azatin O[O], Azatrol EC[O] (azadirachtin)	See label	---	2	UN	
	Captiva Prime[O] (canola oil/garlic oil)	1-2 pt	---	2-3	NC	
	Delegate WG (spinetoram)	6-7 oz	---	4	5	**Delegate WG:** use with adjuvant to improve control.
	Esteem 35 WP (pyriproxyfen)	4-5 oz	---	3	7	
	Grandevo[O] (*Chromobacterium subtsugae*)	2-3 lb	---	---	NC	
	M-Pede[O] (potassium salts of fatty acids)	See label	1-2 gal	3	NC	**Nexter:** only one application is allowed per season.
	Sivanto prime (flupyradifurone)	10.5-14 oz	---	---	4	
	Ultor/Movento (spirotetramat)	See label	---	3-4	23	**Sivanto prime:** max 20 oz/acre per year.

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	Products	Rate (per acre)	Rate (per 100 g)	Eff.	MOA	Comments
FRUIT PRESENT						
Codling Moth	*Conventional:*					Keep fruit protected through September 15.
	Danitol 2.4 EC[R] (fenpropathrin) (10-14)	16-21.3 oz	---	4	3	
	Endigo ZC[R] (thiamethoxam/lambda-cyhalothrin) (10-14)	5-6 oz	---	2-3	3/4	**Altacor:** max 9 oz/yr.
	Imidan 70-W (phosmet) (21)	3.5-5.75 lb	0.75-1 lb	3-4	1	**Assail, Voliam:** max 4 applications/yr; use with oil.
	Proclaim[R] (emamectin benzoate) (7-14)	3.2-4.8 oz	.8-1.2 oz	2-4	6	
	Voliam Flexi (thiamethoxam/chlorantraniliprole) (14-21)	4-7 oz	---	4	4/28	
	Voliam Xpress[R] (lambda-cyhalothrin/chlorantraniliprole) (14)	6-12 oz	---	4	3/28	**Imidan:** do not apply within 25 ft of human structures.
	Reduced Risk/Organic:					**Proclaim:** max 3 applications/yr.
	Altacor (chlorantraniliprole) (10-17)	3.0-4.5 oz	---	4	28	
	Assail 30SG, 70 WP (acetamiprid) (14)	1.7-3.4 oz	---	3-4	4	
	Biobit HP, Dipel DF[O], XenTari[O] (*Bacillus thuringiensis* sub. *kurstaki*) (7)	See label	---	3-4	11	
	Cyd-X[O] (*Cydia pomonella* granulosis virus) (7)	1-6 oz	---	2-3	NC	
	Delegate WG (spinetoram) (14)	6-7 oz	---	4	5	
	Entrust[O] (spinosad) (7)	2-3 oz	.7-1.0 oz	2-3	5	
	Exirel (cyantraniliprole) (14-21)	10-17 oz	---	4	28	

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 and other structures from orchards where larvae overwinter

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff.	MOA	Comments
Pear or Cherry Slug (Pear Sawfly) *(this pest rarely needs treatment in commercial orchards)*	*Conventional:*					Just one application will suffice.
	Voliam Xpress[R] (lambda-cyhalothrin/chlorantraniliprole)	6-12 oz	---	4	3/28	**Altacor, Entrust, Delegate WG:** max is 4 applications/yr.
	Reduced Risk/Organic:					
	Altacor (chlorantraniliprole)	3.0-4.5 oz	---	4	28	
	Aza-Direct[O], AzaGuard[O], Azatin O[O], Azatrol EC[O] (azadirachtin)	See label	---	3	UN	
	Delegate WG (spinetoram)	4.5-7 oz	---	4	5	
	Entrust[O], Success (spinosad)	See label	---	4	5	

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

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PEAR Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff.	MOA	Comments
FRUIT PRESENT (continued)						
Spider Mites	*Conventional:*					**Agri-Flex:** apply before a threshold of 5 spider mites per leaf is reached. Using with an adjuvant is required. Oil can russet light-skinned varieties such as Golden Delicious. **Agri-Mek SC:** adjuvant is required. Using within 14 days of captan or sulfur can cause phytotoxicity. **Agri-Mek SC, Kanemite, Vendex:** max 2 applications/yr. **Apollo SC, Acramite, Envidor, Nexter, Onager, Savey, Vydate:** max 1 application/yr.
	Agri-Flex[R] (abamectin/thiamethoxam)	5.5-8.5 oz	1.5-2 oz	4	4/6	
	Agri-Mek SC[R] (abamectin)	2.2-4.2 oz	2.5-5 oz	3-4	6	
	Apollo SC (clofentezine)	4-8 oz	---	2-4	10	
	Envidor 2 SC (spirodiclofen)	16-18 oz	---	3-4	23	
	Nexter (pyridaben)	7-10.7 oz	---	2-3	21	
	Onager (hexythiazox)	12-24 oz	---	3	10	
	Savey 50 DF (hexythiazox)	3-6 oz	---	2-4	10	
	Vendex 50WP[R] (fenbutatin-oxide)	1-2 lb	---	3	12	
	Vydate L[R] (oxamyl)	6-8 pt	---	4	1	
	Reduced Risk/Organic:					
	Acramite 50WS (bifenazate)	0.75-1 lb	---	4	UN	
	Captiva Prime[O] (canola oil/garlic oil)	1-2 pt	---	2-3	NC	
	Horticultural oil[O] (many brands)	1%			NC	
	Kanemite 15 SC (acequinocyl)	21-31 oz	---	4	20	
	M-Pede[O] (potassium salts of fatty acids)	1-2 %	1-2 gal	1-2	NC	

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	Products	Rate (per acre)	Rate (per 100 g)	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:*					**Belay:** max 2 applications/yr. **Beleaf:** max 3 applications/yr. **Brigade 2EC**: Only allowed after petal fall. Must wait 30 days between applications. **Danitol:** max 42.6 oz/ acre per year. **Gladiator:** max 32 oz/ acre per year.
	Brigade 2EC[R] (bifenthrin) (21)	2.6-12.8 oz	---	4	3	
	Closer SC (sulfoxaflor) (14)	2.8-5.8 oz	---	3	4	
	Danitol 2.4 EC[R] (fenpropathrin) (14)	16-21.3 oz	---	4	3	
	Gladiator[R] (abamectin/zeta-cypermethrin) (21)	19 oz	---		3/6	
	Voliam Xpress[R] (lambda-cyhalothrin/ chlorantraniliprole) (14)	6-12 oz	---	3	3/28	
	Reduced Risk/Organic:					
	Belay (clothianidin) (14)	6 oz	---	---	4	
	Beleaf 50 SG (flonicamid) (14)	2.0-2.8 oz	---	4	9	

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

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	Products	Rate (per acre)	Rate (per 100 g)	Eff.	MOA	Comments
POST-HARVEST (EARLY FALL)						
Pearleaf Blister Mite and Rust Mites *(these pests rarely need treatment in commercial orchards)*	*Conventional:*					**Agri-Mek SC:** max 2 applications/yr. **Acramite, Nexter:** max 1 application/yr.
	Agri-Mek SC[R] (abamectin)	2.2-4.2 oz	---	4	6	
	Nexter (pyridaben)	7-10.7 oz	---	4	21	
	Sevin 4F (carbaryl)	1.5-3 qt	---	3	1	
	Reduced Risk/Organic:					
	Acramite 50WS (bifenazate)	0.75-1.0 lb	---	4	UN	
	Captiva Prime[O] (canola oil/garlic oil)	1-2 pt	---	2-3	NC	
	Kumulus DF[O], Microthiol Disperss[O], Sulfur 6L (sulfur)	See label	See label	3	M2	
	Lime-sulfur[O] (calcium polysulfide)	See label	---	4	M2	
	M-Pede[O] (potassium salts of fatty acids)	1-2%	1-2 gal	1-2	NC	

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			
European Red Mite (minor pest)	monitor						monitor				
	eggs on limbs				immatures/adults/eggs on leaves						eggs on limbs
San Jose Scale (minor pest)	⟷						monitor				
	immatures						adults/crawlers/immatures on limbs, leaves, and fruit				immatures on limbs
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								
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 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.

CHERRY (Tart and Sweet) Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
DORMANT						
Bacterial Canker *(sweet cherry only)*	*Conventional:*					Apply copper as a dormant application before foliage buds swell.
	Champ Dry Prill, Champ Formula 2, Kocide (copper hydroxide)	See label	---	2	M1	
	Phyton 27 AG (copper sulfate pentahydrate)	---	20-40 oz	2	M1	**Champ Formula 2:** use on yellow varieties may cause discoloration.
	Reduced Risk/Organic:					
	Cueva[O] (copper octanoate)	---	0.5-2 gal	2	M1	**Cueva:** max 1 application/yr.
	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:*					**Champ Dry Prill:** make application before bud swell.
	Bravo Ultrex (chlorothalonil)	2.8-3.8 lb	0.9-1.3 lb	3	M5	
	Champ Dry Prill, Champ Formula 2, Kocide (copper hydroxide)	See label	---	3	M1	
	Phyton 27 AG (copper sulfate pentahydrate)	---	20-40 oz	3	M1	**Champ Formula 2:** use on yellow varieties may cause discoloration.
	Reduced Risk/Organic:					**Cueva:** max 1 application/yr.
	Badge X2[O] (coppers)	3.5-14 lb	---	3	M1	
	Cueva[O] (copper octanoate)	---	0.5-2 gal	3	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	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
DELAYED DORMANT (Bud Swell - First White)						
Aphid Eggs (Black Cherry Aphid) *(sweet cherry only)*	*Conventional:*					**Beleaf:** max 8.4 oz/yr. **Diazinon:** max 2 applications/yr.
	Diazinon 50W[R] (diazinon) + 2% oil	---	1.25 lb	4	1	
	Reduced Risk/Organic:					
	Beleaf 50 SG (flonicamid) + 2% oil	2-2.8 oz	---	3	9	
	Horticultural oil[O] (many brands)	2%	2 gal	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)	2 qt		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:*					**Sevin 4F:** max 3 applications/yr.
	Asana XL[R] (esfenvalerate)	5-14.5 oz	2-5.8 oz	3	3	
	Sevin 4F (carbaryl)	2-3 qt	---	2	1	
	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
European red mite eggs *(this pest rarely needs treatment)*	*Conventional:*					**Onager, Savey:** max 1 application/yr.
	Apollo SC (clofentezine)	2-8 oz	---	4	10	
	Onager (hexythiazox)	12-24 oz	---	4	10	
	Savey 50 DF (hexythiazox)	3-6 oz	---	4	10	
	Reduced Risk/Organic:					
	Horticultural oil[O] (many brands)	2%	2 gal	4	NC	
	Pest Biology: • overwinter as eggs on limbs	*Scouting/Threshold:* • look for red eggs on limbs				*Cultural*: • none

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CHERRY (Tart and Sweet) Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
DELAYED DORMANT (Bud Swell - First White) (continued)						
San Jose Scale	*Conventional:*					In heavy infestations, apply second treatment targeting crawlers in early summer.
	Centaur WDG (buprofezin) + 2% oil	34.5 oz	---	4	16	
	Reduced Risk/Organic:					
	Captiva Prime[O] (canola oil/garlic oil)	1-2 pt	---	2-3	NC	**Centaur WDG**: max 2 applications/yr.
	Esteem 35 WP (pyriproxyfen) + 2% oil	4-5 oz	---	3-4	7	
	Horticultural oil[O] (many brands)	2%	2 gal	4	NC	**Esteem**: max 15 oz/ acre per year.
	Pest Biology: • overwinter as nymphs on limbs; an armored scale	*Scouting/Threshold:* • look for gray-white scale bodies on limbs				*Cultural*: • none
PETAL FALL						
Black Cherry Aphid *(Sweet cherry only)*	*Conventional:*					**Actara:** max 11 oz/acre per year.
	Actara (thiamethoxam)	3-4 oz	---	4	4	
	Admire Pro (imidacloprid)	1.4-2.8 oz	---	4	4	**Admire Pro:** max 14 oz/acre per year.
	Calypso 4 F (thiacloprid)	2-4 oz	---	3	4	
	Closer SC (sulfoxaflor)	1.5-2.75 oz	---	4	4	**Assail:** max 4 applications/yr.
	Leverage 360[R] (cyfluthrin/imidacloprid)	2.4-2.8 oz	---	4	3/4	
	Voliam Flexi (thiamethoxam/ chlorantraniliprole) (10)	4-7 oz	---	4	4/28	**Beleaf:** max 3 applications/yr.
	Reduced Risk/Organic:					
	Assail 30SG, 70 WP (acetamiprid)	See label	---	4	4	**Calypso 4 F, Closer SC:** after petal fall only.
	Aza-Direct[O], AzaGuard[O], Azatin O[O], Azatrol EC[O] (azadirachtin)	See label	---	2-3	UN	
	Beleaf 50 SG (flonicamid)	2-2.8 oz	---	4	9	**Leverage 360:** max 5.6 oz/acre per year.
	Captiva Prime[O] (canola oil/garlic oil)	1-2 pt	---	2-3	NC	
	M-Pede[O] (potassium salts of fatty acids)	See label	1-2 gal	2-3	28	**Ultor/Movento:** max 24 oz/acre per year.
	Ultor/Movento (spirotetramat)	8-14 oz	---	4	23	
	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 leaf curl				*Cultural*: • many beneficials suppress aphids; avoid insecticides unless necessary

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CHERRY (Tart and Sweet) Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
PETAL FALL (continued)						
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) (30)	---	2.5-5 lb	2-3	33	
	Reduced Risk/Organic:					
	Fosphite (salts of phosphorous acid)	---	1-3 qt	2	33	
	Phostrol (salts of phosphorous acid)	See label	---	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

Oblique-banded Leafroller (and rarely European and Fruittree Leafrollers) *(these pests are sporadic)*	*Reduced Risk/Organic:*					**Altacor:** max 3 applications/yr. **Bt products:** must be applied when larvae are less than 1/2 inch. **Delegate WG:** max 4 applications/yr. **Entrust, Success:** toxic to bees for 3 hours after application.
	Altacor (chlorantraniliprole) (14)	3.0-4.5 oz	---	4	28	
	Biobit HP, Dipel DF[O], XenTari[O] (*Bacillus thuringiensis* sub. *kurstaki*) (7)	See label	---	3-4	11	
	Delegate WG (spinetoram) (14)	4.5-7 oz	---	4	5	
	Entrust[O], Success (spinosad) (14)	See label	---	4	5	
	Venerate XC[O] (*Burkholderia* spp.) (5-7)	1-4 qt	---	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

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CHERRY (Tart and Sweet) Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
PETAL FALL (continued)						
Powdery Mildew	*Conventional:*					Do not apply more than 2 sequential applications of one MOA.
	Luna Experience (fluopyram/ tebuconazole) (7-14)	6-10 oz	---	4	3-7	
	Luna Sensation (fluopyram/ trifloxystrobin) (7-14)	5-7.6 oz	---	4	7/11	**Abound:** max 92.3 oz/ acre per year.
	Merivon Xemium (pyraclostrobin/ fluxapyroxad) (7-14)	4-6.7 oz	---	4	7/11	**Fontelis:** max 61 oz/ acre per year.
	Procure 480SC (triflumizole) (7-14)	8-16 oz	---	3-4	3	
	Quash (metconazole) (10-14)	3.5-4 oz	---	3	3	**Gem 500 SC, Rhyme:** max 4 applications/yr.
	Quilt Xcel (propiconazole/azoxystrobin) (10-14)	14 oz	---	3-4	3/11	
	Rally 40 WSP (myclobutanil) (10-14)	2.5-6.0 oz	---	3-4	3	**Merivon:** max 20.1 oz/ acre per year.
	Rhyme (flutriafol) (7)	7 oz	---	4	3	
	Tilt, PropiMax EC (propiconazole) (10-14)	4 oz	---	3	3	**Pristine, Quilt Xcel:** max 5 applications/yr.
	Topsin M WSB (thiophanate-methyl) (14)	1-1.5 lb	0.3-.5 lb	2-3	1	
	Vivando (metrafenone)	15.4 oz	---	4	50	**Quadris Top:** max 56 oz/acre per year.
	Reduced Risk/Organic:					
	Abound (azoxystrobin) (7-14)	12-15.5 oz	---	4	11	**Quash:** max 3 applications/yr.
	Kaligreen[O], MilStop[O] (potassium bicarbonate) (7)	See label	---	1	NC	
	Kumulus DF[O], Microthiol Disperss[O], Sulfur 6L (sulfur) (5-7)	See label	---	3	M2	**Quintec:** max 32 oz/ acre per year.
	Fontelis (penthiopyrad) (7-14)	14-20 oz	---	4	7	
	Gem 500 SC (trifloxystrobin) (7-14)	1.9-3.8 oz	---	4	11	**Serenade, Sonata, and botanical oils:** work best early in the season.
	Pristine (boscalid/pyraclostrobin) (7-14)	11-15 oz	---	4	7/11	
	Quadris Top (azoxystrobin/ difenoconazole) (7)	12-14 oz	---	4	3/11	**Sulfur:** may burn leaves, especially when temperatures >90° F.
	Quintec (quinoxyfen) (10-14)	7 oz	---	3-4	13	
	Regalia[O] (*Reynoutria sachalinensis*) (7)	1-4 qt	---	---	P5	**Tilt, PropiMax EC:** max 20 oz/acre per year.
	Serenade MAX[O] (*Bacillus subtilis*) (7)	1-3 lb	---	2	44/ NC	
	Sonata[O] (*Bacillus pumilis*) (7)	2-4 qt	---	2	44/ NC	**Vivando:** max 2 applications/yr.

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

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CHERRY (Tart and Sweet) Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
FRUIT PRESENT						
Grasshoppers	*Conventional*:					**NOLO Bait:** most effective on nymphs. Do not use if rain w/in 8 hours.
	Sevin 4F (carbaryl)	0.5-1.5 qt	---	2-3	1	
	Reduced Risk/Organic:					**Sevin 4F:** use higher rate for mature grasshoppers. Bait form available.
	NOLO Bait^{O} (*Nosema locustae*)	1 lb	---	2-4	---	
	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.		
Oblique-banded Leafroller (and rarely European and Fruittree) *(these pests are sporadic)*	*Conventional:*					**Altacor, Entrust, Success:** max 3 applications/yr. **Bt products:** must be applied when larvae are less than 1/2 inch. **Delegate WG:** max 4 applications/yr. **Entrust, Success:** toxic to bees for 3 hours after application.
	Voliam Flexi (thiamethoxam/ chlorantraniliprole) (14)	4-7 oz	---	4	4/28	
	Reduced Risk/Organic:					
	Altacor (chlorantraniliprole) (14)	3.0-4.5 oz	---	4	28	
	Biobit HP, Dipel DF^{O}, XenTari^{O} (*Bacillus thuringiensis* sub. *kurstaki*) (7)	See label	---	3-4	11	
	Delegate WG (spinetoram) (14)	4.5-7 oz	---	4	5	
	Entrust^{O}, Success (spinosad) (7)	See label	---	4	5	
	Intrepid 2F (methoxyfenozide) (14)	8-16 oz	---	4	18	
	Venerate XC^{O} (*Burkholderia* spp.) (5-7)	1-4 qt	---	---	NC	
	Pest Biology: • OBLR does not feed on fruit, but causes sanitation issue • 2 summer generations; larvae present mid-July 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		

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CHERRY (Tart and Sweet) Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
FRUIT PRESENT (continued)						
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) (7)	6-12 oz	---	4	3/28	
	Warrior II[R] (lambda-cyhalothrin)	1.3-2.6 oz	---	4	3	
	Reduced Risk/Organic:					
	Aza-Direct[O], AzaGuard[O], Azatin O[O], Azatrol EC[O] (azadirachtin)	See label	---	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

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
Prionus Root Borer	*Reduced Risk/Organic:*					Set out traps in late June and empty weekly.
	Alpha Scents Prionus lure and trap (pheromone mass trapping)	1 trap	---	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	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
Shothole Borer	*Conventional:*					**Sevin 4F:** max 3 applications/yr.
	Asana XL[R] (esfenvalerate)	5-14.5 oz	2-5.8 oz	3	3	
	Sevin 4F (carbaryl)	2-3 qt	---	2	1	

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

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CHERRY (Tart and Sweet) Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
FRUIT PRESENT (continued)						
Spider Mites	*Conventional:*					**Acramite, Apollo SC, Envidor, Onager, Savey, Zeal:** max 1 application/yr. **Kanemite, Nexter, Vendex:** max 2 applications/yr.
	Apollo SC (clofentezine)	2-8 oz	---	4	10	
	Envidor 2 SC (spirodiclofen)	16-18 oz	---	4	23	
	Nexter (pyridaben)	4.4-10.7 oz	---	4	21	
	Onager (hexythiazox)	12-24 oz	---	3	10	
	Savey 50 DF (hexythiazox)	3-6 oz	---	4	10	
	Vendex 50WP[R] (fenbutatin-oxide)	1.5-3 lb	---	3	12	
	Reduced Risk/Organic:					
	Acramite 50WS (bifenazate)	0.75-1 lb	---	4	UN	
	Aza-Direct[O], AzaGuard[O], Azatin O[O], Azatrol EC[O] (azadirachtin)	See label	---	2	UN	
	Captiva Prime[O] (canola oil/garlic oil)	1-2 pt	---	2-3	NC	
	Kanemite 15 SC (acequinocyl)	31 oz	---	4	20	
	M-Pede[O] (potassium salts of fatty acids)	See label	1-2 gal	1-2	28	
	Zeal (etoxazole)	2-3 oz	---		10	

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

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CHERRY (Tart and Sweet) Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
FRUIT PRESENT (continued)						
Spotted Wing Drosophila	*Conventional:*					Monitoring in individual orchards is important to know if this pest is present.
	Admire Pro (imidacloprid) (10)	2-2.8 oz	---	3	4	
	Asana XL[R] (esfenvalerate) (10)	5-14.5 oz	2-5.8 oz	3	3	
	Baythroid XL[R] (beta-cyfluthrin) (14)	2.4-2.8 oz	---	4	3	
	Bexar (tolfenpyrad) (10)	21-27 ox	---	3	21	**Delegate WG:** max 4 applications/yr.
	Imidan 70-W (phosmet) (10)	2.125 lb	---	3	1	
	Malathion 57 EC (malathion) (5-7)	1 pt	---	3	1	**Exirel:** max 3 applications/yr.
	Sevin 4F (carbaryl) (10)	3 qt	---	3	1	
	Warrior II (lambda-cyhalothrin) (14)	1.3-2.6 oz	---	4	3	**Grandevo:** use with spreader-sticker.
	Reduced Risk/Organic:					
	Aza-Direct[O], AzaGuard[O], Azatin O[O], Azatrol EC[O] (azadirachtin) (7)	See label	---	2-3	UN	**Imidan:** max 7.5 lb/acre per year.
	Delegate WG (spinetoram) (7)	4.5-7 oz	---	3	5	
	Exirel (cyantraniliprole) (7)	10-17 oz	---	4	28	**Sevin 4F:** max 14 qt/ acre per year.
	Entrust[O], Success (spinosad) (5)	See label	---	2	5	
	Grandevo[O] (*Chromobacterium subtsugae*)	3 lb	---	2-3	NC	**Warrior:** max 10.24 oz/ acre per year.
	Pyganic[O], Tersus (pyrethrins) (10)	See label	---	3	3	

Pest Biology:
- occurs in Intermountain West, but as of 2018, not found to cause economic injury
- adult female has saw-like ovipositor and will lay eggs inside fruit

Scouting/Threshold:
- adults can be monitored with liquid baits (yeast/sugar water or apple cider vinegar)
- 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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CHERRY (Tart and Sweet) Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
FRUIT PRESENT (continued)						
Western Cherry Fruit Fly	*Conventional:*					**Actara:** max 11 oz/acre per year. **Admire Pro:** max 14 oz/acre per year. **Altacor, Assail, Delegate, Malathion, Entrust, Voliam Xpress:** max 4 applications/yr. **Baythroid XL:** max 5.6 oz/yr. **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. **Imidan:** tart cherries only. **Leverage 360:** max 2 applications/yr. **Success:** max 29 oz/acre per year. **Warrior:** max 12.8 oz/yr.
	Actara (thiamethoxam) (7)	4.5-5.5 oz	---	3	4	
	Admire Pro (imidacloprid) (10)	2-2.8 oz	---	3	4	
	Asana XL[R] (esfenvalerate) (10)	5-14.5 oz	2-5.8 oz	3	3	
	Baythroid XL[R] (beta-cyfluthrin) (14)	2.4-2.8 oz	---	3	3	
	Imidan 70-W (phosmet) (10)	2.125 lb	0.75 lb	3-4	1	
	Leverage 360[R] (cyfluthrin/imidacloprid) (14)	2.4-2.8 oz	---	3-4	3/4	
	Malathion 57 EC (malathion) (3-7)	1 pt	---	4	1	
	Sevin 4F (carbaryl) (7)	2-3 qt	---	2-3	1	
	Voliam Xpress[R] (lambda-cyhalothrin/chlorantraniliprole) (10)	6-12 oz	---	3-4	3/28	
	Warrior II[R] (lambda-cyhalothrin) (14)	1.3-2.5 oz	---	2-3	3	
	Reduced Risk/Organic:					
	Altacor (chlorantraniliprole) (14)	3.0-4.5 oz	---	2	28	
	Assail 30SG, 70 WP (acetamiprid) (7-14)	See label	---	3	4	
	Delegate WG (spinetoram) (10)	4.5-7.0 oz	---	3	5	
	Entrust[O] (spinosad) (7)	1.3-2.5 oz	0.4-0.8 oz	2	5	
	Exirel (cyantraniliprole) (10)	10-17 oz	---	4	28	
	GF-120 NF[O] (spinosad + bait) (7)	10-20 oz	---	2-4	5	
	Success (spinosad) (7)	4-8 oz	1.3-2.7 oz	2	5	

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

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CHERRY (Tart and Sweet) Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
FRUIT PRESENT (continued)						
White Apple Leafhopper	*Conventional*:					**Admire Pro:** max 14 oz/acre per year.
	Admire Pro (imidacloprid) (10)	1.4-2.8 oz	---	4	4	
	Avaunt (indoxacarb) (10)	5-6 ox	---	3-4	22	**Assail:** max 4 applications/yr.
	Calypso 4 F (thiacloprid) (10)	2-4 oz	---	4	4	
	Danitol 2.4 EC[R] (fenpropathrin) (10)	10-21 oz	---	3	3	**Calypso 4 F:** after petal fall only.
	Leverage 360[R] (cyfluthrin/imidacloprid) (14)	2.4-2.8 oz	---	4	3/4	
	Voliam Flexi (thiamethoxam/ chlorantraniliprole) (14)	4-7 oz	---	4	4/28	**Leverage 360:** max 2 applications/yr.
	Reduced Risk/Organic:					
	Assail 30SG, 70 WP (acetamiprid) (14)	See label	---	3	4	**Danitol:** max 2 applications/yr.
	Aza-Direct[O], AzaGuard[O], Azatin O[O], Azatrol EC[O] (azadirachtin) (7)	See label	---	2	UN	
	Captiva Prime[O] (canola oil/garlic oil) (7)	1-2 pt	---	2-3	NC	
	Grandevo[O] (*Chromobacterium subtsugae*)	1-3 lb	---	2	NC	
	M-Pede[O] (potassium salts of fatty acids) (7)	See label	See label	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)	1-1.5%	1-1.5 gal	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

Western Cherry Fruit Fly	*Conventional:*					If fruit remains on the tree post-harvest, consider one final treatment.
	Admire Pro (imidacloprid)	2-2.8 oz	---	3	4	
	Dimethoate 4EC (dimethoate)	2 pt	0.5-1 pt	4	1	
	Reduced Risk/Organic:					**Altacor, Delegate:** max 4 applications/yr.
	Altacor (chlorantraniliprole)	3.0-4.5 oz	---	2	28	
	Delegate WG (spinetoram)	4.5-7.0 oz	---	3	5	**Dimethoate 4EC:** apply within 7 days of harvest.

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CHERRY (Tart and Sweet) Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
POST-HARVEST (continued)						
WESTERN CHERRY FRUIT FLY (continued)						
Pest Biology: • adults continue to lay eggs as long as fruit are present	*Scouting/Threshold:* • none				*Cultural*: • none	
FALL						
Shothole (Coryneum Blight) *(this disease rarely occurs on cherry)*	*Conventional:*					**Fixed coppers** or **Ziram** in fall are effective. **Ziram 76DF:** max 4 applications/yr.
	Bravo Ultrex (chlorothalonil)	2.8-3.8 lb	0.9-1.2 lb	3	M5	
	Bravo Weather Stik (chlorothalonil)	3-4 pt	1-1.4 pt	3	M5	
	Kocide (copper hydroxide)	See label	---	3	M1	
	Ziram 76DF (ziram)	5-6 lb	1.6-2 lb	4	M3	
	Reduced Risk/Organic:					
	Badge X2 [O] (coppers)	3.5-14 lb	---	3	M1	
	C-O-C-S WDG (copper hydroxide)	See label	---	3	M1	
	Cueva[O] (copper octanoate)	---	0.5-2 gal	3	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	
Bacterial Canker (*Pseudomonas syringae*) *(sweet cherry only)*	*Conventional:*					Do not apply excessive copper.
	Champ Dry Prill, Champ Formula 2, Kocide (copper hydroxide)	See label	---	2	M1	
	Phyton 27 AG (copper sulfate pentahydrate)	---	20-40 oz	2	M1	
	Reduced Risk/Organic:					
	Badge X2 [O] (coppers)	3.5-14 lb	---	2	M1	
	C-O-C-S WDG (copper hydroxide)	See label	---	2	M1	
	Cueva[O] (copper octanoate)	---	0.5-2 gal	2	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	

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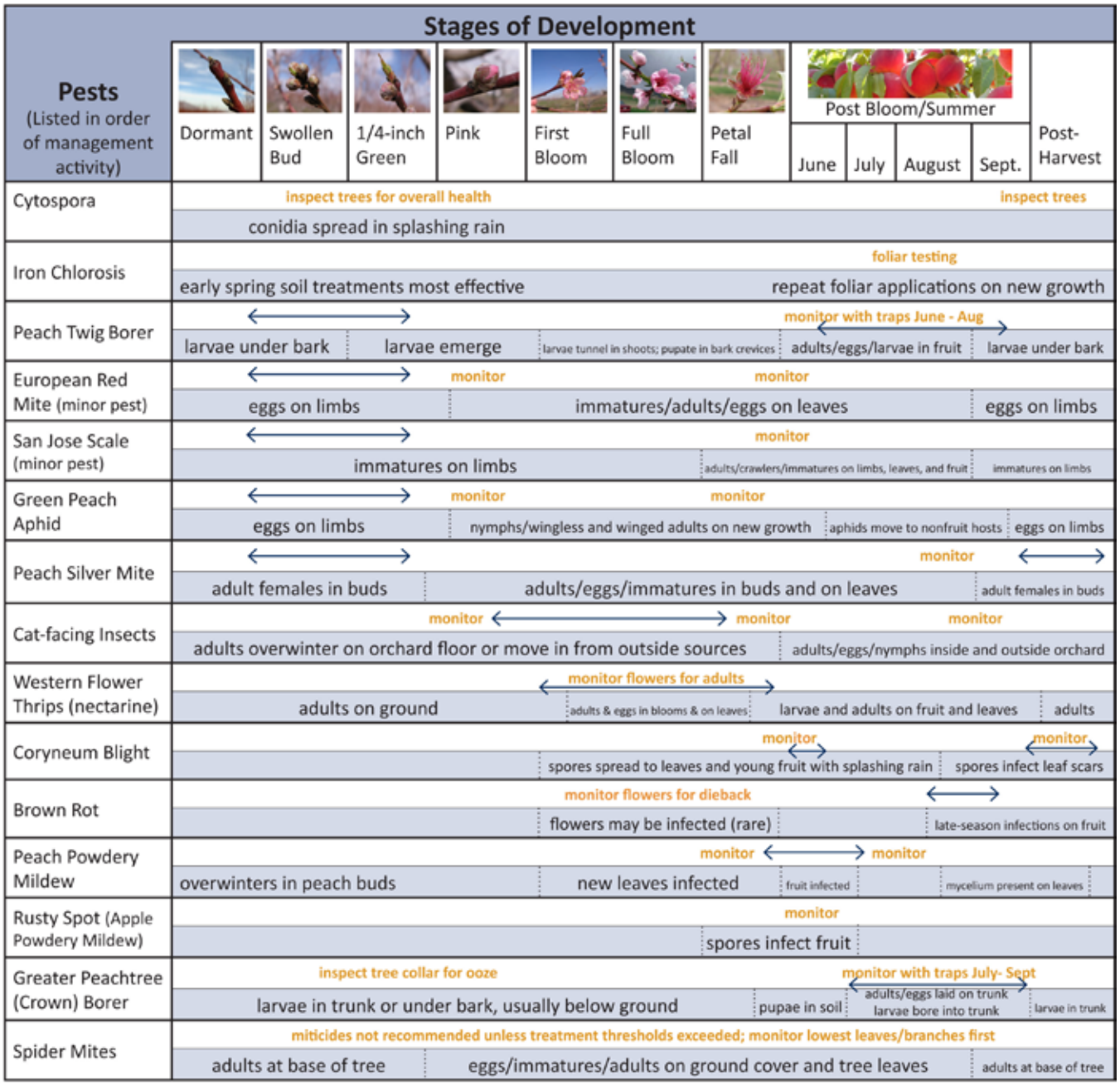
PEACH/NECTARINE Pest Management Recommendations

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.

PEACH/NECTARINE Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
DELAYED DORMANT (Swollen Bud to First Pink)						
Cytospora Canker	no fungicides are effective; only cultural controls					
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			
European Red Mite and Brown Mite Eggs *(these pests rarely need treatment)*	*Conventional:* Onager (hexythiazox) Savey 50 DF (hexythiazox) *Reduced Risk/Organic:* Horticultural oil[O] (many brands)	 12-24 oz 3-6 oz 2%	 --- --- 2 gal	 4 4 3-4	 10 10 NC	**Oil** alone is sufficient. **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) + 2% oil Diazinon 50W (diazinon) + 2% oil *Reduced Risk/Organic:* Captiva Prime[O] (canola oil/garlic oil) Horticultural oil[O] (many brands)	 5-14.5 oz --- 1-2 pt 2%	 2-5.8 oz 1 lb --- 2 gal	 4 4 2-3 3-4	 3 1 NC NC	**Diazinon:** max 2 applications per year and 4-day PHI.
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	Products	Rate (per acre)	Rate (per 100 g)	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. **Bravo:** do not apply between shuck split and harvest.
	Bravo Ultrex (chlorothalonil)	2.8-3.8 lb	.9-1.25 lb	4	M5	
	Champ Dry Prill, Champ Formula 2, Kocide (copper hydroxide)	See label	---	2-3	M1	
	Ziram 76DF (ziram)	8-10 lb	2.6-3.3 lb	4	M3	
	Reduced Risk/Organic:					
	Badge X2[O] (coppers)	See label	---	2	M1	
	C-O-C-S WDG (copper oxychloride)	12-15.6 lbs	---	3	M1	
	Cueva[O] (copper octanoate)	---	0.5-2 gal	3	M1	
	Cuprofix (basic copper sulfate)	5-10 lb	---	2-3	M1	
	Nu-Cop 50 DF, Champ WG[O], ChampION++[O] (copper hydroxide)	See label	---	2-3	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	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
Shothole (Coryneum Blight) *(the optimum timing is at leaf drop in fall)*	*Conventional:*					**Bravo:** do not apply between shuck split and harvest.
	Bravo Ultrex, Weather Stik (chlorothalonil)	See label	---	3	M5	
	Champ Dry Prill, Champ Formula 2, Kocide (copper hydroxide)	See label	---	3	M1	
	Ziram 76DF (ziram)	6 lb	2 lb	4	M3	
	Reduced Risk/Organic:					
	Badge X2[O] (coppers)	See label	---	2-3	M1	
	C-O-C-S WDG (copper oxychloride)	12-15.6 lbs	---	3	M1	
	Cueva[O] (copper octanoate)	---	0.5-2 gal	2-3	M1	
	Cuprofix (basic copper sulfate)	5-10 lb	---	2-3	M1	
	Nu-Cop 50 DF, Champ WG[O], ChampION++[O] (copper hydroxide)	See label	---	2-3	M1	

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

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	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
BLOOM						
Brown Rot *(rarely occurs in commercial orchards)*	*Conventional:*					One application at this timing only if disease was severe the prior year.
	Abound (azoxystrobin)	12-15.5 oz	---	4	11	
	Elevate 50WDG (fenhexamid)	1.5 lbs	1-1.5 lbs	4	17	
	Luna Experience (fluopyram/ tebuconazole)	6-10 oz	---	3	3/7	
	Rally 40 WSP (myclobutanil)	2.5-6.0 oz	---	4	3	
	Reduced Risk/Organic:					
	Kumulus DF[O], Microthiol Disperss[O], Sulfur 6L (sulfur)	See label	---	3	M2	
	Pristine (boscalid/pyraclostrobin)	11-14.5 oz	---	3-4	7/11	

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 population because it is safe on bees.
	Biobit HP, Dipel DF[O], XenTari[O] (*Bacillus thuringiensis* sub. *kurstaki*)	See label	---	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

PETAL FALL						
Borers (Shothole, Flatheaded) *(uncommon)*	*Conventional:*					Repeat applications every 14-21 days until mid-summer
	Asana XL[R] (esfenvalerate)	5-14.5 oz	5.8 oz	3	3	
	Warrior II[R] (lambda-cyhalothrin)	1.3-2.6 oz	---	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

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PEACH/NECTARINE Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
PETAL FALL (continued)						
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. **Baythroid:** max 2 applications/yr. **Beleaf:** max 3 applications/yr.
	Baythroid XL[R] (beta-cyfluthrin)	2-2.4 oz	---	4	3	
	Danitol 2.4 EC[R] (fenpropathrin)	11-21 oz	---	3	3	
	Warrior II[R] (lambda-cyhalothrin)	1.3-2.6 oz	---	4	3	
	Reduced Risk/Organic:					
	Aza-Direct[O], AzaGuard[O], Azatin O[O], Azatrol EC[O] (azadirachtin)	See label	---	2	UN	
	Beleaf 50 SG (flonicamid)	2-2.8 oz	---	4	9	
	Pyganic[O], Tersus (pyrethrins)	See label	See label	2	3	
	Surround WP[O] (kaolin clay)	See label	---	2	NC	

Pest Biology:
- piercing mouthparts cause 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

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
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[O] (spinosad)	1.25-2.5 oz	---	3	5	
	Isomate PTB-TT (mating disruption)	100-200	---	4	---	
	Success (spinosad)	4-8 oz	---	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

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PEACH/NECTARINE Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
PETAL FALL (continued)						
Western Flower Thrips *(mainly a problem on nectarines)*	*Reduced Risk/Organic:*					One application should suffice.
	Aza-Direct^{O}, AzaGuard^{O}, Azatin O^{O}, Azatrol EC^{O} (azadirachtin)	See label	---	2	UN	
	BotaniGard ES (*Beauveria bassiana*)	.25-1 qt	---	2	NC	**Delegate WG:** max 4 applications/yr.
	Delegate WG (spinetoram)	4.5-7 oz	---	3-4	5	
	Entrust^{O} (spinosad)	1.25-2.5 oz	0.4-0.8 oz	4	5	**Entrust, Success:** toxic to bees until dry.
	Grandevo^{O} (*Chromobacterium subtsugae*)	2-3 lbs	---	---	NC	
	Success (spinosad)	4-8 oz	1.3-2.7 oz	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

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
SHUCK SPLIT						
Aphids (Green Peach Aphid, Plum Aphid)	*Conventional:*					**Admire Pro:** do not apply during bloom or when bees are active. Max 14 oz per acre/yr.
	Actara (thiamethoxam)	3-4 oz	---	4	4	
	Admire Pro (imidacloprid)	1.4-2.8 oz	---	4	4	
	Calypso 4 F (thiacloprid)	2-4 oz	---	3	4	**Calypso 4 F, Closer SC:** after petal fall only.
	Closer SC (sulfoxaflor)	1.5-2.75 oz	---	4	4	
	Leverage 360^{R} (cyfluthrin/imidacloprid)	2.4-2.8 oz	---	4	3/4	
	Voliam Flexi (thiamethoxam/ chlorantraniliprole)	4-7 oz	---	4	4/28	
	Reduced Risk/Organic:					
	Assail 30SG, 70 WP (acetamiprid)	See label	---	4	4	
	Aza-Direct^{O}, AzaGuard^{O}, Azatin O^{O}, Azatrol EC^{O} (azadirachtin)	See label	---	2	UN	
	Captiva Prime^{O} (canola oil/garlic oil)	1-2 pt	---	2-3	NC	
	Horticultural oil^{O} (many brands)	1-1.5%	1-1.5 gal	4	NC	
	M-Pede^{O} (salts of fatty acids)	See label	---	2-3	NC	

Pest Biology:
- overwinter as eggs on limbs and become active in spring and cause 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

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PEACH/NECTARINE Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
SHUCK SPLIT (continued)						
Peach Twig Borer	*Reduced Risk/Organic:*					Hang dispensers after bloom or after biofix.
	Checkmate PTB-XL[O] (mating disruption)	200	---	2-3	---	
Pest Biology: • summer generation larvae tunnel into fruit	*Scouting/Threshold:* • hang traps at 250 DD in a non-MD site to determine first moth flight (biofix)			*Cultural*: • hang dispensers in upper third of canopy		
Powdery Mildew	*Conventional:*					Start application at the onset of disease and repeat as needed.
	Indar 2F (fenbuconazole) (10)	6 oz	---	3	NC	
	Inspire Super (difenoconazole/ cyprodinil) (10)	16-20 oz	---	3	3/9	**Fontelis:** max 61 oz/yr.
	Merivon Xemium (pyraclostrobin/ fluxapyroxad) (7-14)	4-6.7 oz	---	3	7/11	
	Quadris Top (azoxystrobin/ difenoconazole) (7-14)	12-14 oz		4	11/3	**Gem 500 SC:** max 4 applications/yr.
	Quash (metconazole) (10-14)	3.5-4 oz	---	---	3	
	Quilt Xcel (azoxystrobin/ propiconazole) (7-14)	14 oz	---	3	3/11	**Kaligreen, Milstop:** must be applied every 5-7 days while humid weather persists as a preventive.
	Rally 40WSP (myclobutanil) (10-14)	2.5-6.0 oz	---	4	3	
	Rhyme (flutriafol) (7)	7 oz	---	3	3	
	Tilt (propiconazole) (10-14)	4 oz	---	2-3	3	
	Vivando (metrafenone) (10)	15.4 oz	---	3	50	**Merivon:** max 20.1 oz/acre per year.
	Reduced Risk/Organic:					
	Kaligreen, Milstop[O] (potassium bicarbonate) (5-7)	See label	---	1-2	NC	**Quash:** max 3 applications/yr. Most effective prior to infection.
	Kumulus DF[O], Microthiol Disperss[O], Sulfur 6L (sulfur) (5-7)	See label	---	3	M2	
	Fontelis (penthiopyrad) (7-14)	14-20 oz	---	4	7	**Quilt Xcel:** do not allow to touch apples.
	Horticultural oil[O] (many brands) (5)	1-1.5%	1-1.5 gal	2	NC	
	Luna Experience (fluopyram/ tebuconazole) (7-14)	6-10 oz	---	3	3/7	**Rhyme:** max 4 applications/yr.
	Luna Sensation (fluopyram/ trifloxystrobin) (7-14)	5-7.6 oz	---	3	7/11	
	M-Pede (potassium salts of fatty acids) (7)	---	0.25 gal	2	NC	**Sulfur products:** do not apply at temperatures >85°F.
	Pristine (boscalid/pyraclostrobin) (7-14)	11-14.5 oz	---	3	7/11	
	Quintec (quinoxyfen) (7-14)	7 oz	---	4	13	**Tilt:** max 20 oz/acre per year.
	Regalia[O] (*Reynoutria sachalinensis*) (7)	1-4 qt	2-4 qt	---	P5	
	Serenade ASO[O], MAX[O] (*Bacillus subtilis*) (7)	See label	---	1	NC	**Vivando:** max 2 applications/yr.
	Sonata[O] (*Bacillus pumilis*) (7)	2-4 qt	---	---	NC	

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PEACH/NECTARINE Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
SHUCK-SPLIT (continued)						
POWDERY MILDEW (continued)						
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	
Shothole (Coryneum Blight)	*Conventional:*					Repeat application as needed, especially before or after rains.
	Bravo Ultrex, Weather Stik (chlorothalonil) (14)	See label	See label	3	M5	
	Captan 80 WDG (captan) (7)	See label	---	2	M4	**Abound:** toxic to apples.
	Luna Sensation (fluopyram/ trifloxystrobin) (7-14)	5-7.6 oz	---	4	7/11	
	Merivon (fluxapyroxad/pyraclostrobin) (7-14)	4-6.7 oz	---	4	7/11	**Bravo:** do not use after shuck split.
	Quash (metconazole) (7-14)	2.5-3.5 oz	---	3	3	
	Ziram 76DF (ziram) (14)	6 lb	2 lb	4	M3	**Fontelis**: max 61 oz/ acre per year.
	Reduced Risk/Organic:					**Ziram 76DF**: max 6 applications/yr.
	Fontelis (penthiopyrad) (7-14)	14-20 oz	---	3	7	
	Pristine (boscalid/pyraclostrobin) (7-14)	11-14.5 oz	---	4	7/11	
	Regalia[O] (*Reynoutria sachalinensis*) (7)	1-4 qt	2-4 qt	---	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	
FRUIT PRESENT						
Brown Rot	*Conventional:*					Apply to ripening fruit before or just after rainstorms only if disease was present the prior year.
	Captan 80 WDG (captan) (7)	2.5-5 lbs	---	2-3	M4	
	Elevate 50WDG (fenhexamid) (7-10)	1.5 lbs	1-1.5 lbs	4	17	
	Rally 40 WSP (myclobutanil) (10-14)	2.5-6.0 oz	---	4	3	
	Reduced Risk/Organic:					**Sulfur products:** do not apply at temperatures >85°F.
	Kumulus DF[O], Microthiol Disperss[O], Sulfur 6L (sulfur) (5-7)	See label	---	2-3	M2	
	Pristine (boscalid/pyraclostrobin) (7-14)	10.5-14.5 oz	---	3-4	7/11	
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	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
FRUIT PRESENT (continued)						
European Red Mite and Brown Mite *(these pests rarely need treatment in commercial orchards)*	*Conventional:*					**Apollo SC:** works against eggs, and is most effective when applied when population size is low. **Nexter:** most effective when applied when population size is low. Max 2 applications/yr. **Savey:** max 1 application/yr.
	Apollo SC (clofentezine)	2-8 oz	---	4	10	
	Envidor 2 SC (spirodiclofen)	16-18 oz	---	4	23	
	Nexter (pyridaben)	10.67 oz	---	4	21	
	Savey 50 DF (hexythiazox)	3-6 oz	---	4	10	
	Reduced Risk/Organic:					
	Acramite 50WS (bifenazate)	1 lb	---	4	UN	
	Captiva Prime[O] (canola oil/garlic oil)	1-2 pt	---	2-3	NC	
	Horticultural oil[O] (many brands)	1-1.5%	1-1.5 gal	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
Grasshoppers	*Conventional*:					**Dimilin 2L:** for non-crop areas only (borders, fence rows, roadsides, etc.) **NOLO Bait:** for non-crop areas. Most effective on nymphs. Do not use if rain within 8 hours. **Sevin 4F:** use higher rate for mature grasshoppers or applications to dense foliage. Bait form available.
	Dimilin 2L (diflubenzuron)	2 oz	---	3	15	
	Sevin 4F (carbaryl)	0.5-1.5 qt	---	2-3	1	
	Reduced Risk/Organic:					
	Aza-Direct[O], AzaGuard[O], Azatin O[O], Azatrol EC[O] (azadirachtin)	See label	---	2-3	UN	
	NOLO Bait[O] (*Nosema locustae*)	1 lb	---	2-4	---	
	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.

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PEACH/NECTARINE Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
FRUIT PRESENT (continued)						
Greater Peachtree Borer (Crown Borer, Trunk Borer)	*Conventional:*					Spray lower 12-18" of trunk. Repeat at interval shown. **Isomate:** mating disruption is very effective and lasts all season. Hang dispensers right after first trap catch or by mid-June.
	Asana XL[R] (esfenvalerate) (21)	5-14.5 oz	2-5.8 oz	3	3	
	Pounce 25 WP[R] (permethrin) (21)	6.4-16 oz	---	3	3	
	Warrior II[R] (lambda-cyhalothrin) (21)	1.3-2.5 oz	---	---	3	
	Reduced Risk/Organic:					
	Aza-Direct[O], AzaGuard[O], Azatin O[O], Azatrol EC[O] (azadirachtin) (7)	See label	---	2-3	UN	
	Isomate-P[O] (mating disruption)	100	---	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 (thiamethoxam) (14)	4.5-5.5 oz	---	3	4	
	Closer SC (sulfoxaflor) (14)	2.8-5.8 oz	---	3	4	
	Danitol 2.4 EC[R] (fenpropathrin) (14)	11-21.3 oz		3	3	
	Endigo ZC[R] (thiamethoxam/lambda-cyhalothrin) (14)	5-5.5 oz	---	4	3/4	
	Lannate LV[R], Lannate SP[R] (methomyl) (7-10)	See label	See label	4	1	
	Leverage 360[R] (beta-cyfluthrin/imidacloprid) (14-21)	2.4-2.8 oz	---	3	3/4	
	Voliam Flexi (thiamethoxam/chlorantraniliprole) (14)	6-7 oz	---	3	4/28	
	Voliam XPress[R] (chlorantraniliprole/lambda-cyhalothrin) (14)	6-12 oz	---	3	3/28	
	Reduced Risk/Organic:					
	Surround WP[O] (kaolin)	See label	---	2	NC	

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

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PEACH/NECTARINE Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
FRUIT PRESENT (continued)						
Oblique-banded Leafrollers *(this pest rarely needs treatment on peach)*	*Reduced Risk/Organic:*					**Altacor:** max 3 applications/yr. **Bt products:** must be applied when larvae are less than 1/2 inch. **Delegate WG:** max 4 applications/yr.
	Altacor (chlorantraniliprole) (10)	3.0-4.5 oz	---	4	28	
	Biobit HP, Dipel DF[O], XenTari[O] (*Bacillus thuringiensis* sub. *kurstaki*) (7)	See label		3-4	11	
	Delegate WG (spinetoram) (10)	4.5-7 oz	---	4	5	
	Entrust[O], Success (spinosad) (7)	See label	---	4	5	
	Exirel (cyantraniliprole) (10)	10-20.5 oz	---	4	28	
	Intrepid 2F (methoxyfenozide) (10)	8-16 oz	---	4	18	
	Success (spinosad) (10)	See label		4	5	
	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		
Peach Silver Mite	*Conventional:*					**Nexter:** works best when applied before mites reach economic threshold. Max 2 applications/.
	Nexter (pyridaben)	10.67 oz	---	4	21	
	Reduced Risk/Organic:					
	Captiva Prime[O] (canola oil/garlic oil)	1-2 pt	---	2-3	NC	
	Horticultural oil[O] (many brands)	1-1.5%	1-1.5 gal	3	NC	
	M-Pede[O] (potassium salts of fatty acids)	See label	---	1-2	NC	
	Pest Biology: • an eriophyid mite, causing "silvering" on leaves	*Scouting/Threshold:* • only treat if symptoms are severe		*Cultural*: • none		
Peach Twig Borer	*Conventional:*					One or two sprays needed per generation, dependent on pest pressure. **Danitol:** max 2 applications/yr.
	Asana XL[R] (esfenvalerate) (14-18)	5-14.5 oz	2-5.8 oz	3	3	
	Danitol 2.4 EC[R] (fenpropathrin) (14-18)	10-21.3 oz	---	2-3	3	
	Imidan 70-W (phosmet) (21)	4.25 lb	1 lb	3	1	
	Voliam Flexi (thiamethoxam/ chlorantraniliprole) (14-21)	4-7 oz	---	3-4	4/28	
	Voliam Xpress[R] (lambda-cyhalothrin/ chlorantraniliprole) (14-21)	6-12 oz	---	3-4	3/28	

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PEACH/NECTARINE Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
FRUIT PRESENT (continued)						
PEACH TWIG BORER (continued)						
Peach Twig Borer	*Reduced Risk/Organic:*					One or two sprays per generation, dependent on pest pressure.
	Altacor (chlorantraniliprole) (14-21)	3.0-4.5 oz	---	4	28	
	Aza-Direct^{O}, AzaGuard^{O}, Azatin O^{O}, Azatrol EC^{O} (azadirachtin) (7-10)	See label	---	2	UN	
	Biobit HP, Dipel DF^{O}, XenTari^{O} (*Bacillus thuringiensis* sub. *kurstaki*) (7)	See label	---	3-4	11	**Altacor:** max 3 applications/yr.
	Delegate WG (spinetoram) (14-21)	4.5-7 oz	---	3	5	
	Entrust^{O} (spinosad) (7)	1.25-2.5 oz	0.4-.8 oz	2-3	5	**Bt products:** must be applied when larvae are less than 1/2 inch.
	Exirel (cyantraniliprole) (14-21)	10-20 oz	---	4	28	
	Grandevo^{O} (*Chromobacterium subtsugae*) (7)	1-3 lb	---	---	NC	
	Success (spinosad) (7)	4-8 oz	1.3-2.7 oz	2-3	5	**Delegate WG:** max 4 applications/yr.
	Venerate XC^{O} (*Burkholderia* spp) (7)	1-4 qt	---	---	NC	

Pest Biology:
- summer generation larvae tunnel into fruit

Scouting/Threshold:
- hang pheromone traps at 250 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.
	Alpha Scents Prionus lure and trap (mass trapping)	1 trap	---	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 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.

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PEACH/NECTARINE Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
FRUIT PRESENT (continued)						
Root Weevils	*Conventional*:					**Belay:** peaches only.
	Sevin 4F (carbaryl)	2-3 qt	---	---	1	
	Voliam Xpress[R] (lambda-cyhalothrin/ chlorantraniliprole)	6-12 oz	---	3-4	3/28	**Botanigard:** must contact the insect; spray at night within one day of mixing.
	Reduced Risk/Organic:					
	Assail 30SG, 70 WP (acetamiprid)	5.3-8.0 oz	---	---	4	**Nematodes:** targets larvae; apply to moist soil and keep soil moist for 14 days; products have 2 week shelf life.
	Belay (clothianidin)	6 oz	---	---	4	
	BotaniGard ES (*Beauveria bassiana*)	---	1-2 qt	2	NC	
	NemaSeek[O], others (*Heterorhabditis bacteriophora)*	See label	---	2-3		
	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:*					**Abound:** toxic to apples.
	Captan 80 WDG (captan) (5-7)	See label	---	3	M4	
	Luna Sensation (fluopyram/ trifloxystrobin) (14)	5-7.6 oz	---	4	7/11	**Fontelis:** max 61 oz/ acre per year.
	Merivon Xemium (pyraclostrobin/ fluxapyroxad) (14)	4-6.7 oz	---	4	7/11	**Ziram 76DF:** max 6 applications/season. 30-day PHI.
	Quash (metconazole) (14)	2.5-3.5 oz	---	3	3	
	Quilt Xcel (propiconazole/ azoxystrobin) (7-14)	14 oz	---	---	3/11	
	Ziram 76DF (ziram) (14)	6 lb	2 lb	3	M3	
	Reduced Risk/Organic:					
	Fontelis (penthiopyrad) (7-14)	14-20 oz	---	3	7	
	Pristine (boscalid/pyraclostrobin) (7-14)	10.5-14 oz	---	4	7/11	
	Regalia[O] (*Reynoutria sachalinensis*) (7)	1-4 qt	2-4 qt	---	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	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
FRUIT PRESENT (continued)						
Spider Mites	*Conventional:*					**Nexter:** works best when applied before mites reach economic threshold. Max 2 applications/yr. **Onager, Savey 50 DF:** max 1 application/yr. **Vendex:** max 2 applications/yr.
	Apollo SC (clofentezine)	4-8 oz	---	4	10	
	Envidor 2 SC (spirodiclofen)	16-18 oz	---	4	23	
	Nexter (pyridaben)	6.6-10.7 oz	---	4	21	
	Onager (hexythiazox)	12-24 oz	---	3	10	
	Savey 50 DF (hexythiazox)	3-6 oz	---	4	10	
	Vendex 50WP[R] (fenbutatin-oxide)	1-2 lb	---	3	12	
	Reduced Risk/Organic:					
	Acramite 50WS (bifenazate)	0.75-1 lb	---	4	UN	
	Captiva Prime[O] (canola oil/garlic oil)	1-2 pt	---	2-3	NC	
	Horticultural oil[O] (many brands)	1-1.5%	1-1.5 gal	2-3	NC	
	M-Pede[O] (potassium salts of fatty acids)	See label	---	1-2	NC	

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	*Conventional:*					Monitoring in individual orchards will be important to know if this pest is present. Do not treat if not found. **Delegate WG:** max 4 applications/yr. **Grandevo:** use with spreader-sticker. **Malathion:** max 3 applications/yr.
	Asana XL[R] (esfenvalerate) (10-14)	5-14.5 oz	---	3-4	3	
	Bexar (tolfenpyrad) (10)	21-27 oz	---	3	21	
	Danitol 2.4 EC (fenpropathrin) (10)	11-21.3 oz	---	2-3	3	
	Malathion 57 EC (malathion) (5-7)	2 pt	---	3	1	
	Warrior II[R] (lambda-cyhalothrin) (10-14)	1.3-2.5 oz	---	3-4	3	
	Reduced Risk/Organic:					
	Delegate WG (spinetoram) (7-10)	4.5-7.0 oz	---	3	5	
	Entrust[O], Success (spinosad) (5-7)	See label	See label	2	5	
	Exirel (cyantraniliprole) (7)	10-17 oz	---	4	28	
	Grandevo[O] (*Chromobacterium subtsugae*)	3 lb	---	2-3	NC	

Pest Biology:
- as of 2018 found in very low numbers in orchards; not yet found in fruit
- adult female has saw-like ovipositor and will lay eggs in unripe fruit

Scouting/Threshold:
- adults can be monitored with liquid baits (yeast/sugar water or apple cider vinegar)
- only treat if adults are detected or neighboring crops are known to be infested

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

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PEACH/NECTARINE Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	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)	5-14.5 oz	2-5.8 oz	3	3	
	Imidan 70-W (phosmet) (14)	4.25 oz	1 oz	3	1	
	Sevin 4F (carbaryl) (10-14)	2-3 qt	---	3	1	**Delegate WG:** max 4 applications/yr.
	Warrior II[R] (lambda-cyhalothrin) (14-18)	2.5-5.12 oz	---	3	3	
	Reduced Risk/Organic:					**Entrust, Success:** works best when mixed with bait, or use GF-120.
	Delegate WG (spinetoram) (14)	4.5-7.0 oz	---	3	5	
	Entrust[O] (spinosad) (7)	1.25-2.5 oz	0.4-0.8 oz	2-3	5	
	GF-120 NF[O] (spinosad + bait) (7)	See label	---	3	5	
	Success (spinosad) (7)	4-10 oz	1-2.5 oz	2-3	5	

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] (salts of fatty acids)	See label	---	2-3	NC	
	Pyganic[O], Tersus (pyrethrins)	See label	See label	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)	2-3 qt	---	3	1	
	Warrior II[R] (lambda-cyhalothrin)	1.3-2.5 oz	---	3	3	
	Reduced Risk/Organic:					**Warrior**: 14-day PHI.
	Entrust[O], Success (spinosad)	See label	---	3	5	
	Pyganic[O], Tersus (pyrethrins)	See label	See label	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	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
FALL TIMING						
Bacterial Canker *(this disease rarely occurs on peach in the Intermountain West)*	*Conventional:*					Treat limbs before frost.
	Cuprofix (copper sulfate)	See label	---	2	M1	
	Kocide, Champ WG (copper hydroxide)	See label	---	2	M1	
	Reduced Risk/Organic:					
	Badge X2[O] (copper oxychloride)	See label	---	2	M	
	Cueva[O] (copper octanoate)	0.5-2 gal	---	---	M1	
	Pest Biology: • overwinters in wood and goes dormant; sometimes buds are killed in early winter	*Scouting/Threshold:* • none		*Cultural*: • none		
Peach Silver Mite	*Conventional:*					**Nexter:** max 2 applications/yr. **Sulfur:** do not let it touch apple or Asian pear.
	Nexter (pyridaben)	5.2-10.7 oz	---	4	21	
	Reduced Risk/Organic:					
	Kumulus DF[O], Microthiol Disperss[O], Sulfur 6L (sulfur)	See label	---	3	M2	
	Pest Biology: • an eriophyid mite, causing "silvering" on leaves	*Scouting/Threshold:* • only treat if symptoms are severe in summer • treat after harvest and before leaf drop		*Cultural*: • none		
Shothole (Coryneum Blight)	*Conventional:*					**Bravo**: can only be used after harvest and before shuck-split. **Fixed coppers** or **Ziram** are effective.
	Bravo Ultrex, Weather Stik (chlorothalonil)	See label	See label	3	M5	
	Captan 80 WDG (captan)	See label	---	3	M4	
	Champ Dry Prill, Champ Formula 2, Kocide (copper hydroxide)	See label	---	3	M1	
	Ziram 76DF (ziram)	6 lb	2 lb	4	M3	
	Reduced Risk/Organic:					
	Badge X2[O] (copper oxychloride)	See label	---	3	M	
	C-O-C-S WDG (copper oxychloride)	12-16 lb	4 lb	3	M1	
	Cueva[O] (copper octanoate)	See label	---	2-3	M1	
	Cuprofix (basic copper sulfate)	5-10 lb	---	2-3	M1	
	Nu-Cop 50 DF, Champ WG[O], ChampION++[O] (copper hydroxide)	See label	---	2-3	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

Pests (Listed in order of management activity)	Stages of Development											
	 Dormant	 Swollen Bud	 1/4-inch Green	 Pink	 First Bloom	 Full Bloom	 Petal Fall	 Post Bloom/Summer: June	July	August	Sept.	Post-Harvest
Cytospora	inspect trees for overall health										inspect trees	
	conidia spread in splashing rain											
Iron Chlorosis							foliar testing					
	early spring soil treatments most effective						repeat foliar applications on new growth					
Peach Twig Borer	⟷							monitor with traps June - Aug ⟷				
	larvae under bark	larvae emerge			larvae tunnel in shoots; pupate in bark crevices			adults/eggs/larvae in fruit			larvae under bark	
European Red Mite (minor pest)	⟷		monitor			monitor						
	eggs on limbs				immatures/adults/eggs on leaves						eggs on limbs	
San Jose Scale (minor pest)	⟷					monitor						
	immatures on limbs						adults/crawlers/immatures on limbs, leaves, and fruit				immatures on limbs	
Green Peach Aphid	⟷		monitor			monitor						
	eggs on limbs				nymphs/wingless and winged adults on new growth			aphids move to nonfruit hosts			eggs on limbs	
Peach Silver Mite	⟷									monitor	⟷	
	adult females in buds				adults/eggs/immatures in buds and on leaves						adult females in buds	
Cat-facing Insects			monitor ⟷			monitor				monitor		
	adults overwinter on orchard floor or move in from outside sources							adults/eggs/nymphs inside and outside orchard				
Western Flower Thrips (nectarine)				monitor flowers for adults ⟷								
	adults on ground			adults & eggs in blooms & on leaves			larvae and adults on fruit and leaves				adults	
Coryneum Blight							monitor ⟷				monitor ⟷	
					spores spread to leaves and young fruit with splashing rain					spores infect leaf scars		
Brown Rot					monitor flowers for dieback				⟷			
					flowers may be infected (rare)				late-season infections on fruit			
Peach Powdery Mildew						monitor ⟷		monitor				
	overwinters in peach buds				new leaves infected		fruit infected			mycelium present on leaves		
Rusty Spot (Apple Powdery Mildew)							monitor					
						spores infect fruit						
Greater Peachtree (Crown) Borer	inspect tree collar for ooze								monitor with traps July- Sept ⟷			
	larvae in trunk or under bark, usually below ground						pupae in soil		adults/eggs laid on trunk larvae bore into trunk		larvae in trunk	
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 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.

APRICOT Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
DORMANT						
Bacterial Canker	*Conventional:*					**Copper:** apply as a dormant application before bud swell.
	Champ Dry Prill, Champ Formula 2, Kocide (copper hydroxide)	See label	---	2	M1	
	Phyton 27 AG (copper sulfate pentahydrate)	---	20-40 oz	2	M1	
	Reduced Risk/Organic:					
	Cueva[O] (copper octanoate)	1 qt	0.5-2 gal	0	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

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:*					**Bravo:** do not apply between shuck split and harvest.
	Bravo Ultrex, Weather Stik (chlorothalonil)	See label	---	3	M5	
	Champ Dry Prill, Champ Formula 2, Kocide (copper hydroxide)	See label	---	3	M1	
	Ziram 76DF (ziram)	6 lb	2 lb	4	M3	
	Reduced Risk/Organic:					
	Badge X2[O] (coppers)	See label	---	2-3	M1	
	C-O-C-S WDG (copper oxychloride)	12-15.6 lbs	---	3	M1	
	Cueva[O] (copper octanoate)	1 qt	0.5-2 gal	2-3	M1	
	Cuprofix (basic copper sulfate)	5-10 lb	---	2-3	M1	
	Nu-Cop 50 DF, Champ WG[O], ChampION++[O] (copper hydroxide)	See label	---	2-3	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	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
DELAYED DORMANT (Swollen Bud to First White)						
Aphid Eggs (Green Peach Aphid, Mealy Plum Aphid) (also targets overwintering Peach Twig Borer)	*Conventional:*					**Oil** alone is sufficient for suppression of aphid eggs. **Diazinon:** max 2 applications/yr.
	Asana XL[R] (esfenvalerate) + 2% oil	5-14.5 oz	2-5.8 oz	4	3	
	Diazinon 50 W (diazinon) + 2% oil	See label	1 lb	4	1	
	Reduced Risk/Organic:					
	Horticultural oil[O] (many brands)	2%	2 gal	2	NC	
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
European Red Mite Eggs *(this pest rarely needs treatment)*	*Conventional:*					**Onager, Savey 50 DF:** max 1 application/yr.
	Onager (hexythiazox)	12-24 oz	---	4	10	
	Savey 50 DF (hexythiazox)	3-6 oz	---	4	10	
	Reduced Risk/Organic:					
	Horticultural oil[O] (many brands)	2%	2 gal	4	NC	
Pest Biology: • overwinter as eggs on limbs	*Scouting/Threshold:* • treat if a problem the previous year					*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)	5-14.5 oz	5.8 oz	3	3	
	Warrior II[R] (lambda-cyhalothrin)	1.3-2.6 oz	---	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

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APRICOT Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
PETAL FALL TO SHUCK SPLIT (continued)						
Peach Twig Borer	*Reduced Risk/Organic:*					Bt is a good option to reduce the population because it is safe on bees.
	Biobit HP, Dipel DF[O], XenTari[O] (*Bacillus thuringiensis* sub. *kurstaki*)	See label	---	3-4	11	
	Entrust[O] (spinosad)	1.25-2.5 oz	---	3	5	**Isomate:** hang up to 1 month before expected biofix to increase efficacy.
	Isomate PTB-TT (mating disruption)	100-200	---	4	---	
	Success (spinosad)	4-8 oz	---	3	5	
	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 250 DD to determine first moth flight				*Cultural*: • hang MD dispensers in upper third of canopy
Shothole (Coryneum Blight)	*Conventional:*					Do not make more than two sequential applications before alternating to a fungicide with a different mode of action.
	Bravo Ultrex (chlorothalonil) (10)	2.8-3.8 lb	0.9-1.25 lb	3	M5	
	Captan 80 WDG (captan) (7-14)	3-5 lb	---	3	M4	**Abound:** toxic to apples.
	Inspire Super (difenoconazole/ cyprodinil) (7-14)	16-20 oz	---	3-4	3/9	**Bravo:** do not apply after shuck split.
	Luna Sensation (fluopyram/ trifloxystrobin) (7-14)	5-7.6 oz	---	4	7/11	**Captan 80 WDG:** max 25 lb/acre per year.
	Merivon (fluxapyroxad/ pyraclostrobin) (7-14)	4-6.7 oz	---	4	7/11	**Fontelis:** max 61 oz/ acre per year.
	Quadris Top (azoxystrobin/ difenoconazole) (7-14)	12-14 oz	---	3-4	3/11	**Gem 500 SC, Inspire Super, Ziram 76DF:** max 4 applications/yr.
	Quilt Xcel (propiconazole/ azoxystrobin) (10-14)	14 oz	---	---	3/11	**Quadris Top:** max 56 oz/acre per year.
	Ziram 76DF (ziram) (14)	6-8 lb	2-2.6 lb	4	M3	
	Reduced Risk/Organic:					
	Abound (azoxystrobin) (7-14)	12-15.5 oz	---	3	11	
	Fontelis (penthiopyrad) (7-14)	14-20 oz	---	4	7	
	Gem 500 SC (trifloxystrobin) (7-14)	2.9-3.8 oz	---	---	11	
	Pristine (boscalid/pyraclostrobin) (7-14)	10.5-14.5 oz	---	4	7/11	
	Regalia[O] (*Reynoutria sachalinensis*) (7-10)	1-4 qt	2 qt	---	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

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APRICOT Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
FRUIT PRESENT						
Earwigs	*Conventional:*					**Sevin 4F:** max 3 applications/yr.
	Sevin 4F (carbaryl) (7)	2-3 qt	---	3	1	
	Warrior II (lambda-cyhalothrin) (14)	1.3-2.6 oz	---	3	3	
	Reduced Risk/Organic:					
	Entrust, Success (spinosad) (7)	See label	---	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
Grasshoppers	*Conventional*:					**Dimilin 2L:** for non-crop areas only (borders, fence rows, roadsides, etc.)
	Dimilin 2L (diflubenzuron)	2 oz	---	3	15	
	Sevin 4F (carbaryl)	0.5-1.5 qt	---	2-3	1	
	Reduced Risk/Organic:					**NOLO Bait:** most effective on nymphs. Do not use if it will rain within 8 hours.
	NOLO Bait[O] (*Nosema locustae*)	1 lb	---	2-4	---	
						Sevin 4F: use higher rate for mature grasshoppers or applications to dense foliage. Bait form available.
	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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APRICOT Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
FRUIT PRESENT (continued)						
Greater Peachtree Borer (Crown Borer, Trunk borer)	*Conventional:*					Two sprays needed on lower trunk: early July and early August. **Voliam Xpress:** max 31 oz/acre per year. **Mating disruption:** hang dispensers right after first trap catch; one application lasts all season.
	Asana XL[R] (esfenvalerate) (21)	5-14.5 oz	2-5.8 oz	3	3	
	Warrior II[R] (lambda-cyhalothrin) (21)	1.3-2.5 oz	---	3	3	
	Mating Disruption (organic):					
	Isomate-P[O] (mating disruption)	100	---	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 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 (thiamethoxam) (14)	4.5-5.5 oz	---	3	4	
	Closer SC (sulfoxaflor) (14)	2.8-5.8 oz	---	3	4	
	Danitol 2.4 EC[R] (fenpropathrin) (14)	11-21 oz		3	3	
	Endigo ZC[R] (thiamethoxam/lambda-cyhalothrin) (14)	5-5.5 oz	---	4	3/4	
	Leverage 360[R] (beta-cyfluthrin/imidacloprid) (14-21)	2.4-2.8 oz	---	3	3/4	
	Voliam Flexi (thiamethoxam/chlorantraniliprole) (14)	6-7 oz	---	3	4/28	
	Voliam XPress[R] (chlorantraniliprole/lambda-cyhalothrin) (14)	6-12 oz	---	3	3/28	
	Reduced Risk/Organic:					
	Surround WP[O] (kaolin) (5-7)	See label	---	2	NC	

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

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APRICOT Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
FRUIT PRESENT (continued)						
Peach Twig Borer	*Conventional:*					One or two sprays needed per generation, dependent on pest pressure. **Altacor:** max 3 applications/yr. **Bt products:** must be applied when larvae are less than 1/2 inch. **Danitol:** max 2 applications/yr. **Delegate WG:** max 4 applications/yr.
	Asana XL[R] (esfenvalerate) (14-18)	5-14.5 oz	2-5.8 oz	3	3	
	Danitol 2.4 EC[R] (fenpropathrin) (14-18)	10-21.3 oz	---	2-3	3	
	Imidan 70-W (phosmet) (21)	4.25 lb	1 lb	3	1	
	Voliam Flexi (thiamethoxam/ chlorantraniliprole) (14-21)	4-7 oz	---	3-4	4/28	
	Voliam Xpress[R] (lambda-cyhalothrin/ chlorantraniliprole) (14-21)	6-12 oz	---	3-4	3/28	
	Reduced Risk/Organic:					
	Altacor (chlorantraniliprole) (14-21)	3.0-4.5 oz	---	4	28	
	Aza-Direct[O], AzaGuard[O], Azatin O[O], Azatrol EC[O] (azadirachtin) (7-10)	See label	---	2	UN	
	Delegate WG (spinetoram) (14-21)	4.5-7 oz	---	3	5	
	Dipel DF[O], XenTari[O] (*Bacillus thuringiensis* sub. *kurstaki*) (7)	See label	---	3-4	11	
	Entrust[O] (spinosad) (7)	1.25-2.5 oz	0.4-.8 oz	2-3	5	
	Exirel (cyantraniliprole) (14-21)	10-20 oz	---	4	28	
	Grandevo[O] (*Chromobacterium subtsugae*) (7)	1-3 lb	---	---	NC	
	Success (spinosad) (7)	4-8 oz	1.3-2.7 oz	2-3	5	
	Venerate XC[O] (*Burkholderia* spp.) (7)	1-4 qt	---	---	NC	

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

Scouting/Threshold:
- time fruit protective sprays at 300-400 degree-days after first adult moth activity

Cultural:
- none

Prionus Root Borer	*Reduced Risk/Organic:*					Set out traps in late June and empty weekly.
	Alpha Scents Prionus lure and trap (mass trapping)	1 trap	---	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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APRICOT Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
FRUIT PRESENT (continued)						
Shothole (Coryneum Blight)	*Conventional:*					**Abound:** toxic to apples. **Fontelis:** max 61 oz/acre per year. **Ziram 76DF:** max 6 applications/season. 30-day PHI.
	Captan 80 WDG (captan) (5-7)	See label	---	3	M4	
	Luna Sensation (fluopyram/trifloxystrobin) (14)	5-7.6 oz	---	4	7/11	
	Merivon Xemium (pyraclostrobin/fluxapyroxad) (14)	4-6.7 oz	---	4	7/11	
	Quash (metconazole) (14)	2.5-3.5 oz	---	3	3	
	Quilt Xcel (propiconazole/azoxystrobin) (7-14)	14 oz	---	---	3/11	
	Ziram 76DF (ziram) (14)	6 lb	2 lb	3	M3	
	Reduced Risk/Organic:					
	Fontelis (penthiopyrad) (7-14)	14-20 oz	---	3	7	
	Pristine (boscalid/pyraclostrobin) (7-14)	11-14 oz	---	4	7/11	
	Regalia^{O} (*Reynoutria sachalinensis*) (7)	1-4 qt	2-4 qt	---	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

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
Spotted Wing Drosophila	*Conventional:*					Monitoring in individual orchards will be important to know if this pest is present. Do not treat if not found. **Delegate WG:** max 4 applications/yr. **Grandevo:** use with spreader-sticker. **Malathion:** max 3 applications/yr.
	Asana XL^{R} (esfenvalerate) (10-14)	5-14.5 oz	---	3-4	3	
	Bexar (tolfenpyrad) (10)	21-27 oz	---	3	21	
	Danitol 2.4 EC (fenpropathrin) (10)	11-21.3 oz	---	3	3	
	Malathion 57 EC (malathion) (5-7)	2 pt	---	4	1	
	Warrior II^{R} (lambda-cyhalothrin) (10-14)	1.3-2.5 oz	---	3-4	3	
	Reduced Risk/Organic:					
	Delegate WG (spinetoram) (7-10)	4.5-7.0 oz	---	3	5	
	Entrust^{O}, Success (spinosad) (5-7)	See label	See label	2	5	
	Exirel (cyantraniliprole) (7)	10-17 oz	---	4	28	
	Grandevo^{O} (*Chromobacterium subtsugae*)	3 lb	---	2-3	NC	

Pest Biology:
- occurs in Intermountain West, but as of 2018, not found to injure fruits
- adult female has saw-like ovipositor and will lay eggs inside ripening fruit

Scouting/Threshold:
- adults can be monitored with liquid baits (yeast/sugar water and apple cider vinegar)
- only treat if adults are detected or neighboring crops are known to be infested

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

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APRICOT Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
PRE-HARVEST						
Boxelder Bug	*Reduced Risk/Organic:*					
	M-Pede[o] (salts of fatty acids)	See label	---	2-3	NC	
	Pyganic[o], Tersus (pyrethrins)	See label	See label	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	
FALL						
Bacterial Canker	*Conventional:*					Treat limbs before frost.
	Champ WG, Kocide (copper hydroxide)	See label	---	2	M1	
	Reduced Risk/Organic:					
	Cueva[o] (copper octanoate)	1 qt	0.5-2 gal	2	M1	
	Nu-Cop 50 DF[o] (copper hydroxide)	See label	---	2	M1	
	Pest Biology: • overwinters in wood and goes dormant; sometimes buds are killed in early winter	*Scouting/Threshold:* • none			*Cultural*: • none	
Shothole (Coryneum Blight)	*Conventional:*					**Bravo**: can only be used after harvest and before shuck-split. **Fixed coppers** or **Ziram** are effective.
	Bravo Ultrex (chlorothalonil)	2.8-3.8 lb	0.9-1.2 lb	3	M5	
	Bravo Weather Stik (chlorothalonil)	3-4 pints	1-1.38 pt	3	M5	
	Captan 80 WDG (captan)	See label	---	3	M4	
	Champ Dry Prill, Champ Formula 2, Kocide (copper hydroxide)	See label	---	3	M1	
	Ziram 76DF (ziram)	6 lb	2 lb	4	M3	
	Reduced Risk/Organic:					
	Badge X2[o] (copper oxychloride)	See label	---	3	M	
	C-O-C-S WDG, others (copper oxychloride)	12-16 lb	4 lb	3	M1	
	Cueva[o] (copper octanoate)	See label	---	2-3	M1	
	Cuprofix (basic copper sulfate)	5-10 lb	---	2-3	M1	
	Nu-Cop 50 DF, Champ WG[o], ChampION++[o] (copper hydroxide)	See label	---	2-3	M1	
	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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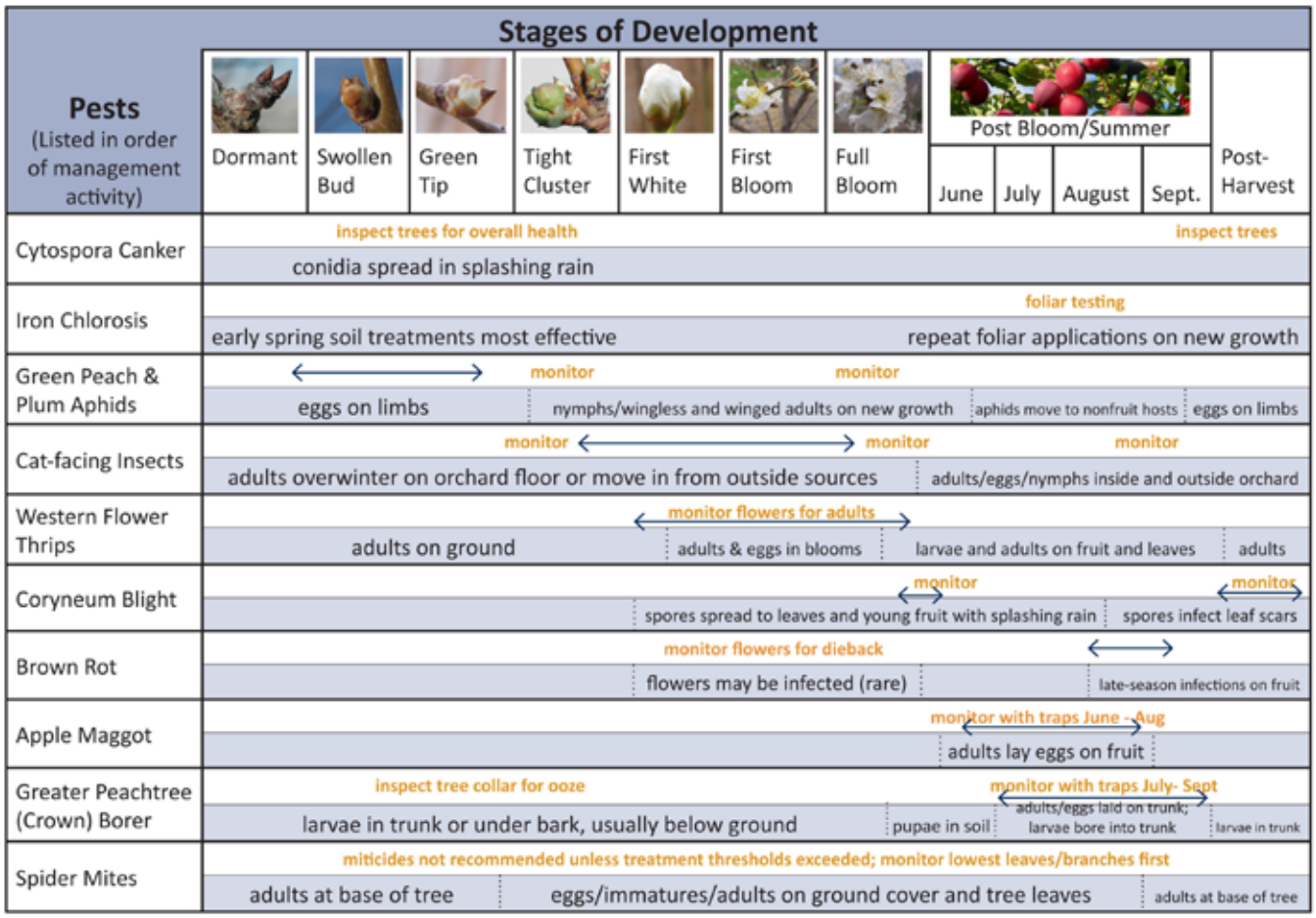
PLUM Pest Management Recommendations

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	Products	Rate (per acre)	Rate (per 100 g)	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	5-14.5 oz	2-5.8 oz	4	3	
	Diazinon 50 W (diazinon) + 2% oil	---	1 lb	4	1	**Diazinon:** max 2 applications/yr.
	Reduced Risk/Organic:					
	Horticultural oil[O] (many brands)	2%	2 gal	2	NC	
	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					
	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		
European Red Mite and Brown Mite Eggs *(these pests rarely need treatment)*	*Conventional:*					**Oil** alone is sufficient for suppression of both mite species.
	Onager (hexythiazox)	12-24 oz	---	4	10	
	Savey 50 DF (hexythiazox)	3-6 oz	---	4	10	**Onager, Savey 50 DF:** max 1 application/ yr.
	Reduced Risk/Organic:					
	Horticultural oil[O] (many brands)	2%	2 gal	4	NC	
	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		

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PLUM Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
BLOOM						
Brown Rot *(rarely a problem on plum)*	*Conventional:*					One application at this timing only if disease was severe the prior year.
	Elevate 50WDG (fenhexamid)	1.5 lbs	1-1.5 lbs	4	17	
	Rally 40 WSP (myclobutanil)	2.5-6 oz	---	4	3	
	Captan 80 WDG (captan)	2.5-5 lbs	---	2-3	M4	
	Reduced Risk/Organic:					
	Pristine (boscalid/pyraclostrobin)	11-14.5 oz	---	3-4	7/11	

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

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
PETAL FALL						
Borers (Shothole, Flatheaded) *(uncommon pests)*	*Conventional:*					Repeat applications every 14-21 days until mid-summer
	Asana XL[R] (esfenvalerate)	5-14.5 oz	5.8 oz	3	3	
	Warrior II[R] (lambda-cyhalothrin)	1.3-2.6 oz	---	3	3	

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	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
Western Flower Thrips *(uncommon on plum)*	*Reduced Risk/Organic:*					Just one application will suffice. **Spinosad** is toxic to bees for 3 hours after treatment.
	Delegate WG (spinetoram)	4.5-7 oz	---	4	5	
	Entrust[O] (spinosad)	1.25-2.5 oz	0.42-0.8 oz	4	5	
	Success (spinosad)	4-8 oz	1.3-2.7 oz	4	5	

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	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
SHUCK SPLIT						
Aphids (Green Peach Aphid, Mealy Plum Aphid, Leaf Curl Plum Aphid)	*Conventional:*					**Actara:** max 11 oz/ acre per year.
	Actara (thiamethoxam) (7)	4.5-5.5 oz	---	4	4	
	Admire Pro (imidacloprid) (10)	1.4-2.8 oz	---	4	4	**Admire Pro:** do not apply during bloom or when bees are active. Max 14 oz/acre/yr.
	Calypso 4 F (thiacloprid) (7)	2-4 oz	---	3	4	
	Closer SC (sulfoxaflor) (14)	1.5-2.75 oz	---	3	4	
	Leverage 360[R] (cyfluthrin/ imidacloprid) (14)	2.4-2.8 oz	---	4	3/4	**Assail:** max 4 applications/year.
	Voliam Flexi (thiamethoxam/ chlorantraniliprole) (10)	4-7 oz	---	4	4/28	**Calypso, Closer:** after petal fall only.
	Reduced Risk/Organic:					
	Assail 30SG, 70 WP (acetamiprid) (10)	See label	---	4	4	**Leverage 360:** max 5.6 oz/acre per year.
	Aza-Direct[O], AzaGuard[O], Azatin O[O], Azatrol EC[O] (azadirachtin) (7)	See label	---	2	UN	
	Captiva Prime[O] (canola oil/garlic oil) (5)	1-2 pt	---	2-3	NC	**Voliam Flexi:** max 14 oz/acre per year.
	Horticultural oil[O] (many brands) (5)	1-1.5%	1-1.5 gal	4	NC	
	M-Pede[O] (salts of fatty acids) (7)	See label	---	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	Products	Rate (per acre)	Rate (per 100 g)	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:*					**Actara:** max 11 oz/ acre per year.
	Actara (thiamethoxam) (7)	4.5-5.5 oz	---	3	4	
	Admire Pro (imidacloprid) (10)	1.4-2.8 oz	---	3	4	**Admire Pro**: do not apply when bees are active.
	Asana XL[R] (esfenvalerate) (14)	5-14.5 oz	2-5.8 oz	2	3	
	Gladiator[R] (abamectin/zeta-cypermethrin) (21)	19 oz	4.75 oz	3	3/6	**Danitol**: max 28 oz/ acre per year.
	Imidan 70-W (phosmet) (14)	2.1-4.3 lb	0.75-1 lb	3	1	
	Leverage 360[R] (cyfluthrin/ imidacloprid) (14)	2.4-2.8 oz	---	4	3/4	**Imidan**: max 13 lb/ acre per year.
	Sevin 4F (carbaryl) (7)	2-3 qt	---	3	1	
	Voliam Xpress[R] (lambda-cyhalothrin/ chlorantraniliprole) (7)	6-12 oz	---	4	3/28	**Leverage 360:** max 1 application/yr.
	Warrior II[R] (lambda-cyhalothrin) (14-21)	1.3-2.6 oz	---	3	3	**Sevin 4F**: max 14 qt/ acre per year.
						Warrior: max 12.8 oz/acre per year.

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PLUM Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
FRUIT PRESENT (continued)						
APPLE MAGGOT, (continued)						
Apple Maggot	*Reduced Risk/Organic:*					**Assail:** max 4 applications/yr.
	Altacor (chlorantraniliprole) (7-10)	3.0-4.5 oz	---	2	28	
	Assail 30SG, 70 WP (acetamiprid) (14-21)	See label	---	3	4	
	Delegate WG (spinetoram) (14)	6-7.0 oz	---	3	5	
	Entrust^{O} (spinosad) (7)	1.3-2.5 oz	.4-0.8 oz	2	5	
	GF-120 NF^{O} (spinosad + bait) (7)	10-20 oz	---	2-4	5	
	Success (spinosad) (7)	4-8 oz	1.3-2.7 oz	2	5	

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 red sphere 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.
	Captan 80 WDG (captan) (7-14)	2.5-5 lbs	---	2-3	M4	
	Elevate 50WDG (fenhexamid) (7-10)	1.5 lbs	1-1.5 lbs	4	17	
	Rally 40 WSP (myclobutanil) (10-14)	2.5-6.0 oz	---	4	3	
	Reduced Risk/Organic:					
	Pristine (boscalid/pyraclostrobin) (7-14)	11-14.5 oz	---	3-4	7/11	

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

European Red Mite and Brown Mite *(these pests rarely need treatment in commercial orchards)*	*Conventional:*					**Acramite, Envidor, Onager, Savey 50 DF:** max 1 application/ yr. **Vendex:** max 2 applications/ season
	Envidor 2 SC (spirodiclofen)	16-18 oz	---	4	23	
	Nexter (pyridaben)	See label	---	---	21	
	Onager (hexythiazox)	12-24 oz	---	4	10	
	Savey 50 DF (hexythiazox)	3-6 oz	---	4	10	
	Vendex 50WP^{R} (fenbutatin-oxide)	1-2 lbs	---	4	12	
	Reduced Risk/Organic:					
	Acramite 50WS (bifenazate)	0.75-1 lb	---	4	UN	
	Horticultural oil^{O} (many brands)	1-1.5%	1-1.5 gal	2-3	NC	

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PLUM Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
FRUIT PRESENT (continued)						
EUROPEAN RED MITE AND BROWN MITE, (continued)						
	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	
Grasshoppers	*Conventional*:					**Dimilin 2L:** for non-crop areas only (borders, fence rows, roadsides, etc.) **Sevin 4F:** use higher rate for mature grasshoppers. Bait form available. **NOLO Bait:** most effective on nymphs. Do not use if rain within 8 hours.
	Asana XL[R] (esfenvalerate)	5-14.5 oz	2-5.8 oz	3	3	
	Dimilin 2L (diflubenzuron) (14)	2 oz	---	3	15	
	Sevin 4F (carbaryl)	0.5-1.5 qt	---	2-3	1	
	Reduced Risk/Organic:					
	NOLO Bait[O] (*Nosema locustae*)	1 lb	---	2-4	---	
	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) *(peachtree borer not usually a problem on plum)*	*Conventional:*					Only lower 12-18" of trunk should be sprayed. **Mating disruption** is very effective and lasts all season. Hang dispensers by early July.
	Asana XL[R] (esfenvalerate) (21)	5-14.5 oz	2-5.8 oz	3-4	3	
	Warrior II[R] (lambda-cyhalothrin) (21)	1.3-2.5 oz	---	---	3	
	Mating Disruption (organic):					
	Isomate-P[O] (mating disruption)	100	---	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 through mid September			*Cultural*: • prevent dense weed growth around base of trees	

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PLUM Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
FRUIT PRESENT (continued)						
Oblique-banded Leafrollers *(this pest rarely needs treatment)*	*Reduced Risk/Organic:*					**Altacor, Exirel:** max 3 applications/yr. **Bt products:** must be applied when larvae are less than 1/2 inch. **Delegate WG:** max 4 applications/yr. **Intrepid 2F:** max 64 oz/acre per year.
	Altacor (chlorantraniliprole) (14)	3.0-4.5 oz	---	4	28	
	Biobit HP, Dipel DF[O], XenTari[O] (*Bacillus thuringiensis* sub. *kurstaki*) (7)	See label	---	3-4	11	
	Delegate WG (spinetoram) (10)	4.5-7 oz	---	4	5	
	Entrust[O], Success (spinosad) (7)	See label	---	4	5	
	Exirel (cyantraniliprole) (10)	10-20.5 oz	---	4	28	
	Intrepid 2F (methoxyfenozide) (10-14)	8-16 oz	---	4	18	
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		
Peach Twig Borer	*Conventional:*					One or two sprays needed per generation, dependent on pest pressure. **Altacor:** max 3 applications/yr. **Bt products:** must be applied when larvae are less than 1/2 inch. **Danitol:** max 2 applications/yr. **Delegate WG:** max 4 applications/yr.
	Asana XL[R] (esfenvalerate) (14-18)	5-14.5 oz	2-5.8 oz	3	3	
	Danitol 2.4 EC[R] (fenpropathrin) (14-18)	10-21.3 oz	---	2-3	3	
	Imidan 70-W (phosmet) (21)	4.25 lb	1 lb	3	1	
	Voliam Flexi (thiamethoxam/ chlorantraniliprole) (14-21)	4-7 oz	---	3-4	4/28	
	Voliam Xpress[R] (lambda-cyhalothrin/ chlorantraniliprole) (14-21)	6-12 oz	---	3-4	3/28	
	Reduced Risk/Organic:					
	Altacor (chlorantraniliprole) (14-21)	3.0-4.5 oz	---	4	28	
	Aza-Direct[O], AzaGuard[O], Azatin O[O], Azatrol EC[O] (azadirachtin) (7-10)	See label	---	2	UN	
	Biobit HP, Dipel DF[O], XenTari[O] (*Bacillus thuringiensis* sub. *kurstaki*) (7)	See label	---	3-4	11	
	Delegate WG (spinetoram) (14-21)	4.5-7 oz	---	3	5	
	Entrust[O] (spinosad) (7)	1.25-2.5 oz	0.4-.8 oz	2-3	5	
	Exirel (cyantraniliprole) (14-21)	10-20 oz	---	4	28	
	Grandevo[O] (*Chromobacterium subtsugae*) (7)	1-3 lb	---	---	NC	
	Success (spinosad) (7)	4-8 oz	1.3-2.7 oz	2-3	5	
	Venerate XC[O] (*Burkholderia* spp) (7)	1-4 qt	---	---	NC	

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PLUM Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
FRUIT PRESENT (continued)						
PEACH TWIG BORER, (continued)						
	Pest Biology: • larvae prefer to tunnel into new shoots and tender twigs in first generation	*Scouting/Threshold:* • time fruit protective sprays at 300-400 degree-days after first adult moth activity			*Cultural*: • none	
Prionus Root Borer	*Reduced Risk/Organic:*					
	Alpha Scents Prionus lure and trap (mass trapping)	1 trap	---	3	NC	Set out traps in late June and empty weekly.
	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.			
Spider Mites	*Conventional:*					**Savey 50 DF:** max 1 application/yr. **Vendex 50WP:** max 2 applications/yr. **Envidor 2 SC:** max 1 application/season.
	Agri-Mek SC (abamectin)	See label	See label	3-4	6	
	Envidor 2 SC (spirodiclofen)	16-18 oz	---	4	23	
	Nexter (pyridaben)	See label			21	
	Onager (hexythiazox)	12-24 oz	---	3	10	
	Savey 50 DF (hexythiazox)	3-6 oz	---	4	10	
	Vendex 50WP[R] (fenbutatin-oxide)	1-2 lb	---	3	12	
	Reduced Risk/Organic:					
	Acramite-50WS (bifenazate)	0.75-1 lb	---	4	UN	
	Captiva Prime[O] (canola oil/garlic oil)	1-2 pt	---	2-3	NC	
	Horticultural oil[O] (many brands)	1-1.5%	1-1.5 gal	2-3	NC	
	M-Pede[O] (potassium salts of fatty acids)	See label	---	1-2	NC	
	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			

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PLUM Pest Management Recommendations

Pest	Products	Rate (per acre)	Rate (per 100 g)	Eff	MOA	Comments
PRE-HARVEST						
Earwigs	*Conventional:*					**Sevin 4F:** make applications no more than once every seven days and no more than three times per crop.
	Sevin 4F (carbaryl)	2-3 qt	---	3	1	
	Warrior II[R] (lambda-cyhalothrin)	1.3-2.5 oz	---	3	3	
	Reduced Risk/Organic:					
	Entrust[O], Success (spinosad)	See label	---	3	5	**Warrior:** 14-day PHI.

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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CHAPTER 8 ORCHARD FLOOR AND WEED MANAGEMENT

Orchardists often think of orchard pests as comprising only insects and diseases. Weeds are also orchard pests and are equally capable of reducing yield and fruit quality as insects and diseases. Weeds are pests by competing with trees for water, nutrients, and in extreme cases, light. On the other hand, orchard floor vegetation prevents erosion on slopes, improves trafficability especially during wet weather, may provide habitat for beneficial insects, and reduces mud.

The ability of weeds to compete with fruit trees is well documented. One experiment showed that grass growing near the trunk of apple trees delayed the onset of fruiting, reduced trunk circumference, and reduced shoot growth when compared to trees grown with bare ground surrounding them. Grasses were more competitive than broadleaf weeds. In another experiment, adding more nitrogen did not overcome the competition imposed by grasses.

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 orchard floor management plan is best determined before the orchard is planted. Management practices for orchard floor management should be executed in a timely manner during the lifetime of the orchard. This chapter describes some factors to consider while making decisions about how the orchard floor will be managed.

Orchard Floor Management Systems

An ideal orchard floor would be easy to maintain, aid the growth of trees and fruit, maintain soil structure, reduce erosion, not block the radiation of heat from the soil on frosty nights, and not compete with trees for water or nutrients. In practice, no single orchard floor management system accomplishes all of these goals. Current systems balance the ideal against real world conditions.

Several general systems for managing orchard floors, listed below, are available and each has advantages and disadvantages to consider before choosing one.

- Grass alleys between tree rows with vegetation-free strips in the tree row;
- Solid vegetation cover;
- Total clear cultivation;
- Mulches in the tree row with vegetation or clear soil between rows.

Grass alleys with vegetation-free strips

This is the most widely adopted method of orchard floor management. It has many of the advantages of both solid grass cover and clean cultivation. Usually, herbicides or cultivation are 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. A cover crop, usually a sod forming grass, is planted and maintained in the alley between the tree rows. This strip provides an area where roots can grow without competition from weeds or grass sod. In orchards with a vegetation free zone, most of the root growth occurs in the vegetation free area, especially for young trees. 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 cover crop sown, weed invasion can be minimized and sod establishment can be fairly quick.

Solid vegetation cover

Solid vegetation cover, usually grasses, has been used by many growers in the past. It is particularly effective on steep slopes where erosion is a severe problem. It is least competitive in mature orchards planted on vigorous rootstocks (MM.111, MM.106, or seedling). However, solid vegetation cover has major drawbacks. Vegetation competes with fruit trees for water and nutrients which reduces tree vigor and results in decreased yields and small fruit size. Vegetation growing right up to tree trunks is also difficult to mow. Mowing equipment can damage trees if operated too close to them. Vegetation surrounding tree trunks creates a favorable habitat for rodents. During the winter when other food is

scarce, rodents will feed on tree trunks up to the snow line. In severe cases rodents will completely girdle the tree leading to tree death.

Clear cultivation

In this system no vegetation remains on the orchard floor. Growers can either use herbicides to kill all vegetation or shallow cultivation. Cultivation may improve water infiltration of some soils, but frequent shallow cultivation damages feeder roots near the soil surface and is energy intensive. Soil erosion on all but very flat sites can be increased with bare soil from either cultivation or herbicide use. Bare soil does not provide good traffic support when soils are wet and may lead to additional soil compaction from heavy equipment. Creation of a disking pan is a common result. During the driest part of the summer, bare ground in the orchard results in increased dust, which will exacerbate mite problems in the orchard canopy.

Mulch

Mulches conserve soil moisture and will initially inhibit weed growth around trees. Effective mulches include straw, sawdust or shavings, hay, leaves, chipped prunings, or shredded newsprint. Mulches are expensive to obtain and apply on an annual or biennial basis. They do not control weeds effectively for long periods, especially perennial weeds. Organic mulches may bring in additional weed seeds and/or new weed species. As they decompose, some organic mulch materials tie up available soil nitrogen.

Development of synthetic plastic film and spun bonded polyester fabric mulches has added an additional management option. However, these products must be covered with an organic mulch to prevent photodegredation of the material. These products are typically applied to the soil and the trees are planted into the weed barrier.

Cover Crops

Cover crops can be one component of orchard floor management, but are not a "system" alone. Cover crops are important in maintaining soil structure, encouraging water infiltration, reducing erosion, reducing mud and dust, and maintaining an acceptable driving surface for equipment. A good cover crop can be established with grasses, broadleaf plants such as legumes, or both, although a uniform plant stand is often easier to manage than one made up of multiple crop species. A cover crop should establish itself quickly and thereafter should not require much maintenance. It should be chosen and managed so that competition with trees is minimal.

Grasses are the most common cover crops in orchards. Many different grasses and grass mixtures are available, so orchardists can choose what is best suited to each particular situation. Several low growing perennial rye grasses are available and allow easy orchard access even when headed out.

Legumes can be used as alleyway cover crops 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 covers does come with a few disadvantages. Stink bugs and lygus can feed on the legumes, and after mowing, could move to the trees and feed on fruits, causing cat-facing injury. Legumes also require more irrigation than some other cover crops. 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 limiting.

Cover crop establishment

Preparation for cover crop 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 non-residual herbicides 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. Establish sod over the entire orchard in the fall before tree planting. Once the sod is growing well, mark out the orchard rows and kill the grass in the planting row using glyphosate or paraquat. The dead sod will help prevent erosion during the winter and spring. With sod already in place, planting will be easier and less muddy.

Legumes are best planted in the spring after the soil has warmed and can be worked. Usually a grass/legume mixture is planted to obtain the benefits of both types of plants.

Cover crop maintenance

Once a cover crop is established, required maintenance should be minimal. Maintenance operations include 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. If dandelions or other weeds are flowering concurrently with tree fruits, the dandelions should be mowed to remove the flowers. Weed flowers compete with fruit tree blossoms for bee visits and poor pollination may result. 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 orchard should be mowed again in the late fall to remove habitat favorable for rodents.

Drought tolerance is another good measure of a cover crop. Irrigation required for cover crops 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 is still required.

Weed Control in Orchards

As orchard tree density increases the importance of controlling competing vegetation (weeds) also increases. Weeds may be managed either mechanically or chemically. Each approach has advantages and disadvantages. Mechanical weed control usually requires more energy, is short lived, non-selective, typically selects for perennial weeds and has a higher risk of damaging tree trunks and shallow roots. Chemical weed management exposes applicators, fruit trees, and the environment to toxic materials.

The advent of chemical weed killers (herbicides) has given fruit growers many choices for controlling orchard weeds. Herbicides have various modes of action, but can conveniently be grouped as either pre-emergent or post-emergent herbicides. Pre-emergent herbicides are active in the soil against germinating seedlings. Post-emergent herbicides are active against vegetation that is already up and growing. Post-emergent herbicides can further be categorized as contact (paraquat) or systemic. Post-emergent systemic herbicides can also be divided as selective (2,4-D) or non-selective (glyphosate).

Effective chemical orchard weed control programs utilize both pre-emergent and post-emergent herbicides. When the initial spring herbicide application includes both a pre-emergent and post-emergent

material the spring 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.

Herbicides are active at relatively low concentrations. Herbicide application 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.

If an herbicide is being used for the first time, treat a small area of the orchard first to gain experience and to check for effectiveness.

Rotate the herbicides used among herbicide classes. Rotating herbicides reduces "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 you are using.
- Wear the personal protective equipment specified on the label for the product(s) being used.
- Use herbicide sprayers only for herbicides.
- Clean sprayers thoroughly following use—especially following 2,4-D.
- Dispose of excess spray material properly. Avoid contact with non-target vegetation.
- Do not graze a treated orchard.
- Store herbicides in a secure location in accordance with label requirements.
- Zinc sulfate is highly corrosive. The spray tank, pump, lines, and nozzles should be thoroughly rinsed and flushed after using.
- Foliar application during or followed by damp weather may result in spray injury on some varieties of stone fruits.

Herbicides Labeled for Fruit Crops

See REI and PHI Table in Chapter 5 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.
Apple, peach	annual grasses and broadleaves	Sinbar 80 WP (terbacil)	Maximum rate is 1 lb per year. Can be used on non-bearing pear, cherry, apricot, and plum.
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.
ALL	annual grasses and listed broadleaves	Surflan AS (oryzalin)	Rainfall or irrigation to 0.5 inch required for activation.

[R] = restricted use pesticide

Herbicide Sprays, continued

Crop	Weeds Treated	Formulation Name (active ingredient)	Remarks
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.
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 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.
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.

[R] = restricted use pesticide

Herbicide Sprays, continued

Crop	Weeds Treated	Formulation Name (active ingredient)	Remarks
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.
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.
ALL	annual grasses and listed broadleaves	Snapshot 2.5 TG (isoxaben+trifluralin)	Pre-emergence herbicide; 0.5 inch rain or irrigation required within 3 days of application.

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. 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.

Voles can injure or destroy trees.

An effective vole management plan in orchards consists of five components:

- Habitat destruction
- Scarce food supply
- Exclusion
- Facilitating predators
- Baiting with rodenticide

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. Depending on the site and landowner's personal preferences, these areas could have more benefits than negative effects.

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 emergence.

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.

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.

- **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.

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/files/publications/fact sheet/NR_Wldlife_2012-02.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

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

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 out" of the pipe. The openings are small enough to keep non-target animals from the bait and the bait is protected from moisture.

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.

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.

Common Rodenticides Used in Orchards

Rodenticide	Type	Days of Feeding	Bird Toxicity Risk	Mammal Toxicity Risk
Brodifacoum	Anticoagulant	Single	Highest	Highest
Bromadiolone	Anticoagulant	Single	Moderate	Moderate
Chlorophacinone	Anticoagulant	Multiple	Slight	Highest
Diphacenone	Anticoagulant	Multiple	Moderate	Highest
Defethialone	Anticoagulant	Single	Highest	Moderate
Warfarin	Anticoagulant	Multiple	Slight	Low
Bromethalin	Non-anticoagulant	Single	Low	Low
Cholecaciferol	Non-anticoagulant	Multiple	Low	Low
Strychnine	Non-anticoagulant	Single	Possible	Possible
Zinc phosphide	Non-anticoagulant	Single	Low	Slight

CHAPTER 10 PLANT GROWTH REGULATORS AND THINNING

Plant growth regulators (PGRs) can be used with some precision for controlling bloom, thinning fruit, regulating growth, and adjusting harvest season 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.

This chapter provides information on which plant growth regulators to use for a specific effect and gives instructions on how, when, where, and in what quantities to apply them. Because plant response can vary greatly due to a range of factors, it is important to keep detailed records of use and plant response to help you fine-tune applications for your orchard.

Naturally Occurring Plant Hormones

A plant hormone is commonly defined as an organic substance that is produced in one part of a plant and translocated to another part where, at very low concentrations, it stimulates a physiological response. Plant hormones may promote or inhibit growth, depending on the specific hormone involved, the concentration, the time, and the plant part it is acting on. Plant hormones occur naturally. When they're synthesized chemically they're known as plant growth regulators or PGRs. Some PGRs act by blocking either the synthesis or the activity of plant hormones.

Plant hormones 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. 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 herbicides (2,4-D and other phenoxy herbicides). In apple production, NAA and NAD are synthetic auxins that can be used to thin fruit, to inhibit water sprout and sucker growth, and to prevent pre-harvest fruit drop. Carbaryl, while not strictly an auxin, has a similar chemical structure.

Gibberellins

Gibberellins also promote growth. They are produced in very young leaves, developing seeds, fruit, and roots. Gibberellins cause cell elongation, including shoot growth, and are involved in regulation of dormancy. Commercially, gibberellins have been used to improve fruit size and to prevent russeting. Several growth retardants, including Apogee, 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).

Abscisic Acid

Abscisic acid (ABA) is a growth inhibitor. It controls the dormancy of buds and seeds and inhibits shoot growth. Exactly how ABA works is not well understood. It may act directly by blocking synthesis of enzymes, or it may operate indirectly by blocking RNA synthesis, thus blocking the formation of enzymes that in turn form the growth promoters. ABA is produced in mature leaves, along with many other plant tissues. It is not currently used as a PGR in tree fruits but is available for promoting fruit color development in table grapes.

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. 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. ReTain interferes with ethylene biosynthesis, allowing fruit to hang on trees longer and lengthens storage life. 1-Methylcyclopropene (1-MCP or SmartFresh) blocks the receptor for ethylene, preventing ethylene action. Since 1-MCP is a gas, it has been used to slow post-harvest ripening in storage, but has not been used in orchards.

Factors Affecting Plant Response

The effectiveness of a PGR application is 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 of low humidity and high temperatures typical of Intermountain West weather, evening or night-time applications are typically best, to allow for proper drying time and avoid volatilization and photo-degradation of PGRs.

Tree Vigor and Age

Weak trees and young trees are more responsive to PGRs. Stresses caused by 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 are applied in very precise and low concentrations. Extreme care must be taken to mix and apply these chemicals accurately to avoid incorrect dosage. PGRs should be applied as dilute high volume sprays (200 + gallons per acre) to ensure uniform coverage and because applying the correct dose is more difficult in low-volume sprays. Growers that only have access to low-volume sprays 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 actually decrease retention of the spray solution on the surface of the plant.

Many of the PGRs are sensitive to spray solution pH, where the stability and activity of the PGR molecules are best in slightly acidic solution. With the alkaline water typical of orchards in the Intermountain West, 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 relatively 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 during future years to achieve the optimal response.

Thinning Apple Fruit

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 the individual fruit to develop marketable size. Also, heavy crop loads inhibit the ability of the tree 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.

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 apple 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.

Determining Crop Load

The following questions will help you evaluate whether your crop needs to be thinned. Remember, it's 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 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 or not 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.

PGR Products for Thinning Apples

Currently four materials are available for fruit thinning. The best material to use will depend on the cultivar, the condition of the trees, and time of application.

- **Carbaryl** (Sevin) is an insecticide that has thinning action.
- **Benzyladenine** (Maxcel) contains a synthesized plant hormones involved in regulating cell division called cytokinin.
- **Naphthalene acetic acid** (NAA) is a synthetic auxin growth regulator.
- **Naphthalene acetamide** (NAD) is also a synthetic auxin growth regulator.

Most have a timing recommendation based on the size of the king fruit. 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 below.

Thinning Stone Fruit

Unfortunately, PGR formulations are not available for post-bloom thinning of stone fruits such as peaches

Characteristics of Products for Thinning Apples

Rate	Timing	Effectiveness	Compatibility	Notes
CARBARYL (SEVIN)				
¼ to ½ lb 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	Very effective Produces larger fruit than NAD or NAA	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 (BA OR MAXCEL)				
75-200 ppm	When king fruits are 5-10 mm in diameter (generally 7-21 days after full bloom)	Use at 70-75°F for peak effectiveness	Only with carbaryl (¼ lb) Do not mix with other pesticides	High temperatures within 8 hr of application will increase thinning Apply at night for greatest drying time
NAPHTHALENE ACETIC ACID (NAA)*				
10-15 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	Carbaryl, decrease amount of NAA by half, for hard-to-thin cultivars	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)				
35-50 ppm	Between late bloom and petal fall (4-8 days after full bloom) Applications after petal fall result in poor thinning		Carbaryl	For cultivars that mature before Sept. 1 On Red Delicious, it can cause excessive pygmy fruit

***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.

and cherries. 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. 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. Blossom thinning with these caustic materials in cold and frost-prone areas of the Intermountain West is extremely risky. Recent trials in Utah indicated that application of caustic bloom thinners to peaches, followed by cold but non-freezing temperatures, resulted in complete crop loss.

Flower Bud Prevention in Tart Cherry

Application of gibberellic acid (GA_3) can be used in stone fruits to reduce the number of flower buds formed for the following season. This has been used successfully to prevent over-cropping 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.

Using ProGibb to Reduce Tart Cherry Bud Formation

Rate	Timing	Notes
4 – 18 grams a.i./acre Use higher rate on older trees. See label for specific rate.	In general, 2 to 4 weeks after bloom. Optimal is when 3 to 5 terminal leaves have fully expanded, or at 1 to 3 inches of terminal shoot growth.	Similar applications can reduce flowering in non-bearing tart cherries.

Effect of Sunlight on Thinning Agents

While the precise mode of action of PGR thinning agents is not clearly understood, evidence is accumulating that the carbohydrate status of the tree plays a key role in plant sensitivity. Carbohydrate status is affected by light levels (more light = more photosynthesis = improved carbohydrate levels) and by overall tree health. This effect occurs both at the whole-tree and the individual-branch level. Overcast conditions and internal shading both make the fruit more sensitive to PGR thinning applications. Likewise, well-exposed branches under full sunlight conditions tend to be more difficult to thin.

Controlling Apple Tree Vigor

Many reasons exist for controlling an apple tree's vegetative vigor. 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 (Apogee)

Apogee is a PGR that interferes with the production of gibberellins in the plant. Gibberellins are plant hormones involved in shoot elongation. Inhibiting gibberellin production decreases 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 Apogee 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.

A beneficial effect of Apogee 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 Apogee to Control Apple Tree Vigor

Rate of Apogee	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.	

Improving Apple Fruit Quality

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 (GA_{4+7}) during the 45-day period after bloom has been shown to reduce fruit russeting. See table below.

Using ProVide to Prevent Apple Fruit Russet

Rate of ProVide	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

Promalin is a combination of benzyladenine and gibberellic acid (GA_{4+7}) that 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.

Using Promalin 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

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 require cool nighttime temperatures and direct exposure to light for color development, even when ethephon has been applied. Proper

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

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 above for rates and other information.

Preventing Premature Fruit Drop

Some apple cultivars, particularly early ones, are susceptible to pre-harvest fruit drop. Most susceptible cultivars respond to a dilute application of NAA. Ethylene inhibitors can be even more effective than NAA for preventing pre-harvest drop (see table below and the following section).

Using NAA to Prevent Fruit Drop

Rate of NAA	Timing	Notes
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

Delaying Fruit Maturity

Sweet Cherry

Applications of gibberellic acid (GA_3) can be used to extend the harvest season of sweet cherries. GA_3 (ProGibb) 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. GA_3 also slows color and sugar accumulation, resulting in brighter color at harvest but lower soluble solids.

Apple

Aminoethoxyvinyl glycine (AVG or ReTain) blocks the formation of ethylene by plants and can be used to delay maturity and to hold fruit on the tree. AVG can be used as a stop drop with the added benefit of firmer fruit at harvest and a longer storage life. AVG has no direct effect on color development, but allowing the fruit to hang on the trees longer will result in larger fruit with more color development.

Timing is critical. Apply at the label rate 4 weeks before anticipated harvest. AVG acts by preventing the natural abscission process from beginning. However, if this process has already started, AVG applications are not effective. Use at least 100 gallons per acre and spray both sides of the row (no alternate row applications) to ensure good coverage.

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.

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. It is important to conduct regular soil and foliar nutrient testing to determine excesses or deficiencies.

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.

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, 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.

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. 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.

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

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.

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.

Nitrogen applications are ideally applied in spring. Summer applications should be made at least 6 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 between 4 to 18 inches.

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

Phosphorus (P) and Potassium (K)

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 (at each important stage of growth) for sufficiency.

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 when 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. Annual adjustment of phosphorus nutrition is recommended with an application of mono-ammonium phosphate (11-52-0).

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

Deficiencies of zinc, iron, copper, manganese, calcium, magnesium, and boron can be successfully corrected temporarily with sprays. Zinc deficiencies are corrected through dormant sprays, while the other nutrients are corrected through soil applications. 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. Soil application of chelated micronutrients 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: 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. 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 is adjusted so that it remains close to neutral (pH 6-7).

Boron

Leaf analysis results show some boron deficiencies in peaches and apples. However, pears are the fruit crop that most often shows boron deficiency. Where pear trees are affected by "blossom blast" or wilting of the flower buds in early spring due to boron deficiency, a spray should be applied before bloom. A single maintenance spray, applied each year at a low rate, should supply enough boron to prevent the development of a deficiency. While the spray may be applied at any time, late fall applications when leaves are still green or spring pre-bloom applications are recommended.

Calcium

Spray applications of calcium can reduce the incidence of bitter pit and cork spot in apples by 35 to 50 percent. Under average conditions, three sprays are suggested. The first should be applied about mid-June. It should be followed by a second spray in mid-July and a third in mid-August. With young and very vigorous trees or trees with large fruit which have a history of serious bitter pit, more sprays may be necessary. Applications should begin at the same time (mid-June) and should be carried on through to mid-August. The more severe the history of bitterpit, the more frequently should calcium be applied.

Manganese

Manganese deficiencies are especially common in peach orchards located on highly alkaline soils. This deficiency is often masked by zinc and iron deficiencies. 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, applied when the first leaves are fully expanded, is sufficient to maintain an adequate level of manganese in the leaves.

Iron

Iron sprays with iron salts or chelates usually give temporary correction of chlorosis, although peach trees are less likely to respond than other fruits. Soil applications of chelated iron are much more effective than foliar sprays, but need to be protected from breakdown by the sunlight. For soil applications, apply 2 to 4 oz Sequestrene 138 Fe or Miller's Ferriplus per inch of trunk diameter shortly before the first or second irrigation. Distribute the material evenly along the tree in the nearest furrow on each side of the tree and cover lightly. The irrigation water will dissolve the chelate and move it into the root zone.

Zinc

Zinc deficiency symptoms are common in the Intermountain West. Soil applications of zinc have not proven effective. Where zinc levels are known to be low, annual 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.

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 October 10), 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." For more information, see Chapter 5.

Nutrient Sprays

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	4 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	6-12 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. Over-irrigation slows root growth, increases iron chlorosis in alkaline soils, and leaches 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. Applying insufficient irrigation water results in drought stress and reduced fruit size and quality.

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).

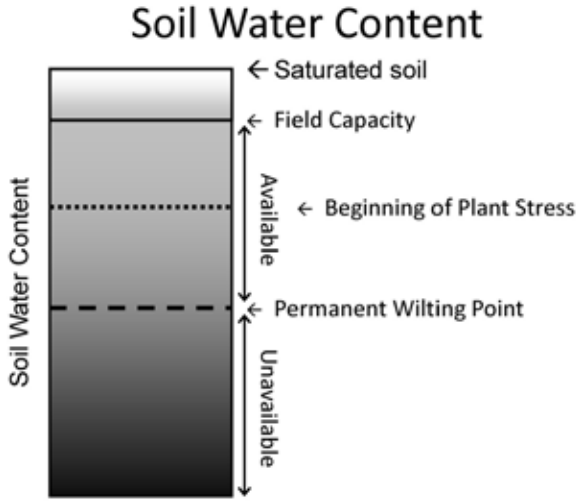


Fig. 12.1. Soil water content from saturated to dry. Optimal levels for plant growth are between field capacity and allowable depletion.

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.)

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. Although tree roots can grow to several yards depth, 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, for example, would contain 1.8 to 2.25 inches of readily available water in an effective rooting depth of 3 feet.

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, 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).

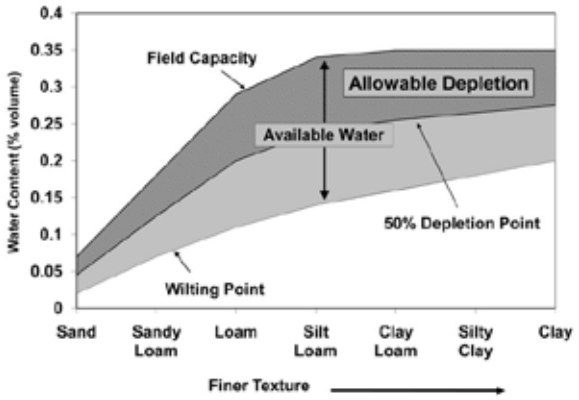


Fig. 12.2. The amount of allowable depletion, or the readily available water, represents about 50 percent of the total available water.

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

Table 12.2. Recommended Watermark sensor values at which to irrigate.

Soil Type	Irrigation Needed (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. 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 (ET_{ref} or ET_r).

Typical weekly ET_r values are shown in Table 12.3. Calculated ET_r can be determined by accessing weather data from a nearby weather station in Utah at: climate.usu.edu/traps, in Colorado at: ccc.atmos.colostate.edu/~coagmet/, in Idaho at pnwpest.org/ID/indexAGRIMET.html, or in Montana at usbr.gov/pn/agrimet/mt_charts.

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.

$$ET_{crop} = ET_r \times K_{crop}$$

The K_{crop} for peach is shown in Fig. 12.3. At full bloom (Growth Stage = 0), a peach orchard is using

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)

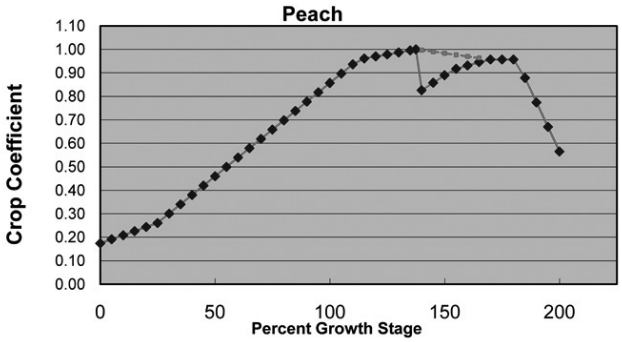


Fig. 12.3. Crop coefficients for peach, based on an alfalfa reference ET. Adapted from Johnson et al. (2000). Full bloom = 0, full canopy = 110; fruit harvest = 140; leaf drop = 200.

about 20% of the amount of water used by the alfalfa reference crop. Water use increases gradually as the 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.

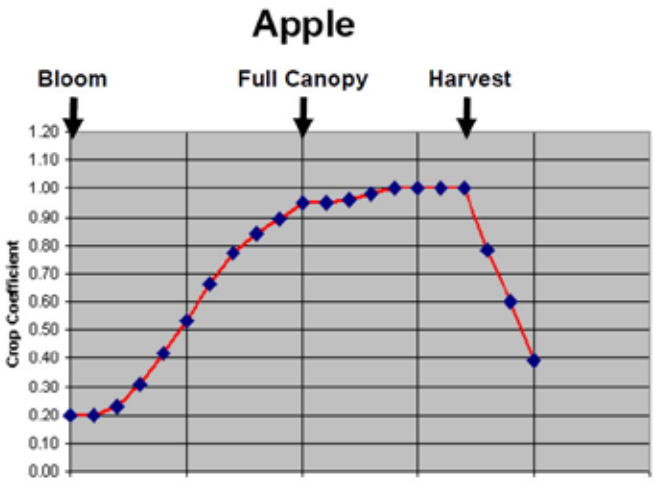


Fig. 12.4. Crop coefficients for apples, based on an alfalfa reference crop.

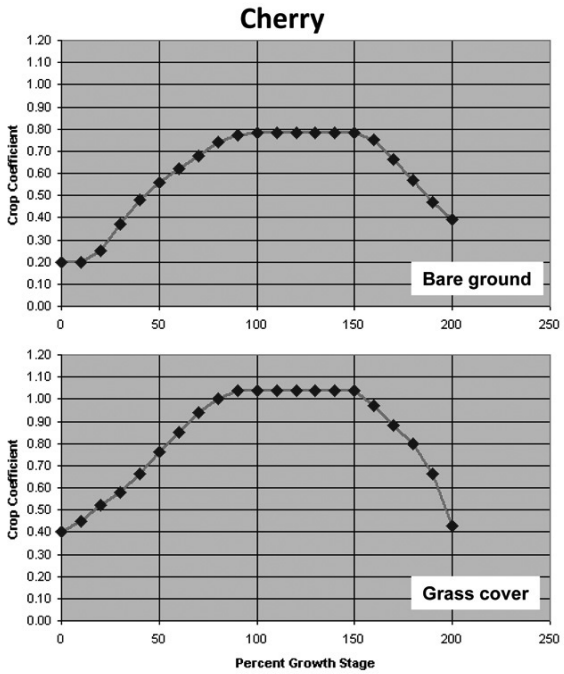


Fig. 12.5. Crop coefficients for sweet cherry with clean cultivated or grass cover row middles. (Tart cherry is similar.)

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 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.

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 (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. Assuming a micro-sprinkler irrigation system with an efficiency of 80%, 1.9 acre inches of water application will be required per acre for each watering.

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. www.usbr.gov/pn/agrimet/cropcurves/crop_curves.html.

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.

Hill, R.W. 1994. Consumptive Use of Irrigated Crops in Utah. Utah Ag. Exp. Stn. Res. Rpt. #145. Utah State University, Logan UT. www.waterrights.utah.gov/techinfo/default.asp.

Smith, T. Irrigating Tree Fruits for Top Quality. Washington State University Extension. extension.wsu.edu/chelan-douglas/agriculture/treefruit/irrigation/irrigatingtreefruitsfortopquality.

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.

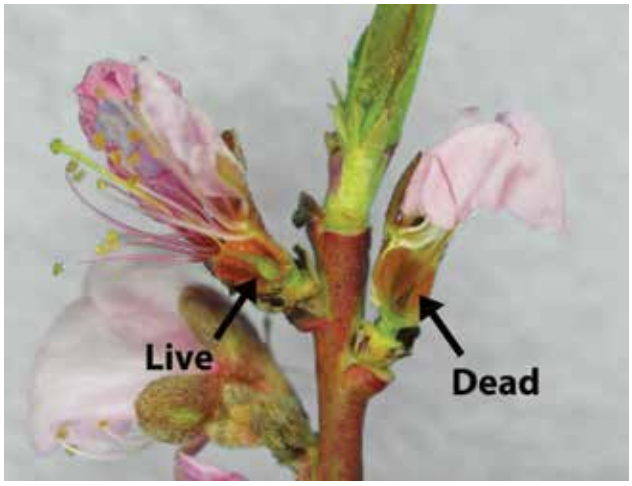
Buds are then cut and examined for brown to black discoloration of the fruit pistil (young fruit within the flower). A general rule of thumb is that sweet cherries need about 50% of the buds produced the previous summer in order to have a full crop; all the other tree fruits (apple, pear, apricot, peach, 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.

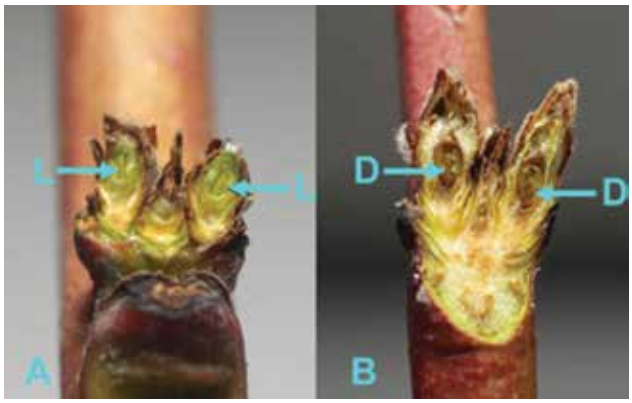
Apricot, Peach, Nectarine

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.

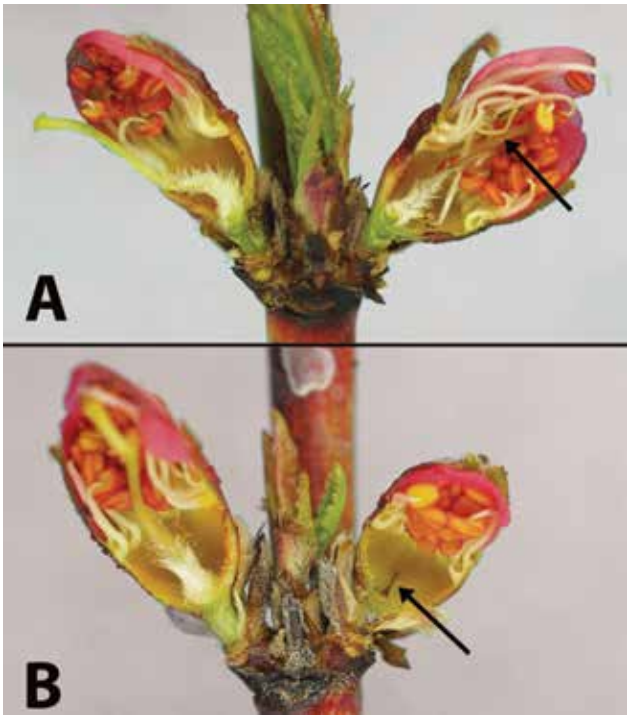
When evaluating damage of young fruit, the cut should be made horizontally through the fruit about 1/3 the distance from the stem end to the stylar end in order to cut through the embryo structure called the funiculus, which is a connection to the exterior fruit tissue. A vertical cut can also be used 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



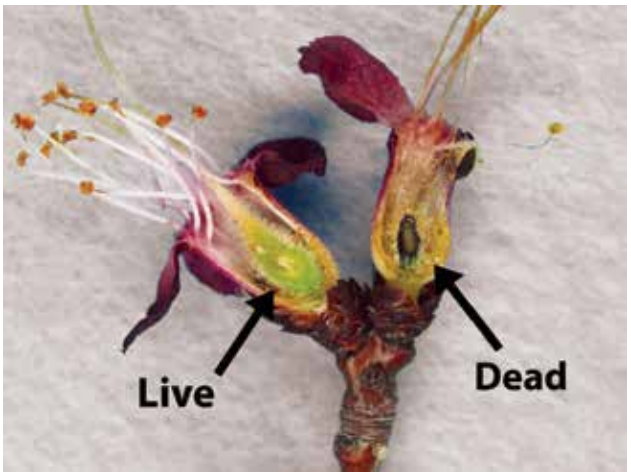
Fantasia **nectarine** buds, cut longitudinally to show the pistil, one live and one dead. (photo by HJ Larsen)



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)



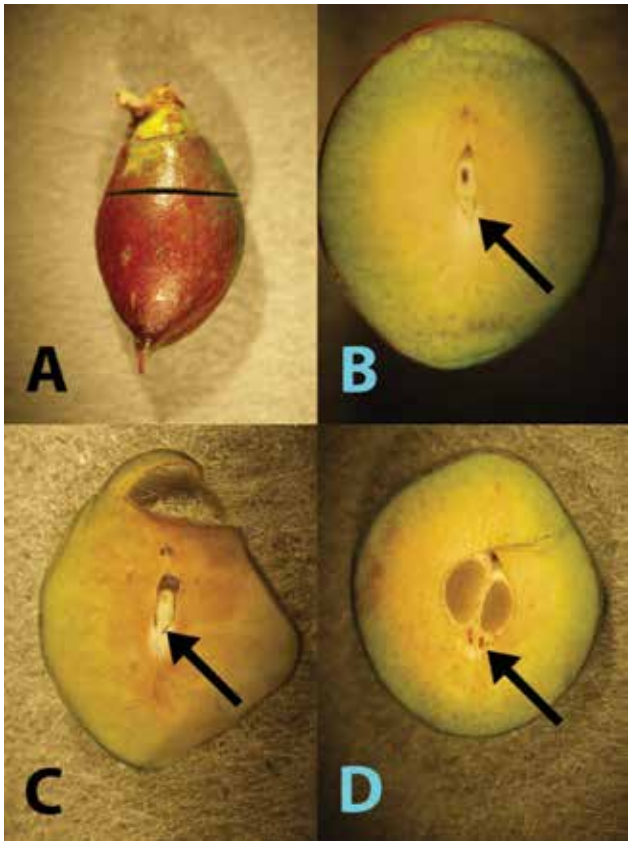
Apricot buds (full bloom stage) cut vertically to expose the pistil for freeze damage evaluation. Note the blackened pistil on the right, killed by the prior night freeze (photo by HJ Larsen).

development. For peach and nectarine, this can be seen at harvest, when the frost occurred at shuck-fall.

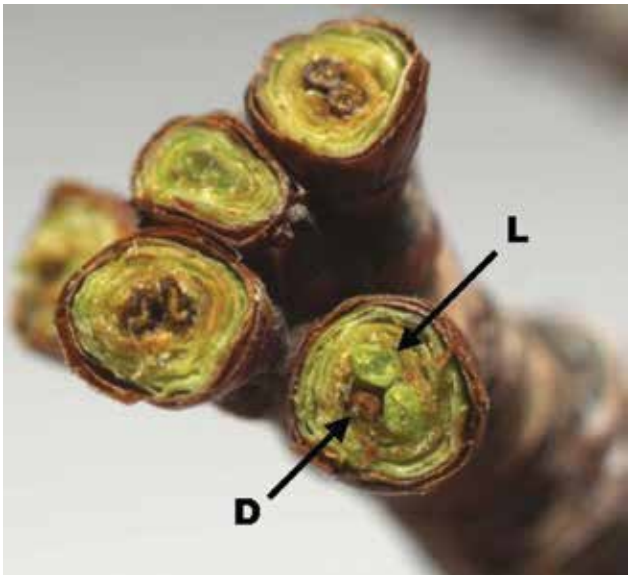
Sweet Cherry, Plum, Apple, Pear

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 ear-



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)

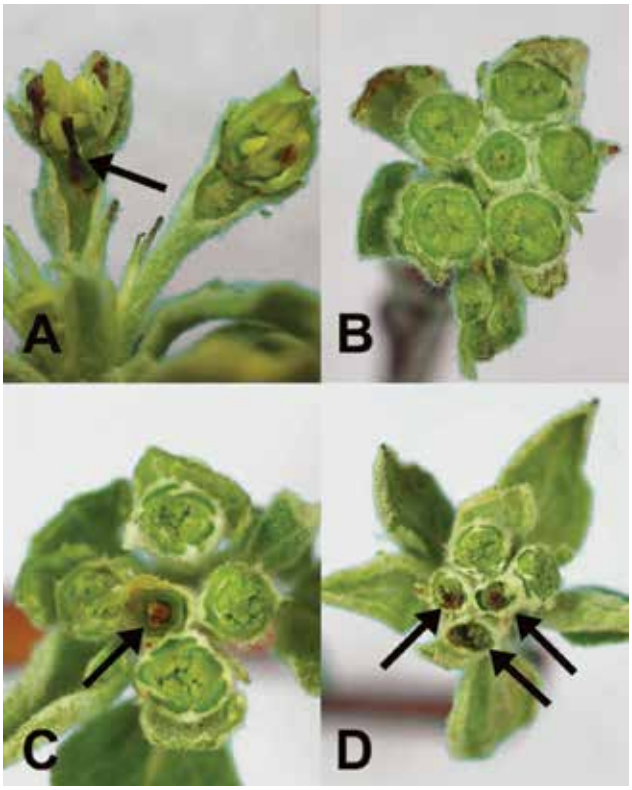
Sweet cherry flowers killed by frost at bloom, cut vertically to expose the blackened pistil. (photo by HJ Larsen)

lier in bud development that the evaluation is done, the greater the possibility of seeing all the flowers within the bud. At or near bloom, one needs to use more angled vertical cuts to reveal the pistils.

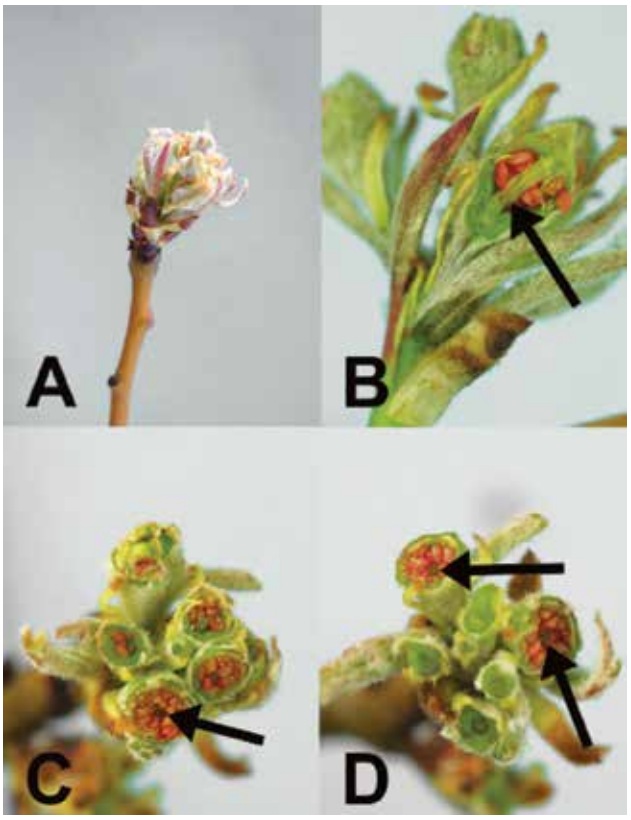
Apple and pear buds, like plum, tend to have differing timing for opening of the flowers within the fruit bud. In apples, the "king bloom" is the first to open and typically has five "side bloom" flowers forming a ring around it. Because it is earliest, it typically will be positioned toward the top 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



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)

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 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

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)

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 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 or at any UDAF District Field Office. 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 9 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, 350 North Redwood Road
Salt Lake City, UT 84114
(801) 538-7180
ag.utah.gov/pesticides

In Colorado:

- Applicants for *private applicator* license must request training materials plus the exam from the Colorado Department of Agriculture website for a fee of $20. Once the applicant passes, he/she must 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 $100 and the license for individuals 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
www.colorado.gov/pacific/agplants/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 $20. 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. All applicants must show proof of financial responsibility. 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 790, Boise, ID 83701
  2270 Old Penitentiary Road
  Boise, ID 83712
  (208) 332-8500
  agri.idaho.gov/main/56-2/pesticides/pesticide-licensing

In Montana:

Applicants can contact the Montana Department of Agriculture at agr.mt.gov/Pesticide-License 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 an 80% in both the core and category-specific section exams to obtain a license. To recertify, the applicator must acquire 12 CEU units in four years for each license category by attending approved training courses.

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. The Idaho Department of Agriculture offers a free program to chip clean, empty plastic containers (pesticide or fertilizer). The containers must be triple rinsed. The CROP truck comes to the site or a central location and chips HDPE #2 plastic. The chipper equipment can handle containers up to and including whole 5 gallons. In Montana, the disposal fee is free for the first 200 pounds and $0.50/lb beyond that weight. More information can be found at agr.mt.gov/Pesticide-Waste-Disposal.

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

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.
paraquat (Gramoxone)	10	1	2 qt Gramoxone Super
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	---

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 above lists those pesticides where storage amounts and threshold spill level require reporting.

The storage limit of an EHS pesticide is called the 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 144810
Salt Lake City, Utah 84114-4840
www.environmentalresponse.utah.gov (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
www.cdphe.state.co.us/oeis/sara/index.html

Idaho:
University of Idaho Environmental Health & Safety
875 Perimeter Drive
Moscow, ID 83844
(208) 885-6524
www.uidaho.edu/public-safety-and-security/environmental-health-and-safety

Montana:
Montana Department of Agriculture
Leonard Berry, Compliance and Enforcement Supervisor
302 N Roberts
Helena, MT 59601
(406) 444-5400
agr.mt.gov/I-Want-To/Learn-About/Pesticides/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. Especially 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.

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 differ in density and render the use of volumetric conversions (to tablespoon/teaspoon equivalents) approximate. Weighing the material provides a more exact conversion.

Preparation of Small Spray Quantities

Label directions for mixing and applying pesticides come in two general scenarios: 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 your pesticide mixing directions state an amount of material per 100 gallons, you should adjust the amount of pesticide to the volume of water you mix. The table on the next page gives mixing rates for label instructions. If your label instructions state a *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 pesticide mixing instructions state an application rate in an amount per area (usually acre, but sometimes 1000 sq. ft.), your sprayer must be calibrated.

Densities of solid pesticides vary with the formulation and the amount of shaking or settling within the package during shipping and in storage. An electronic scale should be used to ensure the correct weight of the dry product is used. These scales are readily available on-line and reasonably priced. Many of these scales measure down to 0.1 gram. The use of an electronic scale is essential for the solid form pesticides (e.g., wettable powders, dry flowables, etc.).

Do not use an ordinary teaspoon for measuring liquids as the common teaspoon varies from 4 to 10 ml. Instead, use a graduated medicine spoon. When measuring out small amounts you will need to use 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 pesticide.

Conversion values for preparation of 1, 3, and 5 gallons of spray from the rate per 100 gallons.[1]

Material	Amount per: 100 gal	5 gal	3 gal	1 gal
Dry: Wettable Powders, & Dry Flowables	4 lbs (1,814.3 grams)	90.7 g or 3.19 oz	54.4 g or 1.92 oz	18.1 g or 0.63 oz
	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
	2 qt (1,920 ml)	96 ml, or 6 tbs + 1 tsp + 1.4 ml	57.5 ml, or 3 Tbs + 2 ½ tsp	19.2 ml, or 1 tbs+¾ tsp+0.45 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

The information on the pesticide label represents the research, development, and registration procedures that a pesticide must undergo before reaching the market, which is paid for by the manufacturer. 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 the safety of yourself, others, the host plant, and the environment. Also, proper application is required by law. Described below are the parts of a typical pesticide label.

Product Information

1 Product classification

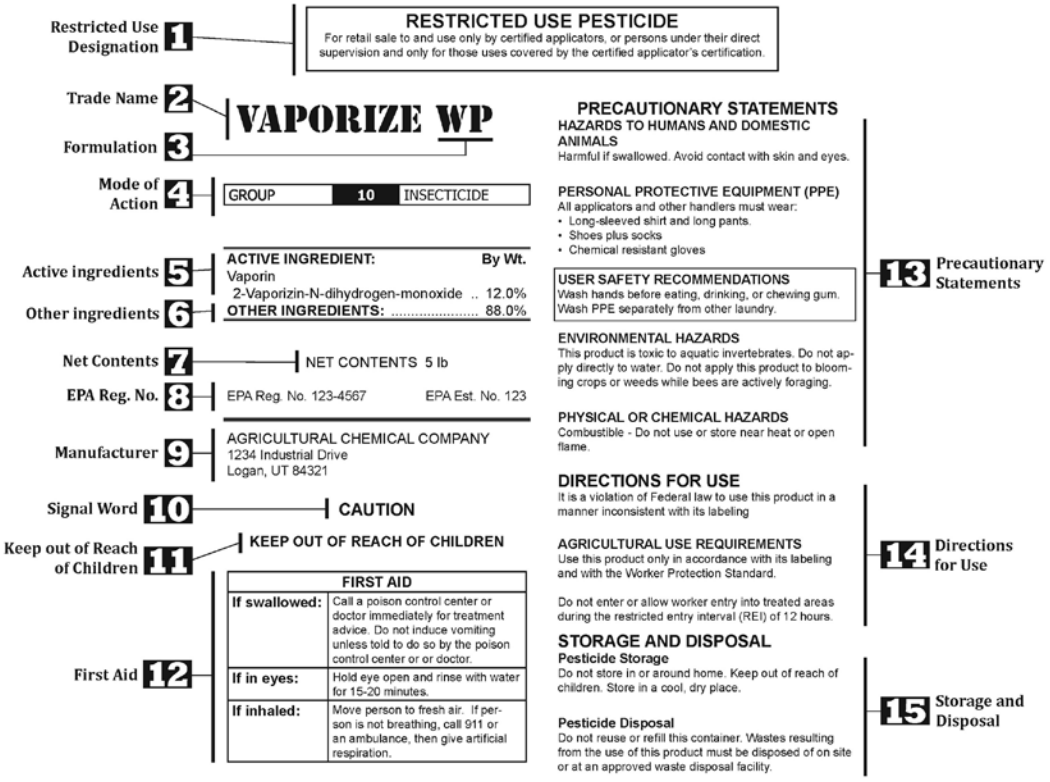
When a pesticide is classified as restricted, the label will state "Restricted Use Pesticide" at the top of the front panel. To purchase and apply restricted-use pesticides, you must be certified and licensed through the appropriate department in your state.

2 Trade Name/Brand Name

This is the name of the product that the manufacturer has created. Examples include "Sunspray," "Pounce," "Warrior," etc.

3 Formulation

- **emulsifiable concentrate (EC)**: an oil-based liquid solution plus an emulsifier that, when mixed with water, forms a milky solution; requires moderate agitation; easy to handle and apply
- **flowable (or liquid) (F or L)**: a thick liquid that contains the active ingredient has been imbedded in an inert solid and ground to a fine powder; requires 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)**: a powder formulation that readily forms a suspension in water; a rare formulation because few pesticide 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 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 do not work to control the target pest directly, but are sometimes added to the product to improve effectiveness (as a dissolving agent, surfactant, etc.)

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:** accompanied by a red skull and crossbones and 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 Warning

The front panel of every pesticide label must bear this statement.

12 First Aid *(May or 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

Specific instructions are included regarding the type of clothing that must be worn during the handling and mixing processes. The personal protective equipment listed is the minimum protection that should be worn while handling the pesticide.

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 usually makes up the bulk of a pesticide label and always begins with the wording: "It is a violation of federal law to use this product in any manner inconsistent with its labeling." 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 such as temperature and light requirements, are provided to prevent the breakdown of the material. Most liquid or flowable formulations have minimum storage temperature requirements. This section also explains how to deal with the unused portion of the product and the container.

EXTENSION

UtahStateUniversity

Utah State University is committed to providing an environment free from harassment and other forms of illegal discrimination based on race, color, religion, sex, national origin, age (40 and older), disability, and veteran's status. USU's policy also prohibits discrimination on the basis of sexual orientation in employment and academic related practices and decisions. Utah State University employees and students cannot, because of race, color, religion, sex, national origin, age, disability, or veteran's status, refuse to hire; discharge; promote; demote; terminate; discriminate in compensation; or discriminate regarding terms, privileges, or conditions of employment, against any person otherwise qualified. Employees and students also cannot discriminate in the classroom, residence halls, or in on/off campus, USU-sponsored events and activities. This publication is issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Kenneth L. White, Vice President for Extension and Agriculture, Utah State University.

Colorado State University

Extension

Colorado State University does not discriminate on the basis of race, age, creed, color, religion, national origin or ancestry, sex, gender, disability, veteran status, genetic information, sexual orientation, gender identity or expression, or pregnancy. Colorado State University is an equal opportunity/equal access/affirmative action employer fully committed to achieving a diverse workforce and complies with all Federal and Colorado State laws, regulations, and executive orders regarding non-discrimination and affirmative action.

University of Idaho

Extension

The University of Idaho recognizes that previous discrimination in employment based upon race, color, national origin, religion, sex, sexual orientation, gender identity/expression, age, disability, or status as a Vietnam-era veteran has foreclosed economic opportunity to a significant number of people in the United States. To correct this inequity and to afford everyone the opportunity to participate without discrimination, UI pledges to eliminate all vestiges of policy that tended, intentionally or otherwise, to discriminate on the grounds proscribed by federal and state laws and on the basis of sexual orientation and gender identity/expression, in order to eliminate all traces of discrimination, to take affirmative action to recruit, employ, and promote qualified members of those groups formerly excluded.

MONTANA STATE UNIVERSITY | EXTENSION

The U.S. Department of Agriculture (USDA), Montana State University and Montana State University Extension prohibit discrimination in all of their programs and activities on the basis of race, color, national origin, gender, religion, age, disability, political beliefs, sexual orientation, and marital and family status. Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Cody Stone, Interim Director of Extension, Montana State University, Bozeman, MT 59717.

Pesticide Use Statement: Cooperative Extension at the state universities of Utah, Colorado, and Montana, and the University of Idaho, and their employees, are not responsible for the use, misuse, or damage caused by application or misapplication of products or information mentioned in this publication. The pesticide applicator is legally responsible for proper use. Always read and follow the instructions printed on the pesticide label. The pesticide recommendations in this guide do not substitute for instructions on the label. Due to constantly changing pesticide laws and labels, some pesticides may have been cancelled or had certain uses prohibited since publication. Trade names provided in this publication are used to simplify the information; no endorsement or discrimination is intended.