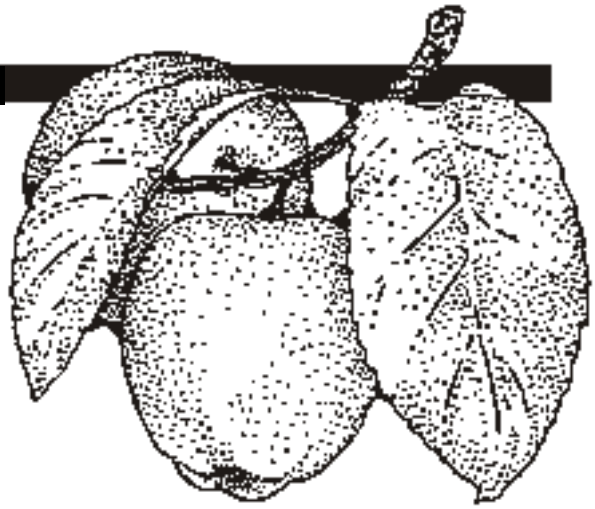
COLORADO TREE FRUITS

Pest and Crop Management Guide

XCM-41



Colorado State University Cooperative Extension

PREFACE

The information and recommendations assembled by the editors and included within this guide are supplied with the understanding that Colorado State University intends neither endorsement of nor discrimination toward any specific product included in or omitted from this guide.

READ THE LABEL! Make certain that the EPA and the Colorado Department of Agriculture have registered the chemical you select for use on the crop in question. Do not use more than the recommended amount and observe restrictions on reentry of treated areas and preharvest intervals.

Handle pesticides that are considered highly toxic (Class I - generally, pesticides with oral LD_{50} of 0 - 50 milligrams per kilogram of body weight or a dermal LD_{50} of 0 - 200 mg/kg of body weight for 24 hours exposure) with extreme care. Pesticides or materials listed in this manual, which are in the highly toxic category, include: azinphos methyl, Carzol, Endocide, endosulfan, Guthion, Lannate, Penncap-M, Parathion, Phosdrin, Supracide, Thiodan, and Vydate.

POISON INFORMATION CENTER

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(800) 424-9300

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Milan A. Rewerts, interim director of Cooperative Extension, Colorado State University, Fort Collins, Colorado. Cooperative Extension programs are available to all without discrimination. To simplify technical terminology, trade names of products and equipment occasionally will be used. No endorsement of products named is intended nor is criticism implied of products not mentioned.

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COLORADO TREE FRUITS: Pest and Crop Management Guide.

Bulletin XCM-41

1997 Edition

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ACKNOWLEDGMENTS

The following individuals contributed sections or information for this handbook:

W. F. Andelt, Dept. of Fish and Wildlife Biology, Colorado State University, Fort Collins, CO.
and E. E. Nelson, Tri-River Cooperative Extension Office, Grand Junction, CO.

Valuable suggestions were provided by the Colorado Agricultural Chemical Association, agricultural chemical dealers, fruit grower associations, county Cooperative Extension agents, individual fruit growers, and others. Finally, we gratefully acknowledge the assistance of Susan Baker in making the necessary editorial changes for the 1997 edition.

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NEW DEVELOPMENTS

PESTICIDES

Registrations expired OR production dropped: The following materials are no longer available, but existing stocks may be used until exhausted if noted:

1. Uniroyal Chemical Co. voluntarily withdrew registration of Omite 30W for use on fruit crops. Contrary to earlier information received, existing supplies CAN still be used according to the label on the product at the time of purchase. However, growers are cautioned to check with those to whom they plan to sell their fruit before using left over stocks. Not all buyers may accept fruit treated with Omite. As few growers have remaining stocks of Omite, usage recommendations and rates have been dropped this year.

2. Rohm and Haas Co. dropped production of both the 18.25WD and 4E formulations of Karathane several years ago. Growers with carryover stock should use them up as soon as feasible. Usage recommendations and rates have been dropped in this edition.

3. Lilly-Miller Co. dropped production of their Envy 2,4-D product in 1994. Growers with existing supplies should use them up as soon as feasible. Recommendations for this product have been dropped from the Guide this year.

Clarifications, corrections, and modified registrations:

1. Aliette WDG (Rhone-Poulenc Ag Co.) -- is NOT registered for use on bearing stone fruits to control *Phytophthora* collar and root rots. The Aliette 80WDG formulation IS registered for apple and pear and NONBEARING stone fruits.

2. Weedar 64 (Rhone-Poulenc Ag Co.) -- A new Supplemental Label was approved for use of this 2,4-D product in pome and stone fruit orchards. Users must have a copy of this new Supplemental Label in their possession at the time of use on apples or pears.

New, cleared, expanded or modified registrations:

Several chemical companies (e.g., Gowan Co., Drexel Chemical Co., Griffin Corp., Micro Flo Co., Miller, etc.) have entered the Colorado chemicals market with generic versions of several materials. In some instances (e.g., copper materials) **only** generic products are available, and these may take a variety of names. Check with your supplier on what materials are available, but remember that they have **not** been evaluated by Colorado State University personnel under Colorado conditions.

1. Agree WG (Ciba Crop Protection/Ciba Geigy Corp.) is a new BT formulation introduced in September 1996 for use on apples, pears, peaches, nectarines, plums, and prunes. It has not been tested on Colorado fruit crops.

2. Agri-Mek 0.15EC (Merk AgVet Co.) is now registered for use on apples and pears to control a variety of mites, spotted and western tentiform leafminers, and pear psylla.

3. Elite 45DF fungicide (Bayer Corp.) is now registered for control of brown rot, leaf spot, and powdery mildew on cherries, peaches, and nectarines. It has not been tested under Colorado conditions.

4. Provado 1.6F insecticide (Bayer Corp.) registration was expanded in 1996 to include control of aphids, mealybug, San Jose scale, and pear psylla in pears. Prior registration was only for aphids, leafminers, San Jose scale, and leafhoppers in apples.

5. Wilthin (Entek) is now registered as a blossom thinner on apple and peach. It provides an option for blossom thinning that was lost with the discontinuation of Elgetol production.

OTHER CHANGES

General Information: A new section on deer damage has been added for 1997.

Pesticide Regulation, Safety & Storage: Information on pesticide hazards to bees has been updated to reflect information in reference L.5 (see below). The section on chemical hazards to plants and chemical compatibilities also has been updated and the compatibility chart modified to reflect currently available chemicals.

Supplemental Information Sources: Several unavailable references have been deleted and several new references have been added (cf. reference L.5, an excellent new reference on avoiding bee poisoning by pesticides). In addition, a new reference section on Internet access has been added.

Growth Regulation & Thinning: Recommendations for chemical thinning have been reorganized by timing of sprays and expanded to include blossom thinning.

GENERAL INFORMATION

INFORMATION UPDATES

Code-A-Phone: Conditions continually change throughout the growing season. These changes affect trees, fruit, and pests. Colorado State Agricultural University Experiment Station and Cooperative Extension personnel monitor these changes and adjust their recommendations accordingly. These updated recommendations, suggested timing for fruit sprays, and pest alerts are available to growers via the code-a-phones on a 24-hrs/day basis throughout the growing season.

Code-A-Phone messages for the Tri-River area have been consolidated at the Grand Junction Cooperative Extension Office. This number is (970) 244-1806.

Weekly updates are completed by Friday noon through the growing season (March 1 - October 15). Non-regularly scheduled updates may be provided as needed through the off season (October - February); these off-season messages will include notice of meetings, pesticide regulation changes, and (in late February) notice of when weekly updates will resume. Growers are encouraged to use this information system on a year-round basis.

FRUIT BUD CRITICAL TEMPERATURES

The following table, from Washington State University Extension Bulletins (see Reference section B, p. 5.2), list typical temperatures at which 10% and 90% bud kill occurs at each stage of development after 30 minutes exposure. Please note that the number for each bud stage is from the table of drawings on page 2.2. These are not always the same as used with the color photos on the WSU Extension Bulletins. Two stages not in the drawing are also included: 8) apple and pear full bloom, and 9) post bloom. The percentage bud kill which causes crop reduction will vary with crop. 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.

[addition: 4/2008]

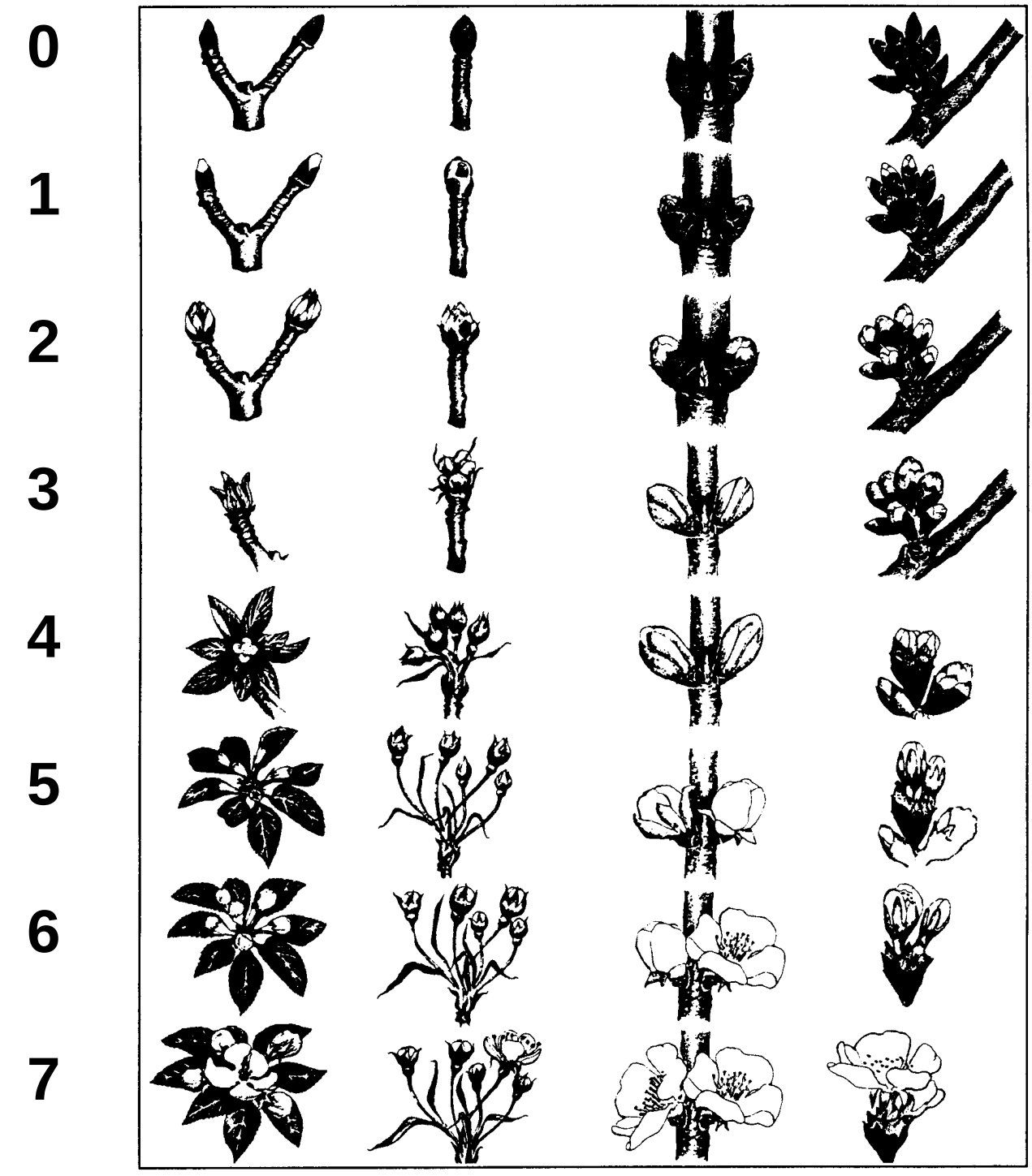
Electronic versions of the critical temperature charts with color photographs of the bud stages are available for apple, pear, apricot, peach / nectarine, European plum, Japanese plum, sweet cherry, and tart cherry on the Colorado State University – Western Colorado Research Center website under the "Fruit Growing Information" link:

http://www.colostate.edu/programs/wcrc/pubs/research_outreach/fruitinfo.htm

Look for the "Critical Temperature Charts" box in the center of the page and click on the crop of your choice. Each crop chart is a PDF file of 69 - 126 Kb size to facilitate download over phone line access.

Crop phenology (bud development) information for Orchard Mesa (Mesa County), Rogers Mesa and Cedaredge (Delta County) is available through the winter - late spring on the same web page in the box just above the "Critical Temperature Charts" box. The black arrow in the left column for each crop indicates the most recent bud stage reached according to either actual observation or estimation.

BUD DEVELOPMENT CHART



The illustrations on this chart have been borrowed, with permission, from Washington State University Cooperative Extension publication EB0419-1990, Spray Guide for Tree Fruits in Eastern Washington.

Table 1. Critical temperatures (° F) for fruit buds[1].

Bud Development Stage	1	2	3	4	5	6	7	8	9
APPLES*									
Ave. Temp. for 10% Kill	15	18	23	27	28	28	28	28	28
Ave. Temp. for 90% Kill	2	10	15	21	24	25	25	25	25
*For Red Delicious. Critical temperatures prior to petal fall are approx. 1° lower for Golden Delicious and Winesap and approx. 2° lower for Rome Beauty. All varieties are equally tender after petal fall.									
PEARS*									
Ave. Temp. for 10% Kill	15	20	24	25	26	26	27	28	28
Ave. Temp. for 90% Kill	0	6	15	19	22	22	23	24	24
*For Bartlett. Anjou is similar but may bloom earlier.									
APRICOTS									
Ave. Temp. for 10% Kill	15	20	22	24	25	25	27		28
Ave. Temp. for 90% Kill	--	0	9	14	17	19	22		25
PEACHES*									
Ave. Temp. for 10% Kill	18	21	23	25	26	26	27		28
Ave. Temp. for 90% Kill	1	5	9	15	18	21	24		25
*For Elberta. Critical temperatures for some peaches and most nectarines are somewhat higher at the same stage.									
CHERRIES (SWEET)*									
Ave. Temp. for 10% Kill	17	22	25	26	27	27	28		28
Ave. Temp. for 90% Kill	5	9	14	17	21	24	25		25
*For Bing. Critical temperatures for Lambert and Rainier are approx. 1° to 2° lower through Stage 6.									
PRUNE PLUMS*									
Ave. Temp. for 10% Kill	14	17	20	24	26	27	28		28
Ave. Temp. for 90% Kill	0	3	7	16	22	23	23		23

[1]NOTE: Based on samples composed of 200 to 500 flowers. The actual stage is defined by the most advanced buds in the sample, and the 10% and 90% numbers reflect the entire sample. Caution is advised -- it is dangerous to attribute too much precision to critical temperature data.

PEST MANAGEMENT MODELS AND TRAP SOURCES

Pest management models have been or are being developed to determine spray need and/or timing for codling moth, peach twig borer, pear psylla, and tentiform leaf miner.

Most insect management models depend heavily upon knowledge of the number of adult forms moving about within the orchard. Pheromone traps provide an easy, efficient means to monitor adult populations of codling moth, tentiform leaf miner, peach twig borer, and peach crown borer. Non-pheromone, color attractant traps are used to monitor orchards for apple maggot. All of these traps are relatively inexpensive and are available from several sources:

Western Colorado Sources:

Randall Industries, Inc., 745 Struthers Ave., G. J., CO ph. (970) 242-3787
Grand Mesa Discount, 1087 Hwy. 65, Eckert, CO ph. (970) 835-3335
United Fruit Growers, 144 Kluge Ave., Palisade, CO ph. (970) 464-5671
Hi-Quality Packing Co., 215 Silver St., Delta, CO ph. (970) 874-4478

A listing of other trap sources compiled by Dr. Cranshaw is available at the two tree fruit research centers (OMRC, 3168 B½ Road, Grand Junction, CO 81503; & RMRC, 3060 Hwy. 92, Hotchkiss, CO 81419) and the Cooperative Extension offices in Delta, Fremont, Mesa, and Montrose Counties.

REDUCING BIRD DAMAGE TO RIPENING FRUIT

Damage to ripening fruit by finches, robins, starlings, sparrows, and other birds is a concern to Colorado growers. When one or two backyard fruit trees are being damaged by birds, the trees can be protected with nylon or plastic netting. A few trees also can be protected by hanging in them devices that both move and frighten (e.g., flash tapes, twirlers, aluminum pie tins, and aluminum strips). Flocks of birds tend to be scared away by flasher types of units more than do individual birds. Snake, hawk, owl, or human scarecrows also may frighten birds. These should be moved occasionally so birds do not get used to them. Some birds also are frightened by bird distress or alarm calls played from recorded messages.

Use of hawk-kites, propane exploders, and possibly netting can also reduce bird damage to fruit. Hawk-kites are helium-filled balloons imprinted on the underside with a life-like image of a hawk which frightens birds. The balloons are suspended above an orchard and should protect an acre or more. The hawk-kites are easy to use and cost about $100. Disadvantages of hawk-kites include the possibility of vandalism, damage by high winds, and the need and cost to occasionally refill with helium.

Propane exploders are relatively inexpensive ($200) devices which produce loud blasts that frighten birds from several acres, particularly when the exploders are supported above the crop. The major disadvantage of propane exploders is that the blasts may annoy neighbors; however, the annoyance can be minimized by firing the exploders only during daytime. The propane exploders may be supplemented by firing exploding shells from a 12 gauge shotgun. Orchards containing small trees also can be protected with netting, but this technique is relatively expensive.

Frightening birds from fruit trees can be accomplished most successfully by employing a variety and diversity of techniques just prior to or as soon as the damage begins. Although no single

technique can be depended on to solve all bird problems, persistent application of the above techniques should reduce fruit losses to birds.

A new product, Bird-X, is available for application to cherries. However it is quite costly and has not been tested by Colorado State University personnel. It depends upon the bird placing the entire fruit within its bill in order to detect the taste and decide that isn't what it wants after all. Thus the product is not useable for larger tree fruits. Reports from Colorado growers as to how well it works are mixed at this time.

DEER DAMAGE TO FRUIT TREES

Deer can cause major damage to fruit trees, both by browsing the young, succulent shoot growth in the spring and summer and by raking young (usually 2 or 3 year old) trees in the fall to remove the velvet from the antlers of the bucks. Saliva residues left by browsing deer on the nibbled shoots inhibit further shoot growth from that shoot for the year in which the browsing occurs. This can severely curtail or damage a tree training program in new plantings because the scaffold system development depends upon growth and development of the new branches. Many approaches have been tried to reduce or eliminate deer browsing in young orchards. These have included spraying trees with soapy water, diluted coyote or mountain lion urine, egg whites, or pepper extracts. Some growers have tried tying bags of human hair to trees scattered within the orchard. Of all these, the best (although not 100% effective) is application of pepper extract sprays (e.g., Miller's "Hotsauce") on a weekly basis during the spring to mid-summer. However, a better approach is to fence orchard property with a deer fence. It has the advantage of keeping deer out of the orchard the entire year.

PREPARATION OF SMALL SPRAY QUANTITIES (updated 4/6/2007)

Labels on pesticides packaged for commercial application typically give the application rates in terms of either quantity per acre (most common) or quantity per 100 gallons of spray. Where the former is used (quantity per acre), concentration of the active ingredient (a.i.) is viewed as not being as critical as the total amount of a.i. applied per acre (defined as the land area beneath the treated plants). Where the latter is used, the concentration of the a.i. within the spray mix is viewed as critical to the efficacy of the material.

Spray gallonage per acre varies with: 1) the type of spray surface being treated (3-dimensional trees & shrubs take more spray than 2-dimensional field crops and turf) and 2) type of spray coverage required for the spray (scattered droplets on the target vs. wet-to-drip target). “Spray-to-drip” applications on fruit trees 20 ft high X 20 ft wide were found to apply approximately 400 gallons of spray per acre. This varied some with the adjuvants included within the spray mix; inclusion of a surfactant (spreader) accelerates the drip process and results in lower rates per acre (e.g., 350 gal./acre), while inclusion of a sticker slows the drip process and results in higher rates per acre (e.g., 450 gal./acre). Hand sprayer applications closely approximate a “spray-to-drip” application (approximately 400 gal. per acre); this works out to 0.23 gallons (approx. 1 qt) per 10 ft x 10 ft (=100 sq. ft.) treated crop area. If one determines the spray gallonage per acre for the type of spray to be applied (See the pesticide label!), uses the per acre rate on the pesticide label, and converts this to an equivalent rate per 100 gallons, then the conversion values given in Table 1 below can be used to prepare small spray quantities.

Densities of solid formulation pesticides varies with the formulation and the amount of shaking or settling within the package during shipping (or in storage subsequently). Thus, proportional weights are the most precise for making small spray quantities. Electronic scales are now quite readily

available and affordable. Some of these measure down to 0.1 gram. Their use is essential for the solid form pesticides (e.g., wettable powders, dry flowables, etc.). The following table (Table 1) assumes:

1. For wettable powders (W) and dry flowable (DF) formulations:
   1 lb = 453.6 g
   & 1 oz = 28.4 g

2. For liquids: 1 gal = 4 qts = 8 pts = 16 cups = 128 fl.oz. = 256 Tbsp = 768 tsp
   & 1 fl. oz. = 2 Tbsp = 6 tsp = 29.6 ml

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

Type of Material	Amount per: 100 gal	5 gal	3 gal	1 gal
Wettable Powders, & Dry Flowables	4 lb (1,814.3g)	90.7 g	54.4 g	18.1 g
	2 lb (907.2 g)	45.4 g	27.2 g	9.1 g
	1 lb (453.6 g)	22.7 g	13.6 g	4.5 g
	8 oz. (226.8 g)	11.3 g	6.8 g	2.3 g
	4 oz. (113.4 g)	5.7 g	3.4 g	1.1 g
	2 oz. (66.7 g)	2.8 g	1.7 g	0.6 g
* * * * * * * * * * * *				
Liquids:	1 gal (=3,785 ml)	189 ml (~38 t)	114 ml (~23 t)	37.9 ml (~7.5 t)
Liquid Concentrates,	2 qt (=1,893 ml)	94.6 ml (~19 t)	56.8 ml (~12 t)	18.9 ml (~4 t)
Emulsifiable ",	1 qt (=946 ml)	47.3 ml (~10 t)	28.4 ml (~6 t)	9.4 ml (~2 t)
& Liquid Flowables	1 pt (=437 ml)	23.7 ml (~5 t)	14.2 ml (~3 t)	4.7 ml (~1 t)
	1 cup (=237 ml.)	11.8 ml (~2.4 t)	7.1 ml (~1.5 t)	2.4 ml (~.5 t)
	4 fl. oz. (=118.3 ml)	5.9 ml (~1.2 t)	3.5 ml (~.75 t)	1.2 ml (~.25 t)
	2 fl. oz. (=59.2 ml)	2.96 ml (~0.6 t)	1.8 ml (~ 3/8 t)	0.6 ml (~1/8 t)
	1 fl. oz. (=29.6 ml)	1.48 ml (~0.3 t)	0.9 ml	0.3 ml

PESTICIDE REGULATION, SAFETY & STORAGE

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APPLICATOR CERTIFICATION [incorporating changes effective Jan., 2008]

The Food Quality Protection Act (FQPA) requires the Environmental Protection Agency (EPA) to regulate pesticides and all pesticide uses to be classified as either GENERAL or RESTRICTED USE. It further restricts access to and use of restricted use pesticides to those individuals who are either certified or "under the direct supervision of a certified applicator."

FQPA also 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 in producing agricultural commodities on land owned or rented by that individual or his/her employer. The private applicator is allowed to apply restricted use pesticides on the property of another person only if compensation is through a trading of services between the producers of agricultural commodities. COMMERCIAL APPLICATOR is defined as any person who uses or supervises the use of restricted use pesticides and is not a private applicator. This includes (but is not limited to): ditch company employees, applicators employed by governmental agencies, and applicators who apply pesticides for hire.

The Colorado Department of Agriculture (CDA) took over all pesticide certification responsibility effective Jan. 1, 2008. Private applicator certification is relatively straightforward, but does require a test. Commercial certification in Colorado, however, requires more intensive training and testing. Information on commercial certification can be obtained from:

The Colorado Department of Agriculture
Division of Plant Industry
700 Kipling St., Suite 4000
Lakewood, CO 80215-5894
Telephone (303) 239-4140
FAX (303) 239-4177

There is now a charge for both private and commercial applicator certification with registration and testing fees for initial certification, periodic training updates, and re-certification every three years.

SARA / EPCRA & THE FRUIT GROWER:

A major regulatory change was implemented in 1987 -- SARA (Superfund Amendments and Reauthorization Act of 1986) and its subsection, EPCRA (Emergency Planning and Community Right-to-know Act of 1986). These require private facilities to participate in local community emergency planning, to provide local governments and residents access to information about specific chemical substances (including many pesticides), and to report accidental releases of those chemicals into the environment. According to Ms. Pam Harley, Coordinator & Chairperson of the Colorado Emergency Planning Commission, the law is being interpreted in Colorado to include chemical companies, suppliers, AND agricultural producers (agricultural pesticide end-users, growers) -- in fact to include any facility with quantities of certain chemicals (including many pesticides) above given levels (defined as the THRESHOLD PLANNING QUANTITY or TPQ) at any time.

Specific examples of some orchard-use pesticides included on the list, their TPQ's, and their REPORTABLE QUANTITY (RQ'S) are given in Table 3. The TPQ's and the RQ's are given as amount of active ingredient for each material. Examples include Guthion, Imidan, and Thiodan with TPQ's of 10 lbs each (= 20 lbs of Guthion 50W or 20 lbs of Imidan 50W or Thiodan 50W). The RQ's are the quantities which must be reported if accidentally spilled or released into the environment (other than as legitimate spray applications).

EPCRA compliance requirements are as follows:

1) Whenever any facility first has any amount of a chemical on the list that is above its TPQ -- Notify Colorado State Emergency Planning Commission (c/o Colorado Department of Health, 4210 E. 11th Ave., Denver, CO 8220) that the facility (business, orchard or grower name with the accurate, current address for the facility) is subject to SARA, Subtitle III - EPCRA. Once the State Emergency Planning Commission has been notified for any one material, it is not necessary to re-notify the Commission if quantities of additional materials pass their TPQ's.

2) Notify local Emergency Planning Committee of the name of the person in charge of emergencies at your facility. Contact either your local police/fire/health department or Pam Harley at the State Department of Health (1-303-331-4858) for the name and address of your local Emergency Planning Committee.

3) Additionally, both the State Emergency Response Commission and the Local Emergency Planning Committee must be notified if or when a "REPORTABLE QUANTITY" (RQ) of any agricultural chemical on the list is accidently released into the environment. If the material released is listed under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), then the National Response Center (1-800-424-8802) must be notified.

Additional information (e.g., maintenance of inventory lists of what is in storage at any one time) may be needed eventually. Such information is likely to be found to be of value to the local emergency planning groups and agencies if emergencies (such as fires) should come up.

Table 3. Orchard-use pesticides from the EPA 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.
azinphos-methyl (Guthion)	10	1	2 lbs Guthion 50WP
endosulfan (Thiodan, Endocide)	10	1	2 lbs Thiodan 50WP
fenamiphos (Nemacur)	10	1	1.3 qts Nemacur 3EC or 6.7 lbs Nemacur 15G
paraquat (Gramoxone)	10	1	2 qts Gramoxone Super
phosmet (Imidan)	10	1	2 lbs Imidan 50WP
oxamyl (Vydate)	100	1	2 qts Vydate 2L
parathion	100	1	4 lbs Parathion 25W
formetanate (Carzol)	500	1	1.1 lbs Carzol 90W
dimethoate (Cygon)	500	10	
demeton-s-methyl (Metasystox)	500	1	
methomyl (Lannate)	500	100	
methidathion (Supracide)	500	1	2 qts Supracide 2E
demeton (Systox)	500	1	
ethion	1,000	10	
lindane	1,000	1	
methyl bromide	1,000	1,000	

SPRAY RECORDS / PESTICIDE RECORDKEEPING

The 1990 Farm Bill requires all certified pesticide applicators (private as well as commercial) to keep records of applications of Restricted Use Pesticides (RUP's) effective May 10, 1993. These must be recorded within 30 days of application (the sooner the better), maintained for 2 years after application, and access to them provided to an authorized representative of the USDA or the Colorado Dept. of Agriculture. This information must also be provided to licensed health care professionals when deemed necessary to treat an individual who may have been exposed to the pesticide applied.

No standard form is required (or even available) for these pesticide records. However the following information is required for each application:

- Brand/product name, formulation, and EPA registration number
- Total amount of product applied (use measurement units on the product label)
- Location of application (be specific, not just business or farm address. Can use maps to identify orchard blocks by number)
- Crop/commodity/site treated
- Area treated (in acres, linear feet, etc.)
- Target pest, weed, or disease
- Month, day, year of application
- Name and certification number of applicator or supervisor.

We suggest that information also be recorded on application rate per acre (gals.) and per 100 gal. spray. For spot applications (applications to less than 0.1 acre treated area), the crop/commodity/site and area information may be omitted and the location should be designated as "spot treatment".

RUP's currently registered for use in Colorado orchards include the following: Ambush, Asana, Azinphos-M, some formulations of diazinon, Gramoxone Extra, liquid formulations of Guthion, Kerb, Lannate, Mitac, Penncap-M, Pounce, Ridomil, Supracide, and Vydate. Other, less commonly used RUP's include the nematicides Nemacur and Telone-II and the soil fumigant methyl bromide (all formulations, e.g. Terrogas 98 and Bromogas).

As the new Worker Protection Standard (see below) requires worker notification of all pesticide applications, it is recommended that comparable records be kept of **ALL** pesticide applications. This also will enable the grower to complete a listing of pesticides used on his crops at the time of harvest. These pesticide usage lists are increasingly required by packing sheds and processors before they will accept any fruit.

Violation penalties are stiff. First violations face a fine of up to $500; subsequent offenses are subject to a fine of not less than $1,000 for each violation. For further information, contact: USDA-Agric. Marketing Section, Pesticides Records Branch, 8700 Centerville Rd. Suite 200, Manassas, VA 22110 (phone: 703/330-7826).

WORKER PROTECTION STANDARD (WPS)

Enforcement of the WPS began January 1, 1995. Agricultural operations that depend heavily upon hand labor (such as fruit and other horticultural crops) are prime candidates for EPA site inspections to check compliance. The WPS mandates changes in pesticide labels, redefines "re-entry

intervals" as "Restricted Entry Intervals" (REI's) and changes their minimum time periods, and requires employers that use pesticides to train and supply their workers with information and protective materials/equipment to minimize risk of worker injury from pesticides. Any found not complying face fines of up to $1,000 per violation. Employers also may face liability if an untrained worker is injured or harmed by an unsafe pesticide practice. More importantly however, compliance with the WPS will help minimize pesticide injury risk to all who work where pesticides are used, whether they are employees or family members.

Each farming operation needs to identify its WPS responsibilities. All agricultural owners are subject to WPS employer regulations unless only "immediate family" members work on the farm or orchard; "family only" operations are exempt from some, but not all, of the WPS requirements. Agricultural worker employers have additional duties required as do those employers of pesticide handlers (anyone who mixes, loads, or applies crop chemicals or who cleans, adjusts, or repairs contaminated equipment). See the "How To Comply" manual or the "Quick Reference Guide to the ... WPS". Copies of the "How To Comply" manual are available (while supplies last) from your local Cooperative Extension offices, from either of the two fruit research centers (OMRC and RMRC), or from the Denver office of the EPA. The address of the Denver office of the EPA is: U.S. EPA-Region VII, 999 18th St., Denver Place - Suite 500, Denver, CO 80202-2405. The EPA also has a Hotline available to answer questions on the WPS; it is 1-800-227-8917

Three approaches are used in the WPS to reduce pesticide injury risk to employees/workers. 1) Train and inform employees/workers about pesticide hazards. 2) Eliminate (or at least reduce) worker exposure to pesticides. 3) Minimize damage if pesticide exposure occurs. Full details of the WPS requirements are provided in the "How To Comply" manual.

WPS compliance requires close attention be given to the new labels for all pesticides. All pesticides produced after April 21, 1994 must include this WPS information on revised Restricted Entry Intervals (REI's) and Personal Protective Equipment (PPE) required for application or early entry. Generally, the REI's exclude workers from treated areas for 4 (when dry) to 72 hours depending on the toxicity of the product(s) applied. Give special attention to the REI and Personal Protection Equipment (PPE) information. The PPE specifications must be followed by pesticide handlers/applicators and for workers that have to enter treated areas before the REI has expired. No agricultural pesticide may be sold without the new labeling after October 23, 1995. So **READ THE LABEL!**

Supplies needed to comply with the WPS will be available from both safety supply companies and local agricultural chemical suppliers. These include signs for posting, the pesticide safety poster, PPE items, and training materials. Some of the local agricultural suppliers have indicated they will have videotapes for worker training (including Spanish versions) available for checkout to their customers. These training videotapes also can be ordered for those growers who wish to have their own copy; the cost is around $30-40. Finally, the EPA has a WPS compliance Hotline available to answer questions. It is 1-800-227-8917.

CROP PREHARVEST INTERVALS

The EPA also requires pesticide producers to establish safe residue levels for crops and necessary waiting periods between last application and harvest in order to achieve these safe residue levels. This information on necessary preharvest intervals (waiting periods) is included as part of the label in the recommendations for specific crops. A partial summary of preharvest intervals for some

orchard pesticides is provided in Table 4. Again, READ THE LABEL! Where differences between the information in Table 4 and the label information are found, the label must be followed.

Table 4. Restricted entry intervals (REI's), preharvest spray intervals and other pesticide use restrictions.[1]

PESTICIDE	REI (Hrs)	POME FRUIT APPLE (Days)	POME FRUIT PEAR (Days)	STONE FRUIT PEACH (Days)	STONE FRUIT APRICOT (Days)	STONE FRUIT CHERRY (Days)	STONE FRUIT PLUM (Days)
Agri-Mek	12	28	28	---	---	---	---
Agristrep	12	50	30	---	---	---	---
Aliette	12	14	14	NB	NB	NB	NB
*Ambush	24	P	14	7	---	3	---
Amid-thin W	12	PF+14	PF+14	---	---	---	---
Apollo	12	---	21	21	21	21	---
*Asana	12	21	28	14	14	14	14
**Azinphos-M	72	7	7	21	21	15	15
Bayleton	12	45	45	---	---	---	---
Benlate	24	14	14	3	3	3	3
Bravo	24	---	---	SS	SS	SS	SS
Caliber 90	12	F	F	P	---	F	P
Captan	96	14	4	4	4	4	4
Carbaryl	4	1	1	1	3	1	1
Carzol	48	7	7	21(14)[2]	---	---	7
Casoron	12	D	D	31	---	31	31
Coppers	12-48[3]	V	V	V	V	V	V
Cygon	24	28	28	---	---	---	---
Devrinol	12	35	35	35	35	35	35

* = Restricted Use Pesticide

** = Some product formulations are Restricted Use Pesticides, others are not.

[1]Code Key: "---" =Not Registered for crop; D =Dormant Only; F =Fall; NB =Nonbearing trees only; P =Prebloom; PF =Petal Fall; PH =Postharvest; SS =Shuck Split; V =Various (see label); T = Trunk.

[2]Shorter interval for nectarines.

Table 4. Restricted entry intervals (REI's), preharvest spray intervals and other pesticide use restrictions (Cont'd).[1]

PESTICIDE	REI (Hrs)	POME FRUIT APPLE (Days)	POME FRUIT PEAR (Days)	STONE FRUIT PEACH (Days)	STONE FRUIT APRICOT (Days)	STONE FRUIT CHERRY (Days)	STONE FRUIT PLUM (Days)
**Diazinon	12-24[2]	21	21	21	21	21	21
Dimethoate	48	28	28	---	---	---	---
Elite	12	---	---	0	---	0	---
Ensign	48	---	---	SS	SS	SS	SS
Endocide	72	30	21(7)[3]	30(21)[4]	30(21)[4]	21	7
Endosulfan	24	30	7	30(21)[4]	30(21)[4]	21	7
Envy	12	V	V	40	40	40	40
Ethephon	48	7	---	---	---	---	---
Ethion	24	20-60	30-60	---	---	PH	---
Ethrel	12	7	---	---	---	7	---
Fruitone-N	12	5	5	---	---	---	---
Funginex	12	PF	---	PF	PF	PF	PF
Fusilade Dx	12	NB	NB	14	14	14	14
Goal	24	D	D	D	D	D	D
**Guthion	72	7	7	21	---	15	15
**Gramoxone Extra	12	1	1	1	1	1	28
Imidan	24	7	7	14	14	7	7
Karmex	12	P,F	P,F	3 mo	---	---	---
Kelthane (dicofol)	12	7	7	---	---	---	---
*Kerb	12	PH,F	PH,F	F	---	F	F

* = Restricted Use Pesticide

** = Some products or formulations are Restricted Use Pesticides, others are not.

[1]Code Key: "---" =Not Registered for crop; B =Bloom; D =Dormant Only; F =Fall; NB =Nonbearing trees only; P =Prebloom; PF =Petal Fall; PH =Postharvest; SS =Shuck Split; V =Various (see label); T = Trunk.

[2]REI varies with the product; see label.

[3]Shorter interval applies if two or less sprays were applied to the fruit.

[4]Shorter interval applies for Crown borer sprays.

Table 4. Restricted entry intervals (REI's), preharvest spray intervals and other pesticide use restrictions (Cont'd).[1]

PESTICIDE	REI (Hrs)	POME FRUIT APPLE (Days)	POME FRUIT PEAR (Days)	STONE FRUIT PEACH (Days)	STONE FRUIT APRICOT (Days)	STONE FRUIT CHERRY (Days)	STONE FRUIT PLUM (Days)
Kocide 101	48	P,PH	B,PH	21	B	B,PH	B
Kocide DF	48	P,PH	B,PH	21	B	B,PH	B
Kolospray	12	12 hr	12 hr	12 hr	12 hr	12 hr	12 hr
*Lannate	72 (96)[2]	14	---	4[3]	---	---	---
Lorsban[4]	24	D,28	D	D,T(14)[4]	---	D,T(6)[4]	D
Malathion	24[5]	3	1	7	7	3	3
*Mitac (Amitraz)	24	---	7	---	---	---	---
Morestan	24	P,NB	P,NB	NB	PH,NB	NB	NB
NAA	12	5	5	---	---	---	---
Nova	24	14	---	7	---	7	---
Omite	7 da	7	PH	14	14	NB	12
*Penncap-M	48	30	30	14	---	14	14
Poast	12	14	14	NB	NB	NB	NB
*Pounce	12	P	14	7	---	3	---
Princep	12	F	F	---	---	F[6]	---
Procure	24	14	14	---	---	---	---
Pro-Gibb	12	---	---	---	---	7	---

* = Restricted Use Pesticide.

[1]Code Key: "---" =Not Registered for crop; D =Dormant Only; EC =Early Cover; F =Fall; NB =Nonbearing trees only; P =Prebloom; PF =Petal Fall; PH =Postharvest; SS =Shuck Split; V =Various (see label); T = Trunk.

[2]Longer REI for peach.

[3]Lannate is NOT registered on nectarines in Colorado.

[4]Check formulation label CAREFULLY! Formulations vary in crops, locations, and preharvest intervals. The 50W or 50WP cannot be used on tart cherries in Delta, Larimer or Mesa Counties; the 4E formulation cannot be used after delayed dormant except as a one-time trunk application for crown borer control on cherry, peach, and nectarine.

[5]REI varies by crop; 12 hrs for all except peach which is 24 hrs.

[6]Tart cherries only.

Table 4. Restricted entry intervals (REI's), preharvest spray intervals and other pesticide use restrictions (Cont'd).[1]

PESTICIDE	REI (Hrs)	POME FRUIT APPLE (Days)	POME FRUIT PEAR (Days)	STONE FRUIT PEACH (Days)	STONE FRUIT APRICOT (Days)	STONE FRUIT CHERRY (Days)	STONE FRUIT PLUM (Days)
Promalin	12	PF+21	NB	---	---	D	---
Provado	12	7	7	---	---	---	---
Rely	24 (?)	14	---	---	---	---	---
*Ridomil	12	D	NB	NB	NB	NB	NB
Round-up	12	14	14	14	14	14	14
Rovral	12	---	---	0	0	0	0
Rubigan	12	30	30	---	---	0	---
Savey	12	---	28	---	---	---	---
Sevin	12	1	1	1(3)[2]	3	1	1
Sinbar	12	D	---	D	---	---	---
Solicam	12	F	F	F	F	F	F
Streptomycin	12	50	30	---	---	---	---
Sulfurs	24	1	1	1	---	1	1
*Supracide	2(14) day[3]	P	P	P	P	P	P
Surflan	12	F	F	F	F	F	F
Thiodan	72	30	21(7)[4]	30(21)[5]	30(21)[5]	21	7
Vendex	48	14	14	14	---	14	14
*Vydate	48	14	14	NB	---	NB	---
Ziram	48	14	14	30	30	30	---

* = Restricted Use Pesticide.

[1]Code Key: "---" =Not Registered for crop; D =Dormant Only; EC =Early Cover; F =Fall; NB =Nonbearing trees only; P =Prebloom; PF =Petal Fall; PH =Postharvest; SS =Shuck Split; V =Various (see label); T = Trunk.

[2]Shorter interval for peach, longer for nectarine.

[3]Shorter interval if application rate is 1 gal./acre or less, longer interval if more is used.

[4]Shorter preharvest interval applies if two or less sprays were applied to the fruit.

[5]Shorter preharvest interval applies for Crown borer sprays.

TOXICITY RATINGS OF SOME ORCHARD PESTICIDES

Tree fruit pesticides differ greatly in their toxicity to warm blooded animals. This typically is rated by the oral toxicity when fed to test animals such as rats or rabbits and is given as an LD_{50} value, the amount (lethal dose) determined to kill 50% of the test animals. These figures are expressed as milligrams of pesticide active ingredient per kilogram of test animal body weight (mg/kg). Pesticides with lower LD_{50} values are more toxic than those with a higher value. Toxicity values of tree fruit pesticides are listed in Table 5.

Table 5. Toxicity values of commonly used orchard pesticides & chemicals.

Oral LD_{50} (mg.ai/kg)	Pesticide	Oral LD_{50} (mg.ai/kg)	Pesticide
[Highest Toxicity]			
5	oxamyl (Vydate)	684-809	dicofol (Kelthane)
6	methyl parathion (Penncap-M)	800	amitraz (Mitac)
7	demeton (Systox)	850	carbaryl (Sevin)
9	ethylparathion	980	dinocap (Karathane)
3-12	mevinphos (Phosdrin)	1000	NAA
13	azinphosmethyl (Guthion)	1300	dichlone
		1375	malathion
17	methomyl (Lannate)	1400	ziram
21	formetanate hydrochloride (Carzol)	2500	fenarimol (Rubigan)
		2631	fenbutatin-oxide (Vendex)
30-110	endosulfan (Thiodan, Tiovel)	2500-3000	oxythioquinox (Morestan)
44	methidathion (Supracide)		
97-276	chlorpyrifos (Lorsban)	3160	dichlobenil (Casoron)
150	paraquat	3400	diuron (Karmex)
		4000	permethrin (Pounce, Ambush)
147-316	phosmet (Imidan)	4143-4870	imadicloprid
208	ethion		
215	dimethoate (Cygon)	4229	ethephon
350	diazinon	4300	glyphosate (Roundup)
		5200	zineb
370	2,4-D	7520	dalapon
400-1000	triadimefon (Bayleton)		
451	fenvalerate (Pydrin)	9000	captan
458	esfenvalerate (Asana)	10000+	benomyl (Benlate)
		10000+	chlorothalonil (Bravo)
500	napropamide (Devrinol)	10000+	oryzalin (Surflan)
669	metalaxyl (Ridomil)	[Lowest Toxicity]	

PESTICIDE HAZARDS TO BEES

Bees are required for the pollination of fruit trees, yet the use of pesticides on these crops can often kill wild bees and destroy honeybee colonies. It is in the interest of both the orchardist and the beekeepers that the following precautions be taken when using pesticide in orchards. See reference L.5 (p. 5.9) for a comprehensive discussion of pesticide risks to honeybees and wild bees. Wild bees can also play a significant role in pollination of fruit crops in some locations.

1. Do not apply pesticides that are hazardous to bees when crops (including cover crops) are in bloom (See Table 6). The herbicides Fusilade, Simizine, and amine salt formulations of 2,4-D also should not be applied to blooming weeds in or near orchards except during late evening, night or early morning.

Table 6. Relative hazards of some fruit tree pesticides to honeybees. The length of time that residues remain toxic is in parentheses.[1]

Most Hazardous -- Do not apply to blooming crops or weeds.

Ambush	(1-2 days)[2]	Malathion WP	(2 days)
Asana	(1 day)[2]	Methyl parathion	(2 days)
Cygon	(3 days)	Penncap-M	(5-8 days)
Diazinon	(2 days)	Pounce	(1-2 days)
Dimethoate	(3 days)	Sevin WP	(3-7 days)
Guthion	(2.5 days)	Sevin-4-oil	(3+ days)
Imidan	(1-4 days)	Sevin XLR (1+ pt/acre)	(1+ days)
Lorsban	(4-6 days)	Supracide	(1-3 days)

Hazardous -- Apply only during late evening.

Malathion EC	(2-6 hours)	Sevin XLR Plus	(8 hours)
Phosdrin	(less than 5 hours)	Thiodan	(8 hours)
Provado	(8 hours)		

Moderately Hazardous -- Apply only during late evening or early morning.

Carzol	(2 hours)	Metasystox-R	(less than 2 hours)
Lannate L	(2 hours)	Ryania	(2 hours)
horticultural oils	(less than 3 hours)	Vydate	(3 hours)

Reasonably Safe to Bees -- Can be applied at any time.

Apollo	Kelthane	Mitac	Nova	sulfur
Bayleton	Kryocide	M-Pede	Procure	Vendex
Bt products	Lime Sulfur	Morestan	Rubigan	

[1] Extracted from Mayer, Johansen, and Baird. 1996. How to Reduce Bee Poisoning from Pesticides Bull. WREP15, Wash. St. Univ., Pullman. (See Reference L.5, p. 5.9)

[2] These materials tend to repel bees under dry conditions.

2. Remove from orchards all flowering weeds that may attract foraging bees. This is particularly important prior to the first cover spray of apples when bees will fly considerable distances in search of flowers.

3. Whenever possible, make applications of pesticides during periods when honeybees are not foraging, i.e., late in the day or early in the morning. This allows sprays to dry and/or dissipate before bees forage on the crop.

4. Where effective alternatives exist, substitute pesticides with less potential hazard to bees.

5. Both orchardist and beekeeper should become familiar with each other's problems so that the hazards are recognized by both parties.

CHEMICAL HAZARDS TO PLANTS / CHEMICAL COMPATIBILITIES

Information on the next three pages has been adapted with permission from Washington State University Cooperative Extension publication EB0419-1996, Spray Guide for Tree Fruits of Eastern Washington. Caution is strongly advised in <u>any</u> tank mixing of spray chemicals. One instance of physical incompatibility was reported in 1988 for a mixture of Kelthane, Mitac, and SorbaSpray. Extensive spherical precipitates clogged nozzles in that case.

Combinations of materials can cause injury; also, risk of injury to plants increases with the number of chemicals being mixed in a single spray. The compatibility chart on page 3.13 gives information on combinations of two materials at standard dosages. Combining two emulsifiable concentrates or an emulsifiable concentrate with a wettable powder can lead to compatibility problems. Whenever possible, combine only the same type of formulation. If tank mixes of different formulations are used, add in the following order: 1) wettable powders, 2) flowables, 3) emulsifiable concentrates, 4) oils. Making a slurry of wettable powders first, before adding them to the tank, aids thorough mixing. Chemicals should be added under good agitation and when the spray tank is one-half to two-thirds full. Excess foaming may be reduced by adding surfactants after filling and by using silicone antifoaming materials.

In some cases injury results not only when two materials are mixed in the same tank, but also when one material is applied after another (particularly oil applied before or after a pesticide or nutrient spray). The chemicals and combinations below (marked with the symbol "1" in the compatibility chart) cause injury to specific fruits or varieties.

Aliette + 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.

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 + 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.

Captan + Sulfur - Apples.

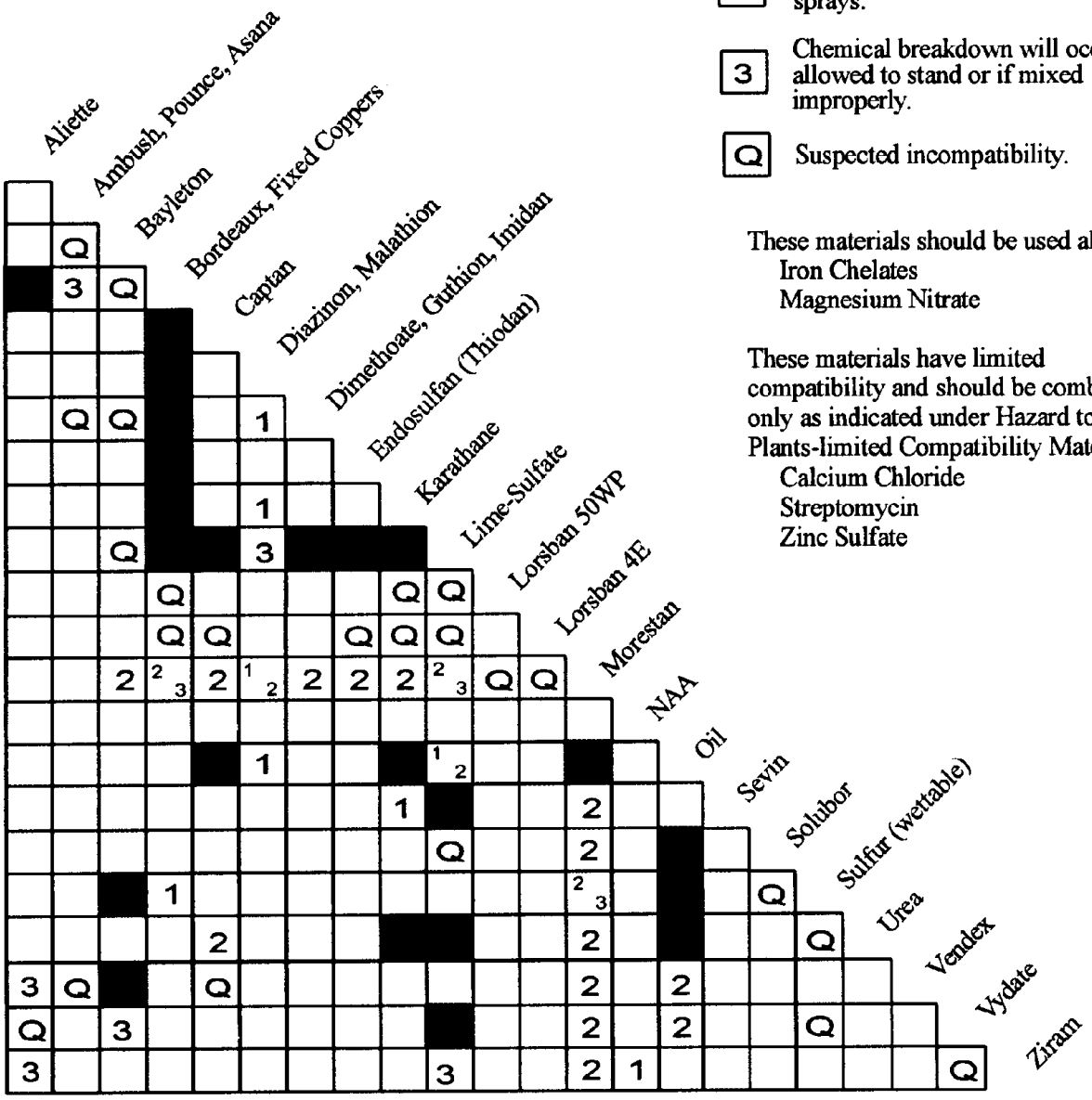
COMPATIBILITY CHART

This compatibility chart is based principally on observations and reports in central Washington. It is intended as a guide, and may not be applicable in all areas or under varying conditions of use.

- Apparently compatible.
- Chemically incompatible or cause general injury.
- 1 — Cause injury to specific varieties of fruits in some cases
- 2 — Cause injury when used in foliage sprays.
- 3 — Chemical breakdown will occur if allowed to stand or if mixed improperly.
- Q — Suspected incompatibility.

These materials should be used alone:
- Iron Chelates
- Magnesium Nitrate

These materials have limited compatibility and should be combined only as indicated under Hazard to Plants-limited Compatibility Materials:
- Calcium Chloride
- Streptomycin
- Zinc Sulfate



This chart has been adapted from Washington State University Cooperative Extension publication EB0419-1996, the 1996 Spray Guide for Tree Fruits in Eastern Washington. It is intended as a guide only and may not be applicable in all areas or under varying conditions of use.

Funginex - Direct application or drift can injure asian pears.
Imidan - Can injure cherry leaves.
Lime-Sulfur - May cause injury when followed by hot weather.
Malathion - has caused moderate to severe fruit and foliage damage to cherries. The sweet cherry variety 'Ranier' is particularly susceptible. ULV applications of technical grade malathion (Cythion) by aircraft have the least risk, but even these can cause injury without proper ULV nozzles.
Mitac (amitraz) - Emulsifiable concentrates may cause fruit injury if applied when cool, moist, or poor drying conditions exist or when night temperatures are below the dew point.
Morestan - Should not be used on Seckel or Asian pears.
Morestan + Diazinon or Parathion - Foliage injury at prepink on Red and Golden Delicious under poor drying conditions.
NAA + Ziram - Can cause red spots on Golden Delicious fruit.
Oil - Injury to trees and/or fruit may result from: weather (applied when cool, damp, extremely dry, or windy); broken emulsions; application at the pre-pink stage on apples (alone or with lime-sulfur); summer oil sprays before or after many organic insecticides or fungicides; and faulty application (including poor agitation and mixing).
Oil + Diazinon - May damage apple foliage and fruit if used as a summer spray.
Oil + Ethion - May damage apples as a foliage spray.
Oil + Guthion - May damage apple foliage and Anjou pear foliage and fruit.
Oil + Lime-Sulfur - Apples. May cause severe foliage and fruit injury under some conditions if sprayed after stage 2 and would be in violation of the manufacturer's label.
Oil+ Malathion - Anjou pears, Golden Delicious and Jonathan apples as a foliage spray.
Oil + Thiodan - All deciduous fruits as a foliage spray.
Soap (M-Pede) - Can cause injury to apple fruit and foliage at high temperatures. Injury to pear fruit and foliage is even more likely (especially on cv. Anjou) and is not necessarily temperature dependent.
Sulfur and Sulfur Compounds - Do not use when temperatures are expected to exceed 85^{o}F within 24 hours of application. Do not use on apricots; do not use after prebloom on Delicious apples or Anjou pears.
Urea - Use of formulations with 2% or higher biuret may injure apples, pears, or stone fruits.
Vendex (fenbutatin-oxide) - Do not apply within 28 days of any oil application; do not apply oil within 28 days of any Vendex application.
X-77 surfactant - Can russet apple and pear fruit, especially during cool weather or slow drying conditions.
Ziram + NAA - Can cause red spots on Golden Delicious fruit.

Also use caution with foliar nutrient sprays. Zinc sulfate sprays applied within five days of an oil spray can damage apples. Others may be compatible with most or all fungicides and insecticides if care is taken to check their effect on the pH of the spray solution. Some Leffingwell products, for example, can drop the spray solution acidity to below pH 3.5 which would de-activate pyrethroid insecticides if pH is not adjusted before they are added.

SPRAY ADJUVANTS

Spray adjuvants are materials added to sprays in order to enhance their effectiveness. As such, many categories of such additives may be defined: spreaders (ionic and nonionic surfactants and wetting agents), emulsifiers, stickers, spreader-stickers, extenders, activators, pH adjusters, foam control agents, drift control agents, suspending agents, etc. 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.

Most insecticides and some fungicides are formulated by the manufacturers with their own adjuvants. These were selected so as to enhance the effectiveness of their product under most conditions commonly encountered by the prospective users. Because of the breadth of conditions these users will encounter, additional adjuvants may further enhance the effectiveness of the product. However, selection of such a supplemental adjuvant must be done with care, considering all the factors that may affect spray performance. Use of the wrong adjuvant for the conditions can decrease product effectiveness; any spray that fails to accomplish the purpose for which it was applied becomes a most expensive spray. See ADDITIONAL INFORMATION SOURCES, section A (page 5.2).

Many growers presently add a spreader-sticker adjuvant when using wettable powder formulations. Be sure to consider the information in the above reference before using a given adjuvant in the coming season and be very careful to follow the manufacturer directions for both the pesticide and the adjuvant. 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; avoid excessive amounts of spreaders or spreader-stickers as that may cause excessive spray runoff. Do NOT use spreader-stickers with growth regulators (unless specifically called for on the label).

Remember also that the pH of water used to prepare spray solutions is very important. Water in many locations in 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) read labels carefully to determine whether water pH is important for that material; 2) apply spray solutions as soon as possible after mixing in the spray tank -- especially avoid leaving mixed spray solutions in the spray tank overnight; 3) check the pH of your water supply and adjust water pH to the needed level before adding any chemical or pesticide that is sensitive to pH. If water is alkaline and the insecticide is sensitive to alkaline solutions, use commercially available pH adjusters such as Acidi-pH-actant, Buffer-X, Nu-trex, Nutra-wet, Sorba-spray, and Tri-fol. See ADDITIONAL INFORMATION SOURCES, section A (page 5.2) for references with expanded treatment of this subject.

PESTICIDE STORAGE AND DISPOSAL

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 well labeled. If the original label has come off or is coming off, paste or tape it back on. The label has all the critical information needed for that pesticide; it should be kept readable as long as the container holds any of the pesticide material. All pesticides should be protected from excessive heat, and liquid pesticides should be stored in an area protected from freezing (see the next section).

A number of orchard pesticides have minimum storage temperature requirements. Most of these are liquid or flowable formulations. Table 7 lists those that are known at this time.

Disposal of unused pesticides is a major problem. Growers are urged to review their annual pesticide needs and stocks on hand well in advance of the growing season. Pesticide purchases should be based on the amount projected for use within any given season so as to minimize season-to-season carryover. This will help avoid the problem of how and where to store opened containers or dispose of chemicals no longer needed. Containers emptied during the season should be triple-rinsed and drained; they often can then be disposed of through regular trash collection, but be sure to check local codes and regulations first! **NEVER**, under any circumstances, 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 **MAJOR** penalties. The best means to dispose of such pesticides is to use them up according to their labeled instructions.

Table 7. Minimum storage temperatures of some common tree fruit pesticides (mostly liquids).

Product	Min. Storage Temp °F	Product	Min. Storage Temp °F
Ambush 2E	10	Manzate 200 FL	32
Asana XL	NSP	Penncap M	32 (b)
Bravo 500F & 720F	32 (a)	Poast	30 (b)
Cygon 400E	45	Pounce 3.2E	10
Cygon 2E	32	Princep 4L	NSP
Diazinon AG500	NSP	Provado 1.6F	NSP
Diazinon 4E	NSP	Ridomil 2E	40+
Endosulfan or Thiodan 3E	20	Ridomil 50W	NSP
Guthion 2L	55	Roundup	NSP
Guthion 2S, 50W	32	Rubigan 1E	32
Kelthane EC	NSP	Sevin Liquids	32 (a)
Kocide 101	NSP	Supracide 2E	32 (c)
Lannate 2.4LV	32	Surflan AS	32 (b)
Lorsban 4E	32	Vydate L	32
Malathion 5750	32 (b)	Wilthin	32 (a)
Manzate FL	32		

NSP -- No special precautions. Try to avoid freezing, but products should reconstitute after warming.
- a -- Avoid freezing if possible; if not possible, warm to 40°F and shake well before using.
- b -- Warm and agitate to dissolve crystals. If crystals do not dissolve, do not use; contact manufacturer.
- c -- Do not use after freezing; contact manufacturer.

CHEMICAL CROSS-REFERENCE LIST:

In 1989, Safeway asked growers whose fruit might be purchased by them to provide a list of chemicals (by common chemical name of each product) that had been applied to the crop. To facilitate any such requests, an easy-access cross-reference list is provided in Table 8.

Table 8. Chemical product / common chemical name cross-reference list.

Trade Name	Common Chemical Name	Category[1]
Agree	Bacillus thuringensis toxin	I
Agri-Mek	abamectin	I
Agristrep	streptomycin	B
Aliette	fosetyl Al	F
Ambush	permethrin	I
Amid-Thin W	NAD	G
Amine-4	2,4-D amine	H
Apollo	clofentezine	M
Asana XL	esfenvalerate	I
Azinphos-M	azinphos-methyl	I
Bayleton	triadimefon	F
Benlate	benomyl	F
Botran	DCNA	F
Bravo	chlorothalonil	F
Caliber-90	simizine	H
Captan	captan	F
Carbaryl	carbaryl	I/M/G
Carzol	formetanate hydrochloride	M
Casoron	dichlobenil	H
Comite	propargite	M
Cygon	dimethoate	I
Cyprex	dodine	F
Dacamine	2,4-D amine	H
Dalapon	dalapon	H
Devrinol	napronamide	H
Diazinon	diazinon	I
Dicofol	dicofol	M
Dimethoate	dimethoate	I
Dipel	Bacillus thuringensis toxin	I
Direx	diuron	H

[1] Combination categories/activities list the primary category/activity first.
B = Bactericide, F = Fungicide, G = Growth Regulator/Thinner, H = Herbicide
I = Insecticide, M = Miticide.

Table 8. Chemical product / common chemical name cross-reference list. (Cont'd.)

Trade Name	Common Chemical Name	Category[1]
Dowpon	dalapon	H
Elite	tebuconazole	F
Endocide	endosulfan	I
Ensign	chlorothalonil	F
Envy	2,4-D	H
Ethion	ethion	I
Ethrel	ethephon	G
Fruitone N	NAA	G
Funginex	triforine	F
Fusilade Dx	fluazifop-p-butyl	H
Goal	oxyfluorfen	H
Gramoxone Super or Extra	paraquat	H
Guthion	azinphos-methyl	I
Imidan	phosmet	I
Karathane	dinocap	F/M
Karmex	diuron	H
Kelthane	dicofol	M
Kerb	pronamide	H
Kocide	copper hydroxide	F/B
Kolospray	sulfur	F/M
K-Salt Fruit Fix	NAA	G
Lannate	methomyl	I
Lorsban	chlorpyrifos	I
Malathion	malathion	I
Mertect 340F	thiabendizol	F
Methoxychlor	methoxychlor	I
Mitac	amitraz	I
Morestan	oxythioquinox	M/F
Mycoshield	oxytetracycline	B
NAA	NAA	G
Norosac	dichlobenil	H
Nova	myclobutanil	F
Nudrin	methomyl	I
Omite	propargite	M

[1] Combination categories/activities list the primary category/activity first.
B = Bactericide, F = Fungicide, G = Growth Regulator/Thinner, H = Herbicide
I = Insecticide, M = Miticide.

Table 8. Chemical product / common chemical name cross-reference list. (Cont'd.)

Trade Name	Common Chemical Name	Category[1]
Penncap-M	methyl parathion	I
Phosphamidon	phosphamidon	I
Poast	sethoxydim	H
Pounce	permethrin	I
Princep	simazine	H
Procure	triflumizole	F
Pro-Gibb	GA_3	G
Promalin	GA_{4+7} + BA	G
Provado	imidacloprid	I
Pro-Vide	GA	G
Rely	glufosinate	H
Ridomil	metalaxyl	F
Ronilan	vinclozolin	F
Roundup	glyphosate	H
Rovral	iprodione	F
Rubigan	fenarimol	F
Savey	hexythiazox	I
Savit	carbaryl	I/G
Sevin	carbaryl	I/M/G
Sim-Trol	simazine	H
Sinbar	terbacil	H
Solicam	norflurazon	H
Supracide	methidathion	I
Supreme Sulfur 6	sulfur	F/M
Surflan	oryzalin	H
Systox	demeton	I
Thiodan	endosulfan	I
Thiolux	sulfur	F/M
Tiovel	endosulfan	I
Uniflow Sulfur	sulfur	F/M
Vendex	fenbutatin-oxide	M
Vydate	oxamyl	I/M
Weedar	2,4-D amine	H
Ziram	ziram	F

[1] Combination categories/activities list the primary category/activity first.
B = Bactericide, F = Fungicide, G = Growth Regulator/Thinner, H = Herbicide
I = Insecticide, M = Miticide.

SPECIAL PROGRAM: APPLE MAGGOT

HISTORY

The apple maggot, *Rhagoletis pomonella* is a serious insect pest of deciduous fruit, particularly apples, in most fruit producing areas in the United States. The female fly lays eggs under the skin of the fruit and the resulting larvae (maggots) feed and burrow into the interior of the fruit. This pest is of sufficient concern to major fruit-growing areas that Arizona and California have imposed quarantine restrictions and requirements on fruit grown in out-of-state locations where the maggot has been found.

Colorado's concern about possible occurrence of this pest increased in the early 1980's because of potential damage to the Colorado fruit industry both through direct effects on the fruit and through economic effects of potential quarantine from outside markets. This initial concern was increased by the discovery and reportedly widespread distribution of this pest in the neighboring state of Utah. A rather intensive program of orchard monitoring was begun at that time in western Colorado (primarily Mesa, Delta and Montrose counties) to determine if this important orchard pest had become established in more recent times.

State records indicate that the apple maggot had not been found in Colorado prior to 1985. Apple maggot traps placed in or near commercial orchards during the early 1980's produced no specimens, and this suggested that this pest did not infest western Colorado fruit orchards. However, in July of 1985, four adult flies were collected from a trap placed in an orchard near Palisade, Colorado and subsequently identified as *Rhagoletis pomonella*, the apple maggot. Continued trapping in that area produced additional flies during 1990; however, it is not clear whether the trapped flies originated within the orchards or if they were wild strays from outside the orchard. No infested fruit has ever been noted from western Colorado. Subsequent investigations by Colorado State University research and extension entomologists during 1986-1988 provided strong evidence that the apple maggot utilizes native hawthorn as its plant host, probably has been in the state for many years and is likely to be widely distributed in western Colorado wherever native hawthorn is well established. Infestation of apple fruit produced by backyard trees has been found, however, in two front range counties--El Paso and Jefferson. Apples produced in eastern Colorado therefore should **NOT** be transported to other parts of the state.

TRAP TYPE

The Pherocon AM trap is the recommended monitoring tool for the apple maggot. It is attractive to the apple maggot fly because of its color (bright yellow) and odor from chemicals mixed in the sticky material on the trap. This trap is NOT attractive from great distances so placement and maintenance are critical if reliable results are to be obtained.

TRAP PLACEMENT AND MAINTENANCE

The AM trap should be placed within the fruiting canopy of the tree. Attach the trap securely to a limb so that it will not move in a light wind. Remove all fruit and foliage from within 12-18 inches of the trap so that it sets in an open area within the canopy. Align the trap such that the broad surfaces of the trap are facing foliage and fruit within the canopy rather than the outside of the tree.

Traps should be placed by the first of July and examined every seven days, more often in commercial orchards if possible. Remove suspect flies from the trap and place in a vial with a solvent (1,1,1-trichlorethane) which can be obtained at hardware stores. After the adhesive has been dissolved by the solvent, remove the specimens and preserve them in alcohol. Include a label written in pencil indicating the date trapped and location. Correct identification of the apple maggot fly can only be made in a laboratory by trained personnel. Thus properly preserved flies must be sent to an appropriate location for identification. Replace traps at least every three weeks, but more often if traps become dirty or covered with other insects. Traps should remain in place through October. For further information, check with personnel at the Colorado Dept. of Agriculture Insectary, Colorado State University Cooperative Extension, or the two fruit research centers (OMRC and RMRC).

APPLE SHIPPING QUARANTINES

Because of the discovery of apple maggot (*Rhagoletis pomonella*) flies in Mesa and Delta Counties in 1985 and 1986, both the California and Arizona state Departments of Agriculture has restricted the movement of fresh apples into their states. Simply put, no backyard grown fruit has been allowed and commercially produced fruit must have been grown with an orchard monitoring or pest control spray program in place.

Colorado growers that plan to ship to California and/or Arizona should be aware of the tightened restrictions and should plan to comply with the individual states' quarantine requirements.

CALIFORNIA REQUIREMENTS

The Colorado Department of Agriculture must provide a list of qualified Colorado commercial apple growers/shippers to the California Department of Food and Agriculture, and a list of qualified growers/shippers of commercially packed organic apples.

Conventional Commercial Apple Orchards:

Commercially packed apples harvested from orchards using conventional pest control practices are authorized entry and movement without restriction. Conventional pest control practices include treatment with Guthion, Imidan, or other codling moth treatments with synthetic pesticides.

Organic Commercial Apple Orchards:

Commercially packed organic apples may be certified for California fresh market under the following conditions:

The orchards shall be trapped by or under the supervision of the CDA. Trapping is to be conducted at the rate of one trap per ten perimeter trees. Apples originating from orchards with negative trapping results are eligible for certification.

If apple maggot is trapped within one half mile of an orchard, but not within the orchard, the apples from that orchard shall receive and pass inspection as specified in Appendix B of this permit to be eligible for certification.

If apple maggot is detected within an orchard, apples from that orchard shall not be certified for the remainder of the 1993 growing season.

For a complete listing of all guidelines regarding sampling of bulk apples for processing and for sampling commercially packed organic apples, contact the Colorado Department of Agriculture or any Colorado State University Cooperative Extension office or research center.

ARIZONA REQUIREMENTS

The Colorado State Department of Agriculture shall ensure that:

1. A biologically-sound trapping program is conducted for apple maggot in the state's apple growing areas.

2. Apples authorized for shipment to Arizona have been produced under one of the following programs:

Program a:

In infested counties, all apple maggot hosts within 1/4 mile of commercial apple orchards are trapped and monitored. (Hosts of concern, in order of importance, are unsprayed hawthorne, apple, crabapple, cherry, and other rosaceous plants).

In uninfested counties, 50% or more of apple maggot hosts within 1/4 mile of commercial apple orchards are trapped and monitored.

If apple maggot is detected within 1/4 mile of commercial apple orchards:

a. All affected orchards are immediately treated with an approved pesticide treatment.
b. Pesticide treatments or other control measures are applied to all noncommercial apple maggot hosts between affected orchards and the point of detection.
c. The borders of all affected orchards are trapped at the rate of at least one apple maggot trap every 100-150 feet.

Program b:

The borders of commercial orchards from which apples might be shipped to Arizona are trapped at the rate of at least one apple maggot trap every 100-150 feet. Catching of an apple maggot in a border trap triggers continuous pesticide treatments in that orchard through harvest. Regardless of trapping results, postharvest sampling and inspection by an approved Colorado Department of Agriculture fruit inspector is mandatory on all lots of apples destined for Arizona from orchards following this program.

Program c:

Commercial orchards from which apples might be shipped to Arizona under this permit receive continuous pesticide protection through harvest. Treatments to commence upon first

emergence (predicted or observed, whichever is earliest) of apple maggot in an area. All lots of apples destined for Arizona from such orchards receive postharvest sampling and inspection.

Materials recommended for apple maggot control should be applied at 21 day intervals from the time immediately following the first apple maggot catch until harvest. These materials, application rates, and PreHarvest Intervals are:

	Application Rate		
Material	per 100 gal	per acre	PHI
Guthion 50W	8 - 12 oz	2 - 3 lb	7 days
Imidan 50W	1.5 lb	4 - 6 lb	7 days
Imidan 70W	1.25 lb	3 - 5 lb	7 days

APPLE STORAGE OPTION FOR SHIPPING

Apples also may be allowed into Arizona and California if they are stored under certain conditions and for specified periods. Any such shipment must have a certificate from the Colorado Department of Agriculture verifying that all fruit within the shipment has either been held in cold storage at a temperature of 32° F for at least 40 days or been held under controlled atmosphere storage at 38° F or lower for at least 90 days.

The grower should realize that the storage periods could delay the shipment and thus reduce the per unit return.

OTHER MANAGEMENT RECOMMENDATIONS

Apple maggot host material within 1/4 to 1/2 mile of the orchard should be removed in order to help reduce the movement of the apple maggot into the orchard. High risk apple maggot hosts which should be removed are crab apples, wild or unsprayed apple trees, and hawthorns (native, imported, or ornamental).

ADDITIONAL INFORMATION SOURCES

All of the following references contain helpful information that sometimes is difficult to find. Several are outstanding resources that are highly recommended for Colorado's fruit growers.

Orchard Pest Management (reference D.1) covers most of the pests found in Colorado orchards in a clear, in-depth way and includes excellent color photographs. It is written from an integrated pest management (IPM) approach; each pest discussion includes available information on biological controls, and there is a separate chapter describing and discussing known natural predators of the pests. Currently out of print, a revised edition is expected to be available in 1997.

Peaches, Plums, and Nectarines: Growing and Handling for the Fresh Market (reference L.2) is an outstanding general reference on these stone fruits. It covers a very broad range of topics: planning and establishing the orchard (varieties, rootstocks, orchard design, orchard establishment, etc.), managing the orchard (training, pruning, pollination, thinning, mineral nutrition, water management, etc.), protecting the orchard (pests, diseases, spray application, frost protection, etc.), and managing the crop during and after harvest (harvest, storage, distribution, etc.). This reference is well worth its cost.

SOURCES

Reference sources for publications listed are as follows:

1. ASHS Press, Dept. L, 600 Cameron Street, Alexandria, VA 22314-2562. Phone: (703) 836-2418.

2. ANR Publications, University of California, 6701 San Pablo Ave., Oakland, CA 94608-1239. Phone: 1-800-994-8849 or (510) 642-2431. (make checks payable to UC Regents).

3. APS Press, 3340 Pilot Knob Road, St. Paul, MN 55121
   Phone: 1-800-328-7560; FAX: 612-454-0766.

4. British Columbia Ministry of Agriculture and Fisheries:
   Obtain by sending a money order for the Canadian price payable to:
   Minister of Finance, Spindle
   1873 Spall Road
   Kelowna, British Columbia V1Y4R2

5. Colorado State University:
   a. Local Cooperative Extension offices
   b. Agricultural Experiment Station--Fruit Research Centers
      1. Orchard Mesa Research Center, 3168 B.5 Rd., Grand Jct., CO 81503-9621
         Phone: 970-434-3264 FAX: 970-434-1035.
      2. Rogers Mesa Research Center, 3060 Hwy. 92, Hotchkiss, CO 81419-9549.
         Phone: 970-872-3387. FAX: 970-387-3397.
   c. Cooperative Extension Resource Center, Colorado State University, Fort Collins, CO 80523-4061. Phone: 970-491-6198.

5. Colorado State University: (Cont'd.)
   d. Rod Sharp, Colorado State University Farm/Ranch Management Specialist, 2764 Compass Dr., Grand Junction, CO 81506. Phone: 970-245-9149.

6. Cornell University:
   Distribution Center - GP, Cornell University, 7 Business & Technology Park, Ithaca, NY 14850. Phone: 607-255-2080.

7. Good Fruit Grower, P.O. Box 9219, Yakima, WA 98909-2149 (Shipping charges: $3.50 for first book, + $2.00 ea. additional book). Phone: 1-800-487-9946; Internet: http//www.goodfruit.com (they have a site specific search engine at their site).

8. University of Illinois:
   Vocational Agriculture Service, Univ. of Ill.--College of ACES, 1401 S. Maryland Dr., Urbana, IL 61801-4732. ($3.00 P & H on orders less than $25.00; make checks payable to University of Illinois). Phone: 217-333-3871; Internet: http://www.aces.UIUC.edu/~Vo-Ag/.

9. Leffingwell/Uniroyal Chemicals:
   Leffingwell/Uniroyal Chemicals, P. O. Box 1880, Brea, CA 92621.

10. Michigan State University:
    MSU Bulletin Office, 10-B Agriculture Hall, Michigan State University, E. Lansing, MI 48824-1039. Phone: 517-353-6740

11. Washington State University:
    a. Bulletins Office, Cooper Publications Building, Washington State University, P.O. Box 645912, Pullman, WA 99164-5912. Phone: 509-335-2857.
    b. Publications, Conferences & Institutes, 208 Van Doren Hall, Washington State University, Pullman, WA 99164-5222. Phone: 509-335-3530.

12. Either: USDA-ARS-NAA, Appalachian Fruit Research Station, 45 Wiltshire Rd., Kearneysville, WV 25430.
    Or: Dept. of Plant Pathology, Cornell University, Ithaca, NY 14853.

REFERENCES

A. Adjuvants/pH:

1. T. E. Whitmore. 1985. Know your adjuvants. Western Fruit Grower 105(4):14-18. (April issue)

2. Yu, K. S. 1985. The pH of spray water affects pest control. Fruit Growers Newsletter 5(5):1. (Sept. Issue)

3. pH Effect on Pesticides. Article #3004. Leffingwell / Uniroyal Chemicals. (Source #9)

B. Bud Development: (Source #11a)

EB0913 Critical Temperatures for Blossom Buds - Apples. ($1.00)
EB0914 Critical Temperatures for Blossom Buds - Peaches. ($1.00)
EB0978 Critical Temperatures for Blossom Buds - Pears. ($1.00)
EB1128 Critical Temperatures for Blossom Buds - Cherries. ($1.00)
EB1186 Critical Temperatures for Blossom Buds - Prunes. ($1.00)
EB1240 Critical Temperatures for Blossom Buds - Apricots. ($1.00)

C. Sprayer Calibration:

1. Washington State University Extension Bulletin (Source #11a):

   EB0871 Orchard Sprayer Calibration ($1.00)
   PNW0174 Orchard Spraying in the Pacific Northwest ($2.00)

2. Service-In-Action Series, Colo. St. Univ. Coop. Extension, Ft. Collins. (Sources #5a-c)

   5.003 Sprayer Calibration Fundamentals. [primary focus is on herbicide sprayers]

D. Diseases and Insect/Mite Pests:

1. E. H. Beers, J. F. Brunner, M. J. Willett, and G. M. Warner, eds. 1993. Orchard Pest Management. Good Fruit Grower, Yakima. 288 pp. (Source #7; cost ?? + S/H). Item no. 105.

   This excellent reference currently is sold-out and is being revised for publication in 1997. The price will be determined later, but is expected to be close to $35-40.00; watch for an announcement in the Good Fruit Grower or in our Fruit Growers Newsletter during 1997. The reference emphasizes an integrated approach to pest management. Fruit pests and information included are those of primary interest and application to Colorado growers.

2. A. H. Howitt. 1993. Common Tree Fruit Pests. Bull. NCR-63, Mich. St. Univ. Coop. Ext., E. Lansing. 252 pp. (Source #10; cost $30.00 softcover or $37.50 hardcover incl. S/H).
   This excellent reference is a much expanded revision of the earlier bulletin of the same number, Tree Fruit Pests. It is an easy-to-use, comprehensive guide to identification and control principles for more than 50 arthropod pests of fruit. Because of the central U. S. focus, not all the included pests are problems in Colorado orchards.

3. A. L. Jones and H. S. Aldwinckle. 1990. Compendium of Apple and Pear Diseases. APS Press, St. Paul. 100 pp. (Source #3; Cost: $35.00)
   An excellent reference on diseases of pome fruits.

D. Diseases and Insect/Mite Pests: (Cont'd.)

4. J. M. Ogawa, E. I. Zehr, G. W. Bird, D. F. Ritchie, K. Uriu, and J. K. Uyemoto, eds. 1995. Compendium of Stone Fruit Diseases. APS Press, St. Paul. 98 pp. (Source #3; Cost $35.00)
   An excellent reference on stone fruit diseases; excellent color photos.

5. D. A. Johnson, G. Mink, R. S. Byther, R. P. Covey, & R. Parker. 1986. Field Guide to Sweet Cherry Diseases of Washington. Coop. Ext. Bul. EB 1323. (Source #11a; Cost $3.00)
   Includes full color photographs of cherry disorders and symptoms of herbicide damage.

6. Tree Fruit Series, IPM Sheets. Cornell University, Ithaca. (24 sheets)
   (Source #6; Cost for Tree Fruit Series [set] $19.55, #102 FSTF)
   An excellent series of IPM sheets on Tree Fruit pests and diseases with excellent color photo illustrations of different life stages, damage symptoms, and size relationships. Available as a set or as individual sheets.

7. T. van der Zwet. 1992. Fire Blight -- Its Nature, Prevention, and Control; A Practical Guide to Integrated Disease Management. U.S. Dept. of Agric., Agric. Inf. Bull. No. 631, 83 pp., illustrated. (Source #12; single copies at no cost while supplies last)
   An excellent, updated reference with an emphasis on an integrated approach to control of this disease.

8. Integrated Pest Management for Apples and Pears. 1991. Pub. no. 3340. Div. of Agric. & Nat. Res., Univ. of Calif., Oakland. 216 pp. ISBN 0-931876-94-X. (Source #2; Cost $30.00 + S/H)
   An **Excellent** reference with many outstanding color photographs and information on horticultural practices, diseases, and pests.

9. Washington State University Extension Bulletins. (Source #11a)
   EB0940 Apple Anthracnose. (Cost $1.50)
   EB1044 Apple Scab. (Cost $1.00)
   EB1047 Brown Rot of Stone Fruits. (Cost $1.00)
   EB1072 Codling Moth Control: A new tool for timing sprays. ($1.00)
   EB1230 Pear Psylla Detection and Control. ($1.00)
   EB1238 Spotted Tentiform Leafminer. (Cost $1.00)
   EB1246 Mite Counting in Apple Pest Management. ($1.00)
   EB1266 Coryneum Blight of Stone Fruits. ($1.00)
   EB1307 Grape Mealybug in Pears. ($1.00)
   EB1320 Apple Maggot Trap Placement. (Cost $1.00)
   EB1322 Dead Spur on Delicious Apples. (Cost $1.00)
   EB1352 Fire Blight. (Cost $1.00)
   EB1448 Cytospora Canker of Stone Fruits. (Cost $1.00)
   EB1497 Collar rot of pome and stone fruits. (Cost $1.00)
   EB1590 Transplanting Ants to Pear Orchards for Pear Psylla Control. ($1.50)
   EB1517 Perennial Canker and Bulls Eye Rot of Apples. (Cost $1.00)
   PNW0328 Using Horticultural Spray Oils to Control Orchard Pests (Cost $1.50)
   PNW0414 Growing Young Fruit Trees in Old Orchard Sites. (Cost $0.50)

D. Diseases and Insect/Mite Pests: (Cont'd.)

10. P. R. Fridlund. 1989. Virus and Viruslike Diseases of Pome Fruits and Simulating Noninfectious Diseases. Special publication SP003, Washington St. Univ. Coop. Ext., Pullman. 336 pp., illustrated. (Source #11a; Cost: $37.50)

11. Horticulture Plant Disease Sheets, University of Illinois (Source #8; Cost $0.40 each)

    X698.46 Fruit Pests I
    X699.46 Apple Diseases I
    X699.47 Apple Diseases II
    X699.48 Cherry & Plum Diseases I
    X699.49 Cherry & Plum Diseases II
    X699.51 Peach Diseases I
    X699.52 Peach Diseases II

    An excellent series consisting of single sheets with color plates on the front and text descriptions of each disease on the back. The series also includes sheets for: trees (3), woody ornamentals (1), turfgrass (3), flowers & houseplants (6), vegetables (4), and small fruits (5).

12. Service-In-Action Series, Colorado State University Cooperative Extension, Fort. Collins. (Sources #5a-c)

    2.800 Backyard Orchard Management: Insect and Disease Spray Guide
    2.907 Fire Blight
    2.910 Bacterial Wetwood (primarily ornamental trees)
    2.914 Coryneum Blight
    2.921 Crown Gall
    5.507 Spider Mites - Characteristics and Control
    5.519 Apple and Pear Insects - Control in Home Plantings
    5.520 Stone Fruit Insects - Control in Home Plantings
    5.560 Pear Slugs - Characteristics and Control
    5.562 Uses of Pheromones for Insect Control in Colorado
    5.566 Peach Tree Borer - Characteristics and Control

13. N. A. Davidson, J. E. Dibble, M. L. Flint, P. J. Marer, and A. Guye. 1992. Managing Insects and Mites with Spray Oils. Pub. no. 3347. Div. of Agric. & Nat. Res., Univ. of Calif., Oakland. 47 pp. [ISBN: 1-879906-07-4] (Source #2; Cost $6.50 + S/H)
    An excellent reference on spray oils (history, types, pest control, factors in use, etc.)

14. A. L. Jones and T. B. Sutton. 1996. Diseases of Tree Fruits in the East. Bull. NCR-45. Michigan St. University, E. Lansing. 95 pp. (Source #10; Cost $10.00 incl. S/H)
    Newly revised and published in late 1996, this reference is a comprehensive identification guide to 65 tree fruit diseases of apple, pear, cherry, peach, and plum found in the Eastern US. It includes more than 170 color photos and diagrams.

E. Disease Resistant Cultivars:

Willet, M. 1986. Pest susceptibility: A handbook to varietal differences. Pages 78-87 in M. Willet & R. L. Stebbins (eds.) 1986. Pear Production in the Pacific Northwest: The Proceedings of the 1986 Pacific Northwest Tree Fruit Shortcourse. Publications-Conferences & Institutes, Washington State University, Pullman. 266 p. (Source #11b; Cost: $11.50, includes postage & handling).

F. Weed Management

1. Whitson, T. D., L. C. Burrill, S. A. Dewey, D. W. Cudney, B. E. Nelson, R. D. Lee and R. Parker (eds.). 1992 Weeds of the West. West. Soc. of Weed Science, Jackson, WY. 630 p. (Source #5c; $19.50 S/H incl.).
   An excellent reference for weed identification!

G. Herbicide Injury:

EB 1207 Symptoms of herbicide injury to tree fruits. 4 p. (Source #11a; Cost $1.00).
An excellent reference on symptoms of herbicide injury to tree fruits (with color photo illustrations).

H. Fruit Tree Nutrition:

1. Nutrient Disorders: (Source #11a)

   PNW0121 Nutrient Disorders in Tree Fruits. (Cost $1.00).
   EB1335 Iron Chlorosis in Washington Orchards and Vineyards. (Cost $1.00)
   EB1595 Orchard Soil Sampling. (Cost $1.00).

2. Nutrition Management:

   a. Peterson, B. and R. Stevens, eds. 1994. Tree Fruit Nutrition. Good Fruit Grower, Yakima. (Source #7; cost $15.00 + S/H). Item no 106.
      A detailed study of orchard soils and nutritional needs.

   b. Stiles, W. C. & W. S. Reid. 1991. Orchard Nutrition Management. Bull. No. 219, Cornell Coop. Ext., Ithaca. 22 p. (Source #6; cost $4.00).

   c. Walser, R. H. & V. D. Jolley. 1986. Effect of foliar fertilizer applications on tart cherry and apple trees. HortSci. 21:224. (abstract).

   d. FG0028F Fertilizer Guide: Nutrient Content - Fruit Trees (Source #11a; cost $1.00)

I. Pruning:

1. Washington State University Extension Bulletins (Source #11a)

   PNW0402 Training Apple Trees in Commercial Orchards (Cost $1.00)
   PNW0403 Training Pear Trees in Commercial Orchards (Cost $1.00)
   PNW0404 Pruning Apple Trees in Commercial Orchards (Cost $1.00)
   PNW0405 Pruning Pear Trees in Commercial Orchards (Cost $1.00)
   VT0001 Pruning Apple Trees: Basic Concepts (VHS videotape, English, color, 24 min. Cost: $10.00)

2. B. C. Ministry of Agriculture & Fisheries (Source #4; Cost $5.00 Canadian or approx. $4.25 U. S.)

   Pruning the Slender Spindle by Herman Obenhoffer (Translated into English by the British Columbia government).

   This illustrated publication provides a hands-on, detailed description (with pictures) of how to develop, handle, and follow through with a productive, high-density slender spindle apple planting.

3. Barritt, B. 1992. Intensive Orchard Management. Good Fruit Grower, Yakima. (Source #7; cost ??). Item no. 101.

   This reference currently is out of print; it is uncertain whether it will be reprinted. The book introduces the HYTEC System, a variation of the European slender spindle and developed for North American apple growers.

4. Forshey, C. G., D. C. Elfving, and R. L. Stebbins. 1993. Training and Pruning Apple and Pear Trees. ASHS, Alexandria. 176 pp. (Source #1; Cost $30.00)

   This reference provides an excellent, basic explanation of all aspects of pome fruit pruning and training.

J. Economic Analyses:

1. Colorado (Source # 5d)
   Sharp, R. & W. Harriman. 1992. Colorado Fruit Enterprise Budgets. Mimeo, 6 p.

2. Washington (Source # 11a)
   a. Multiple orchard crops:

      EB1217 Using Packinghouse Records to Evaluate your Orchard's Financial Performance. ($1.00)
      PNW0332 Evaluating Orchard Performance and Practices from Packout Records. ($.75)

J. Economic Analyses: (Cont'd.)

2. Washington (Source # 11a) (Cont'd.)

b. Pome Fruits (Apples & Pears):
Apple:

EB1159 Estimated Costs of Producing Red Delicious Apples, Columbia Basin. ($1.00)
EB1472 Estimated Cost of Producing Apples in the Wenatchee Area. ($1.00)
EB1635 Estimated Cost of Replanting to a High Density Fuji Apple Orchard on Full Dwarf Rootstock in Central Washington. ($1.50)

Pear:

EB1374 Cost of Producing Pears in the Wenatchee River Valley. ($1.00)
EB1535 1989 Estimated Costs of Reestablishing a Pear Orchard in the Yakima Valley. ($1.00)
EB1549 1989 Estimated Costs of Producing Pears in Yakima Valley, Washington. ($1.00)

c. Stone Fruits (Sweet Cherries & Peaches):

EB1536 1989 Estimated Costs of Producing Peaches in the Yakima Valley, Washington. ($1.00)

3. Other Sources
Seavert, C. F. Practical Grower: Estimation loss of income from tree loss. Good Fruit Grower 56(17):88-90

K. Internet Access:

1. Warner, G. 1996. Agriculture-oriented internet sites of interest. Good Fruit Grower 47(16):23-24. (Nov. 1996 issue).
This article lists a number of internet sites of potential interest to fruit growers. Others are available also.

L. Other References:

1. Service-In-Action Series, Colo. St. Univ. Coop. Extension, Ft. Collins. (Sources 5a-c)
0.116 Plant Analysis [tissue analysis for fertilizer recommendations]
0.507 Services of the Colorado State University Soil Testing Laboratory
0.515 Fate of Pesticides in Soil.
2.928 Iron Chlorosis of Woody Plants
4.703 Drip Irrigation for Orchard Crops
4.708 Irrigation Scheduling
7.002 Pollination of Tree Fruits
7.004 Tree and Shrub Fruits for the Colorado High Plains.

L. Other References: (Cont'd.)

2. J. H. LaRue and R. S. Johnson. 1989. Peaches, Plums, and Nectarines: Growing and Handling for Fresh Market. Pub. No. 3331. Div. of Agric. & Nat. Res., Univ. of Calif., Oakland. 246 pp., softbound. (Source #2; Cost $42.50 + S/H)

   An **excellent** reference written by researchers, extension specialists, and farm advisors. It is comprehensive and is designed to guide a commercial grower through every phase of peach, plum, and nectarine production. It would be helpful for both inexperienced and experienced growers.

3. EB1074 Publications for Commercial Orchardists (Source # 11a; free - catalog).
   C0839 Commercial Tree Fruit and Nut Orchards Publications List (Source # 11a; free - catalog)

4. Pollination and Fruit Set: Proceedings of WSU Shortcourse. Good Fruit Grower. (Source #7; Cost $7.50 + S/H). Item no. 104.
   A collection of papers that explains the basic scientific principles of pollination and fruit set of apple.

5. WREP0015 How to Reduce Bee Poisoning from Pesticides (Source # 11a; Cost $1.50)
   An excellent new (1996) reference which updates information on pesticide risks to honeybees **and** wild bee populations!

6. Petersen, B. 1994. Practical Grower: Estimating Yield need not be a shot in the dark. Good Fruit Grower 45(15):47. (Oct. '94 issue).
   Brooke Petersen's method has NOT been tested yet under Colorado conditions. We recommend growers use caution with it until testing has been done.

7. Ketchie, D. O. 1994. Preparation of orchards for protection against the cold. Good Fruit Grower 45(17):91-107. (Dec., 1994).
   Dr. Ketchie provides an excellent overview of hardiness development within tree tissues and the influence of cultural and environmental factors on cold hardiness.

INSECTS & MITES

DESCRIPTIONS OF INSECT PESTS

Several insect and mite pests can cause economic damage to fruit and fruit trees in Colorado orchards. Chief among these are the coddling moth, pear psylla, peach crown borer, peach twig borer, and several species of aphids and mites. Attention must be given to control of each of these (and the other, less common insect pests) in order to prevent such economic loss. The pest descriptions in this section are intended to provide growers with at least a basic background for those pests included. Further information and assistance may be obtained by contacting local Colorado State University Cooperative Extension and/or Experiment Station personnel and by using the appropriate references listed on pages 5.3-5.5 (Section C).

Table 8. Principal insect and mite pests of Colorado tree fruits

APPLES	APRICOTS
Codling Moth	Peach twig borer
Tent caterpillars	Peach crown borer
Grasshoppers	
Campylomma bug	CHERRIES
Lygus/Stink bugs	
White apple leafhopper	Peach crown borer
San Jose scale	Peach twig borer
Woolly apple aphid	Cherry gouger
Rosy apple aphid	Pear slug
Green apple aphid	Black cherry aphid
European red mite	San Jose Scale
McDaniel & 2-spotted spider mite	
Leafrollers	PEACHES / NECTARINES
Climbing cutworms	
Tentiform leaf miner	Peach crown borer
	Peach twig borer
PEARS	Oriental fruit moth
	Grasshoppers
Codling moth	Lygus/Stink bugs
Pear psylla	Campylomma bug
Pear slug	Flower thrips
Pear sawfly	San Jose scale
Grasshoppers	Green peach aphid
San Jose scale	Peach silver mite
Pear rust mite	
McDaniel & 2-spotted spider mite	PLUMS
Pear leaf blister mite	
Leaf rollers	Peach crown borer
Climbing cutworms	Peach twig borer
Tent caterpillars	San Jose scale
Grape mealybug	Green peach aphid

Codling Moth

Codling moth has caused greater losses to apple and pear growers than any other pest. It is found wherever apples and pears are grown, producing the familiar "apple worm" found in the fruit.

The codling moth is a small grey moth, about 12 mm long, with a chocolate- or bronze-colored rounded spot at the apex of the wings. The grey appearance of the rest of the body takes the form of undulating minute grey lines with interspersed brown. These moths are quite characteristic and can be easily counted in pheromone traps.

The larvae spend the winter inside a silken cocoon which is usually located on the tree, but can occur almost anywhere in the orchard or packing area. The larvae are found hibernating in or on sacks, corrugated paper, (e.g., packing boxes), posts, trees, or wood. When warm spring days begin, the larvae transform into pupae within the silken cocoon. By blossom time pupation is generally complete. Moths typically emerge just at petal fall with the males appearing first. Numbers of males collected in traps progressively increase in the next few days. If the weather is cool, adult emergence is prolonged and may extend over 6 weeks. In warm spring weather, most of the moths will emerge in less than a week. It is easier to obtain control when all moths emerge at once, and extra sprays may be required if the spring emergence is prolonged. Cool weather retards egg deposition; this effectively spreads each generation through the season and places increased dependence on a spray residue. Temperatures at twilight of about 60^{o} F are required before eggs will be deposited. Moths do not fly in the twilight hours when the wind is above 5 miles per hour.

The codling moth egg is a white, translucent, circular disc attached to the leaf or fruit. It resembles the head of a pin that has been pushed through the leaf and is easily visible when numerous eggs are present. Eggs normally hatch in 8 to 10 days during warmer weather, but they may take 12 or more days in cool weather. The peak of emergence generally is identified through the use of pheromone bait traps, and the first cover spray is timed for 10 to 14 days after the peak, depending upon weather. All eggs are deposited on leaves by the spring generation, but the following summer generations deposit their eggs primarily on fruit.

The larvae may feed on foliage when first hatched, but they soon migrate to nearby apples and begin to make entry. At this time, the cup-like opening at the calyx end of the apple is a particularly favorable site for entry, apparently because the young larvae can get better leverage for making the initial cut. Occasionally the stem end of the apple will be entered. At other times, the point of entry will be where two apples touch or where leaves touch the apple. In Colorado, the larvae reach maturity after about 3 weeks inside the apple. Then they emerge and either migrate back to the twigs or trunk or drop to the ground and pupate. Twelve to 14 days are required for the pupal stage at this time of the year, and the second brood of moths appears about the first of July. Forty-four to 48 days are required to complete a generation of the codling moth, so that the third-brood moths begin appearing by the third week of August. The third-brood moths generally do not cause much damage, but their activity may interfere with the pear harvest which occurs at about this time; apples should be watched carefully.

About 35% of the first summer generation enter the over-wintering conditions and emerge the following year; only about 65% of the moths emerge during the current season. Over 50% of the second summer generation enters the overwintering condition, and most or all of the third does so.

Effective control of codling moth is best obtained through careful monitoring of the orchard for flights of adult male moths and then timing the cover sprays to coincide with egg hatch (first cover coincides with accumulation of 250 - 270 degree day heat units after biofix in your own orchard). Later flights will have their own timing for cover sprays.

Use of mating disruption to control codling moth requires closer monitoring and pest management that a strictly conventional program. The grower must follow a regular monitoring

program throughout the growing season; this includes both pheromone traps and visual inspection of the fruit for entries. Use of mating disruption in orchards of less than 10 acres is not recommended due to the greater ratio of border trees to interior trees. The pheromones will not prevent a mated female from entering an orchard and laying eggs. In addition to mating disruption, an insecticide spray on the border trees is recommended. Also, additional cover sprays may be needed to suppress high codling moth populations. Mating disruption may not work for every grower; high codling moth pressure may also cause control failure. Mating disruption should be viewed as only one part of a successful pest management program for codling moth. Prior to using mating disruption, interested growers should contact their local Extension Agent or specialists at the Orchard Mesa or the Rogers Mesa Research Centers.

Black Cherry Aphid

The black cherry aphid is primarily a pest of sweet cherries. This insect is a large, jet-black aphid which likes to feed on terminal foliage. The honey dew which is secreted by the aphids will cause fruit to become sticky and gummy and difficult to harvest. The aphids overwinter as eggs around the fruit buds.

Green Apple Aphid

The green apple aphid may be a very abundant and troublesome problem. Damage is usually confined to younger trees, vigorous water sprouts, and situations of high nitrogen fertility. When numerous, they may discolor and distort the terminals; their wounds also provide entry sites for fire blight bacteria. Under such conditions, multiple spray applications may be required to achieve control. In commercial orchards, the eggs are deposited primarily on water sprouts of the previous season. Water sprouts comprise a pruning problem for the following year, and effective control of green apple aphids can often be obtained by breaking out the water sprouts. This procedure often will minimize the problem so that no spray applications will be required.

The eggs, aside from being found on water sprouts, hatch at about the same time as those of the rosy apple aphid, but the young adults are green and quite distinctive. The winged aphids begin to migrate to summer hosts in June. Unlike the other aphids, summer generations remain on apple and pear, particularly on young plants where they have a tendency to feed on the young terminal growth.

Green Peach Aphid

The green peach aphid is a pest of all stone fruits, but is particularly damaging to peaches and nectarines. The adults are yellow or green with indefinite black stripes on the abdomen. The aphids overwinter on host fruit trees as shiny black eggs (smaller than a pin head) which begin to hatch in early spring. Nymphs from overwintering eggs begin to feed on developing buds, but ultimately move to leaves to feed as wingless females that are known as "stem mothers." These stem mothers give birth to living young without mating. After two to three generations on the overwintering host trees, winged adults are produced which migrate to non-tree hosts such as peppers, potatoes, sugar beets, and lettuce. In late summer, after several generations on these alternate hosts, winged males and females return to their overwintering host trees to mate and lay the overwintering eggs.

On peaches and plums, high populations of aphids can reduce tree vigor and damage the trees. On nectarines, the aphid actually feeds on the young, developing fruit and causes it to become bumpy and unmarketable. Optimum treatment is a prebloom dormant oil spray which smothers the eggs. Chemical treatment becomes very difficult if treatment is delayed until the leaves begin to curl because the chemical cannot always reach the aphids. Success of any treatment after the leaves begin to curl depends upon good penetration of the leaf curls through use of adequate spreaders and thorough soaking of the curls.

Rosy Apple Aphid

The rosy apple aphid can be quite destructive because of its ability to deform fruit. The overwintering eggs are deposited around roughened areas on branches and under bark scales. The eggs are somewhat larger than those of other aphid species on apple, and generally far less numerous. These aphids hatch later than other aphids on apple. At the cluster bud stage, early season estimates of aphid populations are possible. At this time the stem mothers may be observed atop the just maturing buds. If the stem mother population reaches one aphid per fruit cluster, economic problems are certain unless corrective measures are taken. The stem mothers are quite distinctive, relatively large, dark reddish-purple aphids. As soon as the blossom clusters begin to separate, the aphids work their way down among the clusters and are difficult to observe until after petal fall. As the young leaves begin to unfold, the aphids colonize the leaves, especially those close around the fruit clusters. Typically, the highest populations occur in the lower central portion of the tree, and often the fruit in this area will be deformed. The feeding of the aphids both deforms and stunts the fruits. This injury is aggravated by the fact that chemical thinning is ineffective in removing the aphid injured fruit, and the deformed fruits will still be present at harvest time.

During the month of June, the majority of aphids begin their migration to the summer host plants although some aphids remain on apple. The summer host plant is reported to be plantain. In the fall, the aphids migrate back to apple. The sexual stages then develop, and the resulting eggs are deposited on fruit spurs and in bark crevices.

Woolly Apple Aphid

The woolly apple aphid feeds on the woody parts of apple, and causes injuries that are distinct from other aphids on the crop. During summer and fall the aphids colonize the roots and wound sites above ground, such as the edge of pruning cuts or frost cracks. Colonies appear as white tufts of wool and the feeding aphids weaken the plant, sometimes producing knobby galls. Aphid damaged tissues often are more susceptible to freeze injury and sustained infestations can cause a condition known as perennial canker.

During mild conditions, some of the aphids may survive on apple, below ground. However, most migrate to elm in late season, where they produce a resistant egg stage that survives the winters. During the normal life cycle, eggs hatch and populations develop on elm during spring before they disperse to apple, their summer host. Crabapple and mountain ash are also infested by this insect.

Most of the codling moth cover sprays will help keep this aphid in check. Resistant rootstocks also will help keep down infestations in orchards. Aphicide should be used when infestations appear in upper parts of the tree, on water sprouts, or in bark wounds.

The McDaniel and Two-Spotted Mite

The McDaniel and two-spotted mites overwinter primarily as adult females in soil and trash near the base of the fruit trees. The extent to which the mites may survive the winter on the trunk or scaffold limbs is unknown for western Colorado. It is generally thought that any mites on the trunk migrate down to emerging cover-crop vegetation early in the season. At this time, mite populations exhibit a preference for herbaceous plants and seem to attack fruit only secondarily, later in the summer. Because the two-spotted mite spends half the growing season on the cover crop, considerable control can be achieved through cultural practices such as minimizing or eliminating weeds around and under the trees.

The life cycle of the mites, beginning with the egg hatch, passes through three nymphal stages to the adult stage. The egg is spherical and clear when deposited and is commonly found on the undersides of leaves, particularly along the midrib. Typically all stages are present at the same time. The immature larva is six-legged and nearly colorless, gradually becoming pale green. The larva molts into a protonymph which is somewhat larger, is a pale green color that gradually darkens, and has four pairs of legs. After another molt, the deutonymph stage is formed; it is a larger, mature sized mite. At maturity the deutonymph molts and becomes a mature adult. At this time the genital organs are present and mating takes place almost immediately after the molt.

At average temperatures, about 4 days are required to hatch the egg. In the cool part of the season, 2 weeks or more may be required. Duration of the larval stage also is affected by temperature and may range from 1 to 10 days. The protonymph and deutonymph stages require about the same length of time as the larval stage for development and are also temperature-dependent; the life cycle length for this mite therefore varies from about 5 to 30 days.

Each adult female produces 40 to 100 eggs, and the average adult life span is 15-30 days but may be up to 2 months. Unfertilized females produce only male young. Under average growing conditions, probably 10 generations of mites are produced in a season. As temperatures become cooler in the fall and the days shorter, the females turn orange and congregate in crotches and under bark scales on the trunk and scaffold limbs. Clusters of orange mites are often found in the calyx and/or stem end of apples at this time of year. Mite populations experience considerable mortality over winter.

The injury caused by mite populations is largely confined to foliage feeding. This feeding causes collapse of plant cells and loss of vigor in the tree. When infestations are heavy, the mite populations retard fruit color development to such an extent that fruit quality may be downgraded. High mite populations can also affect fruit bud formation.

European Red Mite

This mite has been found on apples in Delta county since 1965. The injury produced is similar to that of the two-spotted mite, but there are some characteristic differences between the species. The two-spotted mite feeds primarily on the undersides of leaves while the red mite tends to migrate to the upper surface of the foliage, especially when population levels are high. European red mites may cause foliage browning and early shedding of leaves. If high populations occur just after the blossom period, feeding may retard fruit bud development for the following year. Late season infestations may affect fruit color and size, but there is no effect on fruit bud formation.

Unlike the two-spotted mites, European red mites overwinter as eggs on branches and twigs, particularly in roughened areas and bark crevices. The red, spherical eggs have a characteristic horn-like spur projecting upward and are very winter hardy. In the spring when daily maximum temperatures begin to exceed 50^{o} F, considerable hatch of eggs occurs. As the young nymphs emerge from the egg, the egg shell is separated into two halves which remain on the bark or foliage. When the

empty egg shells are sufficiently abundant, they may cause a grey to white appearance on the twig or leaf. The first hatch usually coincides with the pink stage of fruit bud development. The young mite nymphs grow and molt, enter the second or protonymph stage, grow some more, and molt again to the deutonymph stage. Development time required by these immature stages varies greatly, depending upon weather conditions. In general, 10 to 12 days are needed to pass through the three stages before mites become adults. Eggs laid by unmated female mites all produce males, but eggs laid by fertilized females produce both male and female offspring. Each female mite deposits an average of 20 to 30 eggs. Considering the reproduction potential of this species, it is not surprising that tremendous populations may occur in the 10 to 12 generations produced during a single growing season.

Pear Rust Mites

Pear rust mite is a sporadic, but serious, pest of fresh market and processing pears; fruit damaged by rust mite is frequently unmarketable. These pests feed on developing pear fruit and can cause severe fruit russet where their populations are not controlled. Early season preventative sprays are essential to control of pear rust mite as populations can increase rapidly over a very short period of time and their feeding injury permanently russets the fruit. Delay of control measures until evidence of damage appears all too often results in economic loss to the grower.

This microscopic, wedge-shaped mite cannot be seen without the aid of a good hand lens (10x to 20x) or a binocular microscope (20x to 35x magnification is needed for best visibility). Pear rust mites overwinter next to leaf buds, mostly on 1 to 2 year old pear shoots. Overwintering forms are pale brown while the summer forms are pale white to cream color and blend in with the white fibrous plant hairs found around the calyx end of the fruit early in the season. These plant fibers provide a well-protected natural habitat in which the mite can readily feed and reproduce; this is why they often go unnoticed until injury to the fruit has occurred. Rust mites also feed on leaves and leaf injury often goes unnoticed until an off color bronzing of the leaves is observed on the terminal growth later in the season.

Localized outbreaks of these pests often occur within a given area and affect some orchards more than others. Several generations occur during the season. Consequently, monitoring the population levels is extremely difficult and time consuming. Interpretation of rust mite infestation data on fruit samples is very complex. Research data suggests that economic injury will result whenever there is an average of five rust mites per fruit in samples taken between petal fall and harvest or whenever 2% to 3% of fruit is infested.

Early season control of this pest is essential because fruit injury can occur rapidly (within 6-10 days) as the fruit is forming after the bloom period. In addition, if control is obtained before bloom, it usually is sufficient for the entire season. For such early season control, delayed dormant sprays should be applied just as the cluster buds separate prior to bloom. Occasionally, additional summer sprays may be needed. Growers should continue to monitor their orchard for any evidence of rust mite feeding throughout the summer because any rust mite feeding injury during the season will appear as russet at harvest and downgrade the fruit. Single summer-applied oil sprays have given good mite suppression in research trials, but growers should expect some short-term leaf stress with summer oil sprays. However, the leaves do recover after a week or so, and no damage to the fruit has been observed with a single application. Caution should be used with these oil sprays, however, because oil can interact with other spray materials applied previously or later (e.g., Guthion, etc.) to cause tree damage. See the discussion of chemical compatibility (pages 3.12-3.14).

Peach Twig Borer

This insect is a pest of peaches, apricots, and plums. The twig borer overwinters as a partially grown larva in shallow cells (hibernacula) on corky, rough bark in crotches and limbs of 2 to 4 year wood. In spring, the very small larvae climb the tree and feed on the emerging buds. The larva also

attack and feed on the terminals, causing the terminals to wilt and die (flagging). The mature larvae are reddish- or chocolate-brown in color. Pupation occurs in the tree; the cocoons usually can be found among silken webs in the latter part of April. Adult moths emerge the first part of May. These moths are very small, about 6 mm in length, and have an ashy-grey color. Adult moths mate and lay eggs on young developing fruit usually just following shuck-split stage of fruit development. Young larvae move first to the terminals to feed and later return to the fruit. Attack on terminals again results in "flagging." Larvae attack fruit just as pits begin to harden. This occurs the latter part of June. Larvae pupate, moths emerge and lay eggs, and a second generation of twig borers occurs. Larval activity of the second generation is confined to fruit. The overwintering third generation damages only the twigs and usually is not a serious problem.

Pheromone dispensers for mating disruption of peach twig borer became available in 1995. Trials were initiated at that time in peach blocks at the Colorado State University Orchard Mesa Research Center. Preliminary results in some locations look promising, but evaluation of effectiveness requires several years of data collection. Efficacy may be site dependent.

Peach Tree Borer (Crown Borer)

Peach, apricot, cherry, and plum trees are attacked by this borer. Attacked trees lose vigor and may be killed when the insects are numerous. The presence of borers usually may be detected by the appearance of gum at or below the soil line of the trunk. There is one generation of the insect per year. Adults, commonly called "clear-winged moths", are about 19 mm long and resemble wasps. The females are black with a single orange band across the abdomen. The males are also black, but have several yellow bands. These moths first emerge in late June - early July and may be found through early September. They lay their eggs on tree trunks or on the soil near the trunk. Upon hatching, the young worms soon enter the bark to feed. As they grow older, they go deeper into the tree and pass the winter in this stage. Full grown borers are about l inch long and are white with a brown head. They complete their growth in late spring and pupate in burrows or in the soil at the base of the tree. Service-In-Action sheet 5.566 discusses peach tree borer in more detail.

Mating disruption for control of peach crown borer has been successfully used by a few growers in the Hotchkiss and Paonia areas of Delta County. Successful use of a mating disruption program requires a careful monitoring program that includes both pheromone traps and visual inspection at frequent intervals throughout the season. Growers interested in using mating disruption in their pest management programs should contact their local Extension Agent or specialists at the Orchard Mesa or Rogers Mesa Research Centers.

Pear Psylla

Pear psylla has long been a major pest of pears in the western United States and has been found in western Colorado pear orchards since 1975. Pear psylla have four to five generations each year. The first generation develops rather uniformly, but there is considerable overlap in development of successive generations. Adults resemble miniature cicadas and are about 2-3 mm long. Their color varies from dark to reddish brown, with either reddish or green markings. The wings are transparent and are held in a rooflike "V" over the body.

The eggs are pear-shaped and usually orange-yellow in color. They are found on the twigs and buds in the early spring, and on the leaf petioles and near the leaf midribs in summer.

The young nymphs are very tiny and yellow in color. As they mature, they become flat and broad, with color varied from yellowish green to reddish brown. The eyes are bright red and each nymph is immersed in a droplet of honey-dew. The last instar is called the "hard shell" stage. This stage is dark in color with prominent wing pads and no longer lives within a drop of honeydew.

Pear psylla prefer cool weather and succulent foliage; populations build up most rapidly during the spring and early summer. If not controlled early, damaging populations will persist throughout the season. Besides devitalizing the tree, the insect produces a honeydew on which a sooty mold grows and causes a black russet-like fruit discoloration. Pear psylla also has been implicated as a factor in pear decline, and their feeding wounds provide entry for fire blight bacteria when conditions favor development of this disease.

Control programs for pear psylla must allow for the historical ability of this pest to develop resistance to control materials used on a frequent, regular basis. Availability of the newer pyrethroid materials allows growers to control pear psylla through application of two or less pyrethroid sprays per season when these sprays are properly timed. This greatly reduces potential development of psylla resistance to these insecticides. Proper timing of these sprays requires effective orchard monitoring for pear psylla. Two methods, the limb-beat/tray-catch method and the psylla nymph/terminal count method, are needed during the year. Dormant and early season counts are best made with the limb-beat/tray-catch method, while summer and mid-season counts are more reliable with the psylla nymph/terminal count method.

The limb-beat/tray-catch method can be used for both psylla and for Campylomma and some predator mites and insects. It requires only a 2 ft. long rubber- covered club plus a 314 sq. inch catch tray with white cloth. Frequently the club is just a section of shovel handle inserted into a section of old rubber hose while the catch tray consists of white muslin cloth stretched over a 20 in. diameter circular metal frame with a handle in back. The tree limbs are struck with the club to dislodge the psylla adults onto the muslin cloth. Each series of three taps on a limb constitute one "beat" or "tray" count. A count of four to 25 adults per 25 beats or trays in fall and winter season indicates a moderate infestation, and an early season spray before many eggs are laid will be essential to control the first psylla generation. Previous surveys of overwintering adult psylla populations show populations generally exceed these numbers in most western Colorado pear orchards. A pyrethroid and oil spray applied the last of Feb. or early March often reduces psylla populations to "0" levels for 30 to 60 days. In areas where unsprayed trees exist, migrating psylla often re-infest treated orchards after the first summer generation completes its cycle. This usually occurs in May and June and, if populations go unchecked, will produce a high population with sticky leaves and fruit by harvest time in August and Sept.

The need for and timing of a second (or subsequent) psylla spray is best determined by use of the psylla nymph/terminal count method after mid-May. Only a 10X hand lens is required (in order to see the nymphs within the honeydew droplet) as you walk through the orchard and run the succulent new growth through your hand. Any sign of sticky residue suggests psylla may be present, and the terminal should be examined closely with the hand lens. The first to third instar nymphs should be visible within the honeydew droplets. Several more trees and shoots should be examined, and controls should be applied if more than 20-50% of the terminals are infested. This second treatment, timed for the appearance of these first to fourth instar nymphs in June, gave good control for the rest of the season in experimental tests. This coincides with the second cover spray in most areas, and Mitac (Amitraz) and some of the pyrethroids have clearance for summer use. Most of these materials will aggravate the mite populations, so a miticide should be included in the sprays.

Control of the first psylla generation in the dormant period and of the recurring second generation in the early summer has given good season-long control. This limitation of pyrethroid treatments to two (or less) per year should also forestall build up of resistance to these materials in the psylla populations and lengthen their period of usefulness. Application of a summer weight oil as needed in early summer has also helped to reduce psylla damage, but it should be applied in evenings or early mornings and it is best if the trees have been watered recently and are not stressed for water.

Tentiform Leaf Miner

The tentiform leaf miner can be a problem in some apple orchards. The species overwinters as the pupal stage in fallen leaves on the orchard floor. Consequently, tilling or disking the leaves into the soil provides some control of this pest. Adults are small moths with brown and white markings and emerge from the fallen leaves over a long period of time in early spring (from tight cluster bud stage through petal fall). After mating, the females deposit their eggs on undersides of leaves. The damage from larval feeding is usually insignificant at low population densities (early in the summer), but can increase rapidly with succeeding generations. The early feeding stage within the leaves (the sap feeding stage) is visible only from the leaf underside. As feeding continues, the mines become more visible and can be seen as white spots on the upper surface (the tissue feeding stage). Larvae mature in approximately three weeks and pupate within the mine. The pupal stage lasts 7-10 days and moths appear in early to mid-June. The second generation develops during July to early August and the third generation from late August through Sept.-Oct. with considerable overlap of generations. Early season sprays applied at the pre-pink (tight cluster) or pink stage provide the best results for apple.

In orchards where leafminer was a problem the preceding year, early season sprays should be considered and the orchard monitored closely. An average of two or more mines per leaf found in late July indicates a possible need for control sprays in the latter part of the season. Sprays for all generations should be directed at the early sap feeding stage when the mines are first visible on the under side of the leaf and appear as small water soaked areas. Vydate is effective against both the larvae and the adults if applied at 2 quarts per acre. Vydate also suppresses both spider mites and mite predators; therefore outbreaks of spider mites may occur later in the season if this material is used.

Several species of parasites and a virus disease attack the larval stages, and parasitism in the later generations can exceed 75%. Orchards which had six to eight mines per leaf the previous season should be monitored closely.

Pear Slug

The pear slug is a sawfly larva that feeds on pear and cherry foliage, skeletonizing the leaves by eating the upper surface. The larvae are slimy and slug-like, olive green to black, and about 12 mm long when fully grown.

There are two generations per year. Larvae of the first generation appear in June, those of the second generation in August.

Pear slugs are very susceptible to most insecticides and are not found in orchards receiving foliage sprays. When control measures are necessary, spray with an insecticide that best fits your pest control program.

Curculios (Gougers)

Several species of small snout beetles occur in eastern Colorado orchards including the cherry curculio, apple curculio, and plum gouger. (The plum curculio, a serious orchard pest in the eastern United States does not occur in Colorado.) These insects develop within the pit of the fruit, but most severe injury is due to feeding punctures made by the adult insects. These are marked by dimple-like depression wounds on the skin, sometimes extending to the pit. Feeding wounds to hard plums by the plum gouger also result in oozing gum.

The most serious pest in the group is the cherry curculio, which limits attacks to sour cherries. The adult beetles (weevils) are active as flower buds swell and the beetles can shred or abort blossoms

at this time. Most egg laying occurs in late May, after fruits begin to develop. There is only one generation of the insect per year.

All the snout beetles can be easily sampled by shaking infested branches over a cloth, which readily dislodges the adult insects. However, they have a habit of playing dead so samples must be carefully examined to detect the inactive insects.

Climbing Cutworms, Green fruitworms

Several species of 'climbing cutworms' can damage plantings early in the season. Eggs of most cutworms are laid in late summer, particularly in weedy areas so weed control can prevent subsequent infestations. The cutworms move from areas of cover around the base of the tree where they spend the day and climb to feed on buds at night. Maintaining the base of trees free from debris or insecticide sprays and baits used around the tree base can control cutworm damage.

Fruitworms, such as the speckled green fruitworm, are related early season pests which can damage and distort developing fruit during late May and early June. Eggs of these insects are laid in early spring and the caterpillars develop over a period of about 6 weeks. Unlike the climbing cutworms, they spend the day in the tree.

Cat-Facing Insects (Lygus, Stink, & Campylomma Bugs, Thrips)

Several bug species may attack peach, apple and pear and, through their injury to the fruit, cause the fruit distortion often called catfacing. The more common ones found in our area are lygus bug, stink bug, campylomma bug and flower thrips. Most of the fruit damage occurs between blossom and petal fall. Early season control in the delayed dormant and petal fall periods generally is best.

Lygus bugs have several generations and are general feeders on many host plants. Some of their preferred hosts include mustards, perennial pepperweed, alfalfa, red clover, lambsquarter, ragweed, pigweed & *Kochia*. Destruction of these weed hosts will greatly reduce the chance of fruit injury. Lygus bugs can cause particular problems in peach and pear orchards that adjoin alfalfa fields. When the alfalfa is cut, the displaced lygus bugs move into the fruit trees and feed on the developing fruit. Their feeding injury to the fruit may produce catfaced peach and can lead to fireblight infection in pears. Rows of peach and pear bordering alfalfa are particularly at risk of lygus damage when the alfalfa is cut. Sprays applied just before alfalfa cutting to both the trees and the bordering cover crop adjacent to the alfalfa can reduce this problem. Pears adjacent to alfalfa may require a preventative spray for fireblight before or immediately after the alfalfa is cut. See fireblight discussion, pp. 7.3-7.5.

Stink bugs are larger than lygus and have a broad shield-shaped lower back covering over the abdomen. Says plant bug and consperse stink bug are the most common ones found in orchards, but they rarely occur in such abundance that would warrant a separate spray. They overwinter as adults in trash or debris on the orchard floor or undisturbed areas. They are often localized within a portion of an orchard and thus the entire orchard may not require treatment.

The small campylomma bug, sometimes called the mullein bug, has caused problems in West Slope orchards. Although not commonly a problem, this pest can be very destructive to commercial production of apples and peaches. Damage is caused by nymphs, and those of the damaging generation appear at about full bloom on apple. Campylomma bugs will feed primarily on aphids when these insects are abundant. At other times, developing fruits will be fed upon. The fruit injury appears shortly after petal fall as a small, corky area surrounded by a depression. On red Delicious varieties small black pimples eventually appear and fruit may be misshaped to the point of making it off-grade. For sampling, a pear psylla beating tray or a white cloth stretched over a frame should be held under the blossoms and the limb tapped to dislodge the campylomma nymphs onto the tray. These are very

minute insects and careful examination of the tray is necessary to detect them. The small, pale green nymphs are fast moving. One or more nymphs collected per tray sample during late bloom indicates a need for control measures. Delayed dormant and petal fall sprays provide best control of this pest.

Thrips feed on peach, nectarine, and apple during the summer and can cause a fruit scarring injury. Early feeding damage on peach and nectarine is most critical and generally is quite inconspicuous until scars appear on the fruit; these may later turn into a type of catfacing. Later generations feed on the fruit surface and cause white, stippled feeding scars or light areas on fruit. These injured areas eventually become a brown, scab-like patch. On some apple varieties (e.g., Jonathan, MacIntosh), thrips egg-laying wounds produce a light-colored blush (termed pansy spot) on the fruit. Incidence of feeding and damage is much higher during periods of dry weather. A petal fall spray is essential in keeping down first generation injury. In addition, control of weed hosts for thrips (e.g., mustards) can greatly help reduce fruit damage by these pests.

White Apple Leafhopper

The pale yellowish white leafhopper adults are about 3 mm long and begin to appear in early summer. Within about three weeks of the adult appearance, eggs are laid on petioles and veins of the leaves. These hatch to produce the nymphs and adults of the second generation. In fall, overwintering eggs are placed in elongate, oval blisters under the bark surface of 1 to 5 year old wood.

Leafhopper feeding causes a white mottling of the leaves, and heavy infestations turn the leaves almost completely white. Feeding leafhoppers also produce considerable honeydew. These drops of honeydew can discolor and mark fruit. The best time to obtain control is when the nymphs, or non-flyers, are the predominant stage present (after petal fall), and sprays should be applied as soon as possible after this stage is present.

Oriental Fruit Moth

Oriental fruit moth infestations are limited mainly to the Palisade and East Orchard Mesa areas of Mesa County. Four complete generations occur in western Colorado; of these, the first two generations mine the terminal shoot growth. The third and fourth generations move from shoots to the fruit.

The grey to dark blackish colored adult is small with a wing span of 12 mm. It is quite similar in size to peach twig borer, but the fruit moth has a series of 12-13 dark, narrow, tapering bars on the outer edge of the wings. The larvae of the Oriental fruit moth are initially white, but become slightly pink when ready to pupate. These are easily distinguished from the peach twig borer larva which has a brown body with white ring-like segments.

Overwintering larvae pupate in early spring and adult moths emerge about mid-April, usually a few days after full bloom on Elberta peaches. Early control of the first two of the four broods in western Colorado will prevent fruit injury later in the season. Oriental fruit moth infestations may remain restricted to particular orchards during the first three broods, even in heavy peach growing areas. Adults from the fourth brood tend to migrate further and are the source of new infestations the following year. The eggs are deposited on the underside of the leaves and hatch in 7-14 days in the early season and 4 to 6 days in mid-summer.

Control programs used for peach twig borer often are also partially effective for Oriental fruit moth and reduce incidence of fruit injury by this pest. Sex pheromone traps which attract male Oriental fruit moths are available in most stone-fruit areas. Although the relationship of male catches to fruit and shoot injury is not currently known, trap catches can determine spray timing, indicate infestation sources, and evaluate spray effectiveness.

Regular releases of oriental fruit moth parasites are made in some areas by personnel from the Colorado State Department of Agriculture Insectary at Palisade. Where parasite releases are made, a cooperative effort should be made to use spray programs that do not destroy these beneficial insects.

San Jose Scale

This scale insect attacks all varieties of fruit trees, causing trees to lose their vigor and, in severe infestations, to die. The scales appear as grayish-colored encrustations on twigs and branches. Where many dead and dying twigs appear in the tops of neglected and abandoned orchards, the presence of San Jose scale can often be detected. On nursery and young orchard plantings, patches of encrusted scales are typically seen in the crotches of smaller branches. The twigs invariably have the bark reddened about the scale colonies. These red spots also occur on the fruit and make bright red freckles surrounding such scale. In the spring, scales begin to feed and grow, reaching maturity about bloom time or a little later. Males emerge from scales and seek females for mating. Soon after, females produce living young (crawlers). These crawlers are small and resemble aphids. They scatter to various parts of the tree, begin feeding, and secrete a protective shell. When these scales mature, they mate and produce another generation. There are several generations a year. Female San Jose scales are nearly round, somewhat larger than a pin head, and have a small raised nipple in the center. The male scale is smaller and oval in shape. Both scales are grey in color. Control should be aimed at the dormant or crawler stages by a dormant spray.

Grape Mealybug:

In recent years grape mealybug has become an occasional problem in some pear orchards in western Colorado. When weather factors are favorable or predators are not sufficient to keep them below economic levels, they can infest the calyx end of the fruit. The honeydew secretion they produce allows growth of a black sooty fungus around the calyx end; this results in a fruit russetting which makes the fruit unfit for fresh shipping. Heavy infestations can be rejected by both the cannery and fresh market handlers.

Mature, fully grown mealybugs are 4-5 mm long and dark purple, covered with a white powdery wax. Filaments of wax extend from the sides and rear of the somewhat flattened bodies. Eggs are yellowish to orange, laid in a cottony mass under bark or protected places. Newly hatched nymphs or crawlers are brownish and lack the powdery wax cover. In the spring before bloom the crawlers move to base of growing shoots and stay until they mature in May & June. The females then move back to protected places under the bark and lay eggs. These eggs hatch in June & July and this generation moves from the bark to feed on the tender shoots or developing fruit, often in the calyx end of the pear. This generation is well protected in the calyx cavity and very difficult to detect and control. Mealybugs overwinter as eggs or crawlers in cottony egg sacs under bark and protected places on the tree.

In the spring the crawlers become active before bloom and move to the base of growing shoots. They are most vulnerable and controls work the best at the finger bud stage just prior to bloom or at petal fall.

A random sample from 20 trees per block with one fruit cluster per tree will help determine the need for control. If two to five fruit clusters show infestations, organophosphate control sprays should be considered.

Western Cherry and other Fruit Flies

Several species of *Rhagoletis* fruit flies are major pests of fruit crops in the United States. These lay their eggs just beneath the fruit skin; the larvae that hatch from the eggs are called maggots and burrow their way through the flesh of the fruit. Infestation of fruit by the maggots renders

the fruit unsalable whether or not the maggots are still present when the fruit is harvested. Because these flies do not occur in all fruit growing areas of the U.S., their occurrence in a fruit growing area often is viewed as a threat to fruit production in areas in which they do not occur. Thus quarantines have been established against importation of fruit from an area known to have them (see **Special Program: Apple Maggot**, pp. 4.1-4.4).

These fruit flies are the size of small houseflies, but have characteristic wing markings that can be used to distinguish the species (Figure 1). All overwinter in the soil as pupae which hatch around early summer, mate, and lay their eggs beneath the skin of the fruit crop they infest. The legless, creamy white maggot larvae are about ½ inch in length with a cylindrical body tapered

toward the head and blunt at the rear. The walnut husk fly larvae become yellowish prior to pupation.

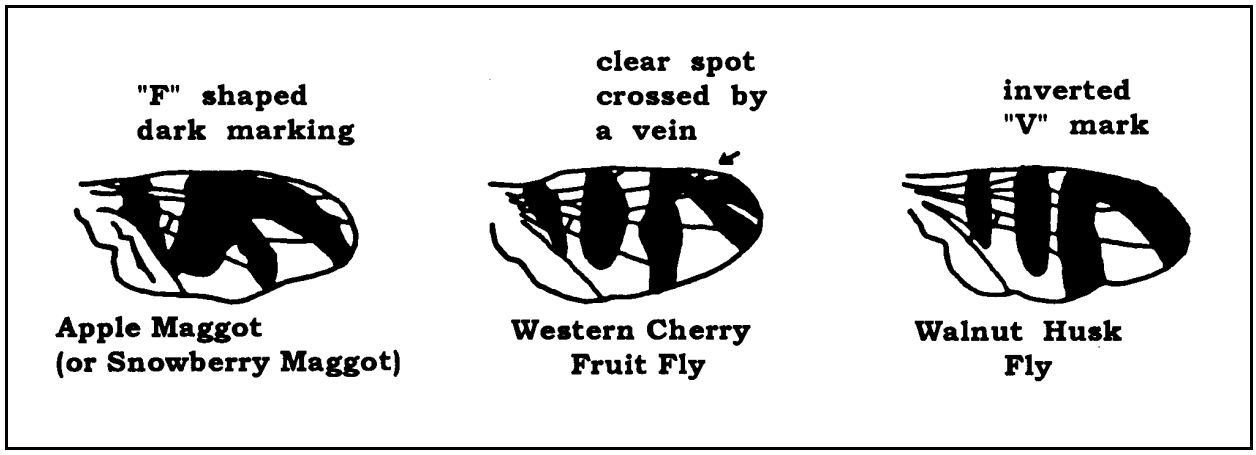


Figure 1. Comparative wing patterns for the apple maggot, western cherry fruit fly, and the walnut husk fly.

The maggots drop from the fruit to the ground beneath the tree at maturity and pupate.

Different species infest different fruit crops. The apple maggot, *Rhagoletis pomonella*, goes to apple, crabapple, and hawthorne; it also has been reported from cherries in some states including Utah. The western cherry fruit fly, *Rhagoletis indifferans*, goes only to cherry. The walnut husk fly, *Rhagoletis compleata*, infests walnuts and, rarely, peaches adjacent to walnut trees.

A Colorado population of Western cherry fruit fly, *Rhagoletis indifferens*, has been confirmed in the Paonia and Durango areas. Western cherry fruit fly can be controlled on cherries with Guthion or Imidan. Proper treatment timing is shortly after petal fall. Detection of adult activity is best determined by use of yellow sticky AM traps.

Isolated infestations of walnut husk fly, *Rhagoletis completa*, also may occur in peach. However, such infestations are rare and usually involve only a very small number of fruit on a tree. Controls are not warranted.

The apple maggot, *Rhagoletis pomonella*, also belongs to this group of insects. It has been the subject of a special program for monitoring to enable apple shipment into other states. See the Section **Special Program: Apple Maggot** (pp. 4.1 to 4.4), for discussion and details.

ORCHARD DISEASES

DESCRIPTIONS OF PRINCIPAL DISEASES:

(See section C, pages 5.3 - 5.5)

Coryneum Blight (Shothole)

Coryneum blight, caused by the fungus *Stigmina carpophilum (=Coryneum beijerinckii)*, is a disease of stone fruits. In Colorado, it affects mainly peaches, apricots, and, to a lesser degree, sweet cherry. Both leaves and fruit may be attacked; severe leaf infections with extensive shotholing may weaken a tree, while infections on the fruit produce the most apparent damage and economic loss.

The fungus typically overwinters on infected dormant leaf and/or blossom buds, and in small twig cankers. Spore production begins in early spring and continues until fall. First symptoms of infection are observed on young leaves as small red spots which enlarge and become purple with a tan-white center. The spots then drop out of the leafblade leaving a "shothole". Severe leaf infections produce numerous holes and give the affected leaves a very tattered appearance.

Economic loss from Coryneum blight results from infection of fruit. The purple-red spots on the epidermis blemish or disfigure the fruit. Spot development depends on the occurrence of wet weather periods, and spots may appear on the fruit from 10-12 weeks before harvest to throughout the postharvest period. Early infections when the fruit is small generally produce the largest (to 6 mm in diameter) and the roughest, scab like spots. In severe cases, spots coalesce and cause the skin to crack and gum. Late infections on apricots when the fruit is large generally produce smaller red spots, but these also reduce fruit quality and increase cullage. However, late infections on peaches as the fruit approaches harvest are the most obvious. The fungal infection spreads very rapidly to produce finger- to thumb nail size, sunken, greyish lesions that render the fruit non-marketable. Particular attention to preharvest sprays will likely be necessary in orchards with a history of coryneum blight problems, especially if rainy weather is anticipated at that time.

Under Colorado conditions, most infections appear to occur during wet periods in spring and early summer, but cool, wet weather prior to harvest can trigger blight outbreaks even at that time. The wet, rainy weather spreads the spores from infected twigs and leaves to uninfected branches, young leaves, and developing fruit by splashed and wind-blown rain. Free water is required for spore germination, and wet periods can make rapid spread of the disease within a tree possible, although movement from tree to tree is usually somewhat slower. Leaf infections are a major threat to developing fruit as they produce spores that can infect the fruit. Lesions can develop very slowly even at 45°F, but their development is much faster at optimal temperatures of 70-80°F. Between two and five days are required for a spore to germinate, infect, and cause a spot.

Once established in an orchard, Coryneum blight is difficult to eradicate. Infected buds and twigs may produce spores for 2 to 3 years. A conscientious annual program of chemical control with particular emphasis on fall sprays and removal of dead wood is necessary over a 3-year period to alleviate the problem. Summer sprays also may be needed until control has been obtained.

Cytospora Canker ("Gummosis")

Cytospora canker or gummosis is destructive on peaches and is important on sweet cherries, apricots, and plums. The canker is caused by a fungus (*Cytospora leucostoma*) which infects the tree bark. At least one-third of producing peach trees have cankers present on the trunks, scaffold limbs, or in the fruiting wood. The usual symptom is the amber gum, or gummosis, which flows from the infected area. Within a season or two, dieback occurs and the limb or tree becomes nonproductive and eventually dies.

Apples also can become infected with Cytospora canker, but without the gumming associated with the disease on stone fruit. The fungus kills the outer bark of branches and eventually may result in dieback as the infected branches become girdled.

Cytospora is a wound parasite -- it needs an injury to the bark to enter the tree. At this entry point the injured cells provide necessary food for the fungus spore to germinate and grow. This entry may be through low-temperature injury to the bark, pruning wounds, cultivation and implement wounds, borer damage, and spray injury. Yellow or amber gum indicates the presence of *Cytospora*, while clear gum indicates borer, low-temperature, or other physiological injury, at least initially (*Cytospora* frequently invades injured tissues within a few weeks). About 30 days after infection and the start of canker formation, fruiting bodies (pycnidia) have formed and a new crop of spores is ready for release.

Recent studies show that canker development can take place throughout the year. However, the greatest canker growth occurs in the spring as temperatures warm up and before tree activity resumes. Canker development is at a minimum during the summer when tree growth is greatest. Extensive gumming frequently shows up in early summer because of this rapid canker growth in the spring where there were no symptoms of canker the previous fall. Also, the studies indicate that active tree growth with woody tissue deposition and callus development creates a barrier that temporarily halts the fungus.

Studies of spore production and dissemination in the orchard using various trapping techniques have given us the following information:

(a) Viable *Cytospora* spores can be found on the surface of peach trees all year long, including during below-zero weather, with peak months being July through September.

(b) *Cytospora* spores are carried primarily by splashing rain, pruning tools, or insects.

This information suggests the following practical implications:

(a) Any surgical removal of cankers should be delayed until December-February to minimize possible reinfection of wounds;

(b) Trees are being "showered" with spores most of the year, so chemical protection is necessary following any severe damage to bark or pruning injury;

(c) Replanting of young peach trees in an older, infected orchard should be avoided wherever possible. The spore inoculum (for new infections) will be very heavy under such conditions and the resulting high number of infections on the young trees will be too costly;

(d) Delay of pruning until late winter-early spring greatly reduces risk of infection. The immediate use of wound dressings (See Stone Fruit recommendations, pages 8.6, 8.9, 8.12, & 8.21 under post pruning wound paint) on large cuts (over 2-3 cm diameter) is helpful, particularly if cuts are made in early winter. The period of lowest spore availability usually is between March and May and corresponds to the period of low relative humidity and temperatures below 85° F.

Studies continue attempts to find chemical and nonchemical controls to eradicate and prevent Cytospora canker. The following suggestions for canker control can be offered:

(a) Cultural practices -- promote early hardiness of trees in autumn; prune in late winter/early spring; use reflective paints on tree bark to prevent sunscald.

(b) Eradication -- surgically remove cankers where feasible, and prune off infected twigs and limbs.

(c) Use pruning wound dressings such as Benlate. Treatment of canker wounds after cutting and scrapping is particularly critical, and application generally should be repeated a day later. Be sure to round the incision edges especially around the top and bottom. Wounds with that shape heal more readily. For rates and other comments, see stone fruit Recommendation Tables on pages 8.6, 8.9, 8.12, and 8.21 under Cytospora canker.

(d) Fungicide sprays for protection of small pruning wounds during wet periods -- use at delayed dormant, petal fall, and shuck fall. For instructions on use of Benlate, see the stone fruit Recommendation Tables.

(e) Avoid injuries to trees -- replace cultivation close to tree trunks by chemical weed control.

(f) Control all borer insects.

Fireblight

Fireblight is caused by bacteria that kill the inner bark and, as a result, cause the shoots and foliage above the affected bark to become dried and blackened as though killed by fire. The disease is particularly destructive on apple, pear, and quince, but also has been reported on apricot, blackberry, cherry, chokecherry, *Cotoneaster* spp., crabapple, hawthorn, mountain ash, plum, *Pyracantha* spp., raspberry, serviceberry, and other plants in the rose family. Stone fruit infections are extremely rare. Susceptibility to fireblight varies greatly between varieties in pear, apple, and crabapple. For example, Bartlett and Bosc pears and Jonathan, Lodi, Rome Beauty, and Transparent apples are all highly susceptible to fireblight and require particular attention to avoid possible damage due to the disease. Occurrence and severity of fireblight appears to be greater and more regular along Colorado's front range.

The bacteria enter the plant through blossoms or wounds. They can multiply rapidly if weather conditions are favorable and move into the inner bark of adjoining branches and structures below the entry point. Optimum temperatures for bacterial growth are 70-81° F with little growth below 65° F or above 90-95° F. Free moisture or high relative humidity also favors bacterial growth with optimum growth at 80% or higher; usually, little growth occurs if the relative humidity is below 65%. Potential infection periods for fireblight, therefore, are those of 18 hrs or more in which the average hourly temperatures are 65-90° F with rain or with relative humidity above 65%. The closer these averages approach the optimum temperature and humidity values and the longer they continue, the greater the likelihood of blight development. Temperatures above 95° F and relative humidities below 65% appear to slow bacterial growth and aid the canker formation that walls off the infection.

Several kinds of fireblight can be defined according to the initial infection site; these include blossom blight, leaf/shoot blight, and fruit blight. Their probable occurrence changes through the season as the plant continues to grow and insect populations change. Bacteria are carried to blossoms by insects and, occasionally, by wind and rain. Leaf/shoot blight frequently starts in feeding wounds of sucking insects (e.g., pear psylla and green apple aphid) that feed on the succulent young growth and whose populations have not been adequately controlled. Hail damage of these shoots can also provide entry for the bacteria. Fruit blight generally begins when sucking insects such as stinkbugs or Lygus bugs feed on the developing fruit after their usual weed food sources dry up or are cut. Each of these kinds of blight can progress down the tree to progressively larger woody structures if weather

conditions remain favorable for disease development and the initial infection is not removed. Even if weather conditions change to allow the tree to stop the disease progression, drastic pruning and/or plant surgery are called for.

A control program for fireblight should include all the following measures:

1. Remove all limbs with blight during the dormant pruning season or as soon as they are observed. Make initial cuts 15-18 inches below any external evidence of blight and check for a reddish color in the cambial layer beneath the bark at that point. If found, active bacteria have probably already reached that point, and another cut lower on the limb/branch will be required. During times when trees are actively growing, tools MUST BE DISINFECTED AFTER EACH CUT or blight may be carried to other branches or trees throughout the orchard. Soak the tools in a dilute solution of household bleach (1 part bleach + 9 parts water) or alcohol (7 parts alcohol + 3 parts water) for at least 30 seconds or spray tools and cuts with Lysol disinfectant spray. Solutions should be made fresh daily and changed at least every 4 hrs. The alcohol solution and Lysol spray are less corrosive to pruning tools.

2. Cankers on the larger limbs and trunks should be removed by scraping, with care taken to get all the discolored tissue. Carry-over cankers should be treated during the dormant period. Pear orchards should be patrolled during the bloom period to locate any oozing cankers; these should be removed promptly and carefully by scraping, and the tools and cut surfaces disinfected. In summer, scrape cankers in hot, dry weather to minimize possible reinfection. In all cases, remove the outer bark down to the cambial layer and out to one inch beyond the canker margin. Be sure to make the cut as round in face view as possible in order to facilitate rapid healing.

3. Remove and burn all blighted prunings and canker residues from the orchard.

4. Avoid heavy applications of nitrogen fertilizer because such applications frequently stimulate excessive shoot growth and invite colonization by sucking insects. Only enough nitrogen should be added to produce 12-18 inches of terminal growth annually.

5. Control sucking insect populations before they reach critical levels. Those that live in the tree canopy should be controlled with a pest management program. Control of orchard weeds should also minimize insect pest populations that are likely to cause fruit blight. Pear suckers are particularly attractive to sucking insects, and failure to control sucker growth is an open invitation to fireblight infection within them and, eventually, other structures within the tree canopy itself.

6. Monitor orchard and weather conditions for those that favor blight development (e.g., if bloom or abundant succulent shoot growth or fruit with extensive hail or insect injury is present and mean daily temperatures are above 65° F combined with rain or relative humidities above 65%). When such occur, apply a suitable preventative bactericide such as streptomycin or fixed copper. In summer, spraying should be done in the cooler hours of the day to facilitate better absorption because of the slower drying conditions. Blossom sprays are effective for 3-5 days because new blossoms open and need protection if conditions continue to favor disease development. Foliage and fruit protective sprays are effective for 5-10 days and also may need to be repeated if conditions favorable to blight development continue. Sprays applied to protect either foliage/shoots or fruit may have to be repeated if moderate rain (.25-.5 inch) falls within 1-2 hours after application or if heavy rain (.75+ inch) falls within 8 hours after application.

NOTE: Streptomycin cannot be used within 30 days of harvest on pears or within 50 days of harvest on apples. Also, do not apply sprays containing copper to Anjou pears; russet may result. Some fruit growing regions have reported blight resistance to streptomycin. If resistance to streptomycin is suspected, contact Colorado State University Experiment Station personnel or

Cooperative Extension personnel for assistance in verifying the resistance and further information on recommendations.

Powdery Mildew (Apple, Apricot, Cherry, Peach, Pear)

Powdery mildew is caused by several different fungi that form a greyish-white powdery coating on terminal shoots and leaves. It also may form a network of lines (russet) on the fruit if the fruit are infected at relatively early stages of development. The powdery mat consists of fungal strands and spores which are microscopic in size. Because the spores are extremely numerous and easily spread by wind, many infections can occur. Thus the disease can become widespread and increasingly destructive. The most common and economically important type of powdery mildew in Colorado orchards is apple powdery mildew, caused by *Podosphaera leucotricha*. Powdery mildews on other fruit crops, caused by other related fungi, behave similarly with early control needed to avoid fruit damage on some nectarine, peach, and pear cultivars in certain situations.

Apples: Apple powdery mildew overwinters in the buds, making the fungus readily available to infect the unfolding leaves. The leaves are highly susceptible to infection until they are fully expanded, and those infected early in the season (primary infections) subsequently provide inoculum for the destructive secondary spread and disease build up. The fruit appears to be most susceptible to infection and eventual russet between full pink and about four weeks after petal fall; it is relatively unlikely that it will be infected or damaged after that point in its development. This is why varieties susceptible to fruit damage must be protected between pink and 4 weeks after petal fall. However, the fungus invades the buds for the following season when they begin to form in midsummer, and it remains in living bud tissues over winter, ready to resume the disease cycle the following spring. Heavy mildew infection means many buds will be infected, and these are more easily killed by winter temperatures. Substantial bud loss has been observed at OMRC on unsprayed Jonathan and Romes even though winter temperatures were not severe. Thus mildew protection considerations should not be limited to just the fruit and foliage.

Apple varieties differ in their sensitivity to powdery mildew. Jonathan, Rome Beauty, MacIntosh, Granny Smith, Akane, Fuji, Gala, and Braeburn are very susceptible to both foliar and fruit infection and require particular attention to avoid damage. Golden Delicious are also susceptible to fruit damage, but less so to foliar infection. Red Delicious varieties are rarely affected by powdery mildew unless the conditions strongly favor mildew development; of these, "Oregon Spur" and "Red Spur" cultivars were noted as having mildew infection during 1987 at OMRC.

Protection of current season foliage and fruit for these highly susceptible varieties is very important. Protective fungicides should be applied on a regular basis in order to protect newly formed buds and developing leaves. The spray program should be started in the green tip or pink stage to prevent early infections, and additional applications should be made at intervals of 2 weeks or less unless extensive infection and fruit damage was noted the previous year. In such cases, 7-10 day intervals between sprays early in the season may be needed to reduce infection levels to economically bearable levels. Sterol inhibitor or DMI fungicides (e.g., Bayleton 50WP, Nova 40WP, Rubigan 1EC, Procure 50WS) do have some curative properties; they both provide protection for the developing leaves, fruit, and buds and kill young infections that have already begun. However, such materials generally have limits on the amount that can be used within a season, and this needs to be considered in planning a spray program. They also are useable into the midsummer months when temperatures exceed 80° F and other materials are likely to cause fruit spray burn. Rubigan has an earlier cut-off date ("not after the second cover spray or 12 mm fruit diameter, whichever is earlier").

Pears: Like red Delicious apples, most pear varieties suffer relatively little economic damage from powdery mildew. But some varieties (e.g., Bartlett) can be attacked by the apple mildew and the fruit russetted to the point that economic loss is incurred. This generally is limited to situations where such pear varieties are planted adjacent to highly mildew susceptible apple varieties (e.g., Jonathan, MacIntosh, Rome, etc.). In such cases, incidence of economically damaging fruit russet usually is limited to a few rows immediately adjacent to the affected apples.

Fruit in the affected pear rows can be protected by: 1) controlling the mildew in the adjacent apple planting (not always possible if, for example, they belong to a different owner); and 2) by spraying these pear rows for mildew, beginning at bloom or petal fall and continuing until 4-6 weeks after petal fall. Good mildew control in the apples may not eliminate the need for mildew sprays in the pears, but it should greatly limit the number of pear rows to be sprayed.

Peaches / Nectarines: Dr. Norm Leupschen (former Colorado State University-OMRC plant pathologist) reported in 1979 that most mildew damage to peach and nectarine, at least in western Colorado, appears to be that associated with rusty spot, or fruit mildew. The disease apparently is associated with apple powdery mildew since its incidence almost invariably is highest in susceptible peach plantings within ¼ mile of highly mildew susceptible apple varieties (see the preceding discussion under pears).

The term "rusty spot" was used for this disease because dark reddish- or rusty-brown spots ("rusty" areas) are present on the fruit as it begins to mature. It affects only the immature peach / nectarine fruit and is particularly severe when high humidity and showers occur during spring and early summer. Fruit infections first appear as whitish or greyish powdery spots which become rusty brown. On peaches, the fruit skin can become hard and leathery beneath the rusty fuzz, and they will sometimes will lose their typical fuzz and become slick-skinned as the fruit matures. These spots were observed to become highly darkened on affected fruit floated through a sodium silicate dump bath on a packing line in western Colorado during 1987; they rendered the affected fruit unmarketable.

Best control of peach rusty spot is provided by not planting highly or moderately mildew susceptible peach cultivars (Table 9, p. 7.8) within ¼ mile of highly mildew susceptible apple cultivars (see discussion above). Where this is either not possible or already too late, a protective spray program will be needed. A rigorous mildew control program applied to susceptible apple plantings can greatly reduce rusty spot occurrence, but several protective sprays will be needed (at shuck-split and 7-10 day intervals thereafter) for highly susceptible peach cultivars. If periods of high humidity occur or are forecasted to occur before pit hardening, additional sprays should be considered. Moderately susceptible peach cultivars should be protected if they are close to apples with extensive uncontrolled (or poorly controlled) mildew and if periods of high humidity are forecasted. The sterol inhibitor fungicide Nova is now registered for use on cherry, peach and nectarine. It provides another excellent alternative for control.

Cherry (Sweet and Tart): Cherry powdery mildew differs from apple powdery mildew in at least three major ways. 1) It is caused by a different fungus, *Podosphaera oxycanthae*. 2) It does not overwinter in the cherry buds as apple mildew does in apple buds (based on recent research in Utah and Washington). 3) Control is possible by timing the start of bi-weekly sprays to the first observance of mildew on the leaves (Utah research by Dr. Sherm Thomson). This means that fewer spray applications may be needed for cherries than for apples, depending on the season.

The first cherry mildew infections of the season appear as small, isolated spots of whitish growth on the cherry leaves. These are not easily spotted unless the orchard is monitored very closely and the observer is very sharp-eyed. Close observation is needed to train the eye to see these early stages of mildew development.

Phytophthora Root and Crown Rots

Apples are more frequently damaged by crown rot than other fruit commodities, but pears, peaches, and cherries can also be affected. Fungi of the genus *Phytophthora* cause the disease; for apples, the causal organism is frequently *P. cactorum*. Regardless of which species is involved, the fungus invades and kills the cambium and inner bark region of the crown and crown roots. This effectively reduces the available food and water transport system between the root system and top of the tree. The tree is weakened and, with continued infection, eventually may die.

Apple & Pear: Readily visible signs of crown rot infection on apple and pear include poor growth with reduced leaf size, prematurely bronzed or reddened leaves, small and highly colored fruit, and weak tree anchorage. Less visible is the discolored tissue under the bark at or below the ground line.

This tissue (inward from the bark to the cambium layer) is tan in early infections but becomes dark brown as the infections age.

TABLE 9. Peach cultivars susceptible to fruit mildew (rusty spot).

	Highly* Susceptible	Moderately** Susceptible	Occasional Problem
Early Red Haven	x		
Golden Jubilee	x		
Havis	x		
Jefferson	x		
Jersey Glo	x		
Jim Wilson	x		
LaPremier	x		
Loring	x		
Redkist	x		
Redskin	x		
Rio-Oso-Gem	x		
Summer Beaut (white peach)	x		
Summer Queen	x		
Sweet Sue	x		
Washington	x		
Gleason Elberta	x -------- x		
Flamecrest		x	
Flavorcrest		x	
Suncrest		x	
Blake		x ------ x	
Cresthaven			x
Early Loring			x
Encore			x
Georgia Belle			x
Glohaven			x
Harbelle			x
Jim Dandee			x
July Elberta			x
Newhaven			x
Redglobe			x
Redhaven			x
Reliance			x
Roza			x
Topaz			x
Triogem			x

*Routine problem if planted near Jonathan, Rome, or other highly mildew susceptible apples. Requires a minimum of shuck split and/or shuck fall fungicide sprays plus possible additional sprays if humid weather conditions occur prior to pit hardening.

**May require fungicide sprays if near mildew susceptible apples and humid weather conditions occur.

Apples are most susceptible to crown rot attack during the period in the spring prior to bloom, as the trees are breaking dormancy. Their natural resistance is much greater outside this time period.

Control of crown rot on apple is best accomplished by avoiding use of susceptible rootstocks (MM104, MM106, M26) and through careful attention to irrigation procedures. For other tree fruits, attention to irrigation procedures is the best means of control. Furrows close to the trunk and long water sets (15-24 hrs) should be avoided, especially in heavy soils. Similarly, caution should be used not to overwater with microsprinklers. In some circumstances (e.g., where existing orchards have been planted on susceptible rootstocks), other measures may be required. These include:

1). Excavation of the affected crown and crown roots of infected trees during the summer months (prior to the first of August) to allow the affected tissues to dry out and stop spread of the infection. Remove infected tissue by scraping. The crown and crown roots should be covered with soil, gravel, or pumice again before winter in order to avoid winter damage to the trees. Pumice provides both insulation and drainage.

CAUTION: Do NOT apply herbicides around trees where crown roots have been exposed. They are very susceptible to damage from such.

2). Trunks of affected trees may be sprayed from ground level to 2-3 feet height with a fixed copper solution (53% copper at 6 lbs/100 gal of spray). Alternatively, the lower trunk and crown may be painted with a copper paint (1 lb basic copper + 1 gal water + 1 tablespoon of sticker or superior spray oil). Either of these should be done in fall so that the fall and winter rains will wash the copper down into the crown and root zone before the next spring infection period. These copper treatments may not always be effective.

3). Susceptible, fruit trees on susceptible rootstocks can now be protected from crown rot by application of metalaxyl (Ridomil 2E or 50W, Ciba-Geigy Corp.), a fungicide with preventative and some curative properties for crown rot. For apples, drench the soil in a 3 ft diameter circle at the base of the affected tree with the indicated amount of diluted spray (1 qt Ridomil 2E or 1 lb Ridomil 50W in 100 gal water). Supplemental moisture is necessary to move the chemical into the root areas, but precipitation may provide this. Two applications per year are recommended, the first in late dormant and the second in the fall after harvest.

Trunk Diameter	Amount Diluted Spray (per tree)
Less than 1 inch	1 qt.
1-3 inch	2 qt.
3-5 inch	3 qt.
Greater than 5 inch	4 qt.

For stone fruit trees, a banded application is recommended. The rate is 2 qt. Ridomil per treated acre. See the label for further information.

4) Apple and pear trees may be treated by foliar sprays with Fosetyl Al (Aliette 80W, Rhone-Poulenc Ag Co.) for control of crown rot. The rate is 5 lb product/acre on a 60 day interval or 2.5 lb product/acre on a 30 day interval. Up to four sprays may be applied per season with 60 day intervals beginning at the start of the growing season. Neither Aliette nor Ridomil have been extensively tested under Colorado conditions as yet.

Stone Fruits (Cherry, Peach, etc): Poor spring growth with small, yellowish and wilted leaves (for those trees where growth occurs) is one readily visible sign of possible *Phytophthora* root and crown rot in stone fruit trees. Occasionally, affected trees will have normal early season growth, but then will suddenly collapse and die during the first hot days of summer. Further examination of the crown and upper roots of these trees will reveal severely decayed roots, root rot, and/or extensive bark cankers on the lower trunk at or below the ground level. Occurrence of the problem is most likely in orchards that have been overwatered or that have poor internal drainage.

Few methods have been developed to control this disease for stone fruits. Avoidance of overwatering (overly long or frequent irrigation sets) is the primary means of control. For sweet cherries, avoid selection of Mahaleb rootstocks for use in sites with heavy, poorly drained soils. **Nonbearing** stone fruit trees may be treated with foliar applications of Aliette for control of *Phytophthora* root and crown rot. Further development of resistant rootstocks and chemical controls are being sought and may become available in the future.

Verticillium Wilt

Verticillium wilt, caused by the fungus *Verticillium dahliae*, can damage cherry, peach and plum trees. In western Colorado areas, sweet cherry have been more frequently subject to attack than peach or plum. The affected trees are not always killed, but the damage they sustain often is sufficient to reduce growth and productivity for several years. Younger trees (less than 10-12 years old) are more likely to be affected than older, mature trees.

The first obvious symptoms of Verticillium wilt are those that affect foliage and these typically appear with the arrival of hot, dry summer weather in mid-June to mid-July. Leaves at the bottom of current season shoot growth suddenly turn bright yellow or brown and drop; this progresses rapidly upwards toward the shoot tip, often stopping just before the end of the shoot and leaving a few green leaves at the tips of affected shoots. These affected shoots usually die back from the tip the second year from the damage sustained by the developing buds.

The reason for the rapid upward progression of leaf symptoms can be found if the sapwood (1-2 year old wood) of the larger affected branches in the lower part of the tree are examined. Brownish (or sometimes greyish) streaks are readily apparent when the branch is cut at a shallow angle (to provide an elongated oval/elliptical view of the cut end). These result from the fungus clogging the branch vascular system and restricting upward movement of the water (and nutrients) so greatly needed by the leaves because of their high rate of water loss under the hot dry conditions. The sapwood discoloration provides the final and most definitive evidence that Verticillium wilt is indeed the problem.

Verticillium dahliae is a fairly common, soil-inhabiting fungus. It produces both spores that are carried by water to other field areas and drought-resistant structures (sclerotia) which can survive for 2-3 years in the soil. It can build to very high population levels in soils where susceptible crops (eggplant, pepper, potato, raspberry, strawberry, tomato and stonefruit trees) or weeds (geranium, groundcherry, lambsquarters, phlox, pigweed, and shepherds purse) are or have grown. The fungus invades susceptible plants through the roots and high population levels increase the likelihood of successful attack on roots of woody plants such as stone fruit trees.

No chemical control is available for Verticillium wilt although preplant soil fumigation (with methyl bromide or other fumigant that is active against fungi) can reduce soil populations of the causal fungus. Once a tree is infected, treatment is limited to removing severely affected branches and maintaining adequate (but not excessive) soil moisture and balanced soil nutrition. Sometimes this will allow affected trees to recover, but the damage often requires redevelopment of replacement scaffold limbs -- a process that takes years. The best control is therefore to reduce the chances of disease through preventative measures. Maintenance of proper soil moisture and nutrition has already been pointed out; our heavier clay soils can lead to excessively wet soil conditions if care is not taken. Similarly, avoid high nitrogen fertilization, severe pruning, and any other practices that lead to excessive succulent shoot growth. Maintain good control of susceptible weeds. And, if a new planting is planned, avoid planting in soils where susceptible plants have been growing unless a 2-3 year rotation with a non-susceptible crop (e.g., a grass or grain crop) has just been completed.

Replant Problems

Orchardists in Colorado and elsewhere have found that fruit trees do not grow well for several years if planted back into ground used for that same type of crop (e.g., apple after apple, peach after peach). In the past, growers either put up with poor replant tree growth or rotated the land to other crop uses. Shrinking economic margins in the fruit industry have made it necessary to re-evaluate this

approach. No longer can a grower afford to lose those first several years to poor tree growth, especially when working with fruit crops that typically do not begin producing until their 5th to 7th leaf (e.g., apple, cherry, pear). Needed answers for poor replant tree growth are provided by research in several fruit-growing regions.

Early tree growth in replant situations can be significantly increased by attention to several factors. Soil tests should be made to determine soil nutrition, pH, and salt levels. Soil texture and tilth must be considered; high clay content and heavily compacted soils (soils with hardpan or caliche layers) are more difficult for water and roots to penetrate and have less natural aeration (less available oxygen) than sandy soils. Many western Colorado fruit-producing soils fit the first category. These need to be subsoiled (ripped) 3-4 ft deep and/or individual replant tree holes excavated (backhoed, 3 X 3 X 3 ft) and refilled.

Replant site soils may need to be treated with a nematicide or soil fumigant to reduce undesirable plant parasitic nematodes (soil eelworms), fungi, and/or bacteria within them. These organisms can feed on young roots of the new trees and cause stress to the newly replanted trees. Nematode populations can be determined by evaluation of soil samples collected a week or so after irrigation during July. Arrangements would need to be made with nematology services out-of-state since no such services are currently available within Colorado. Several nematicides and soil fumigants are available, but most (if not all) are restricted use materials (e.g., Nemacur, Telone, chloropicrin, and all formulations of methyl bromide). EXTREME CAUTION SHOULD BE USED WITH ANY OF THESE MATERIALS! Fumigants such as the methyl bromide formulations are extremely volatile at temperatures above 40° F and are hazardous to the applicator (and others!) if used without precautions. The fumigants are injected at 18 inch depth into loosened soil during the fall and dissipate from the soil in the replant hole prior to spring planting.

In Colorado, peaches and some apricots have responded well to soil fumigation with methyl bromide or chloropicrin; a 300-400% growth increase through year 6 and a 400% increase in fruit production during year 4 have been seen in several orchards. Response of apples, on the other hand, has not been impressive thus far. Soil temperatures at time of fumigation must be at least 50° F; best results are obtained if soil temperature is 60° F or warmer. Methyl bromide and chloropicrin fumigants work best if heavy clay soils are loosened by excavation prior to fumigation, and excavation provides the additional benefits mentioned above with regard to soil tilth.

Current replant recommendations are as follows:

1. Obtain a soil test for the targeted replant block (check with your local Colorado State University Cooperative Extension office for information and materials).

2. If previous crop shows evidence of knots on tree roots or of nematode-vectored tree fruit virus diseases (e.g., cherry rasp leaf, cherry stem pitting, apple union necrosis, graft union incompatibilities on peach, apricot, cherry, or apple), contact Dr. Larsen at the Orchard Mesa Research Center for further pre-plant soil survey recommendations.

3. Plan to remove previous trees in sufficient time to allow for subsoiling or excavation of the new tree sites (recommended hole size, 3' X 3' X 3') before fall rains arrive. A subsoiled band of soil in the new row, 3' deep x 3' wide, may also be satisfactory.

4. In fall before soil temperatures drop below 50° F, treat moist, loosened soil with appropriate nematicides or fumigants.

   Apple, pear, cherry, & plum: Insufficient data for recommendation on fumigants at this time. Trees should respond to site excavation in most cases.

   Apricot, peach \ nectarine: Inject 0.5 - 1.0 lb of 98:2 methyl bromide:chloropicrin or chloropicrin 18 inches deep at each previously excavated tree hole. Alternatively, one can shank inject 1 lb fumigant per 10 feet of row at 18 inch depth down each intended row; seal the shank rip-marks to prevent fumigant escape. Note quarantine on importation of nectarine, cling and white-fleshed peach trees into Mesa County at present time.

Anthracnose and Perennial Canker

Anthracnose and perennial canker are bark diseases of apple. Neither have been very common in Colorado orchards, although anthracnose-like symptoms have been found in some areas following years with higher fall precipitation. Apple varieties with more tender bark are more susceptible to damage by anthracnose, while apple varieties do not appear to differ in susceptibility to perennial canker.

Anthracnose damage, caused by the fungus *Neofabraea malicorticis*, usually lasts for only a few years as the tree produces new bark tissue from beneath or along the edge of the infection and as the older, killed bark tissue is sloughed away. It is found on the outer bark of twigs and young branches under three inches in diameter.

Perennial canker damage, caused by the closely related fungus *Neofabraea perennans*, is much longer lasting because wooly apple aphids feed on the wound callus at the edge of the canker and cause reinfection of this tissue. This reinfection process continues each year that the aphids are not controlled until the branch is girdled; the continually increasing, concentric rings of callus tissue give the disease its name -- perennial canker.

Anthracnose is characterized by formation of an elongate canker with whitish 'guitar strings', clusters of bast fibers in the bark tissue. These bast fibers run the length of the canker and are exposed through gradual disintegration of the affected bark. Infection usually starts during fall rainy periods as a small, circular, reddish-brown spot on the outer bark tissue. This spot enlarges and elongates along the branch during the spring sap flow until the tree resumes active growth. A well-marked crack then forms and delimits the canker from the surrounding healthy tissue, and the shrunken and shrivelled canker surface gradually breaks up and sloughs off as the season progresses.

During summer, numerous tiny conical pimples or pustules appear on the center of the canker surface and spread to the margins. These finally crack the skin of the bark in triangular or crosswise slits and expose the underlying creamy-white mass of fungus tissue and exuded spores. The spores mature in late summer and early fall and are scattered by wind and rain. Cankers older than one year do not normally extend any further, but can continue to produce spores for the next year. On first year twigs, the dead bark usually drops away in the second or third year to reveal the underlying wood or disintegrates to leave the guitar-string-like bast fibers of the bark stretched lengthwise in the canker. On older branches, the infection may not penetrate to the wood; in such cases, new bark tissue is produced beneath the killed bark tissue, and the bast fibers are left stretched across the healing canker.

Both diseases can be prevented, but no curative materials are available. Control of anthracnose generally can be obtained with sprays of copper compounds after harvest. Control of perennial canker requires control of the wooly aphid; if this pest is not permitted to colonize the new wound callus tissues, no new infection can take place and the disease can be eliminated within a year or so.

Both of these fungi can cause a storage disease of apple and pear known as bull's eye rot. This is not a common problem in Colorado at this time. Should it become a problem, protective sprays applied between petal fall and about a month later and again from about mid-August until harvest may be needed.

Apple Scab

Scab is NOT a major disease of apples in Colorado although it is elsewhere. It is most severe in areas where cool humid weather commonly occurs during the spring months. However, it was observed in 1990 on crabapple leaf samples from the Durango area and could occur in other more moist areas of the state or if abnormally moist weather conditions were to occur over several years in a row.

Fruit damage resembling that caused by apple scab has been reported to Extension agents in the Fremont County Cooperative Extension office; however, the problem has NOT been positively identified as apple scab yet. Suspected cases of apple scab anywhere in Colorado should be forwarded

through the local Cooperative Extension office to Dr. Harold Larsen at the Orchard Mesa Research Center. Specific recommendations on spray materials, rates, and timing will be made on an individual locality basis where apple scab occurrence is confirmed and controls needed.

The most obvious symptoms occur on the leaves and fruit. Domestic apples, flowering crabapples, hawthorn, firethorn (*Pyracantha* spp.), and mountain ash all can be infected by *Venturia inaequalis*, the fungus that causes the disease. Leaf infections consist of velvety brown to olive green spots that look like dark mold on the leaf surface; infected leaves become deformed as the infections age and may appear curled, dwarfed, or otherwise distorted where numerous infections occur on young leaves. Fruit infections begin as similar velvety brown to olive green spots that become brown and corky with cracks often (but not always) appearing in the skin and flesh. Late season infections may produce very small spots (known as pin-point scab) that may not become visible until the fruit is in storage.

The fungus overwinters as fruiting body initials within infected leaves and fruit on the orchard floor. Moisture is required for development of these initials and for spore production in the spring; a surface film of water is also needed for spore germination on the new leaves and/or fruit. A minimum of 5.9 hours of wetting are required for germination of secondary spores (conidia) at temperatures between 60 and 75° F. Longer times are needed at other temperatures and early in the season; 9 or more hours of continuous wetting are needed for germination of the primary spores at the same temperature range early in the growing season. Initial and secondary infections quickly begin to produce the secondary spores (within 9 to 17 days), and these conidia are the main means of disease spread during the summer months.

Apple scab can be minimized by use of scab-resistant apple cultivars and reduced by use of good orchard sanitation practices, but control usually requires the use of a fungicide spray program. Some newer cultivars are more resistant to apple scab; the best of these at present include 'Liberty' and 'Prima', but several others may become available in the near future. Elimination of diseased leaves and/or fruit on the orchard floor is good general policy. This can be done by raking and burning, disking (in clean cultivated orchards), or accelerating the rotting process through the application of nitrogen (e.g., as urea) to the fallen leaves in areas where winter temperatures are mild and moisture is enough to at least partially rot the leaves. Often, however, neither horticultural approach is effective on a commercial basis, and fungicide sprays are needed.

Correct timing is essential for good control; early season control of the primary infections greatly reduces secondary and pin-point scab infections. The period between the start of bud growth and when the young apples are 12 mm in diameter is the most critical. Either protective or post infection eradicative spray materials or both can be used. Protective materials are applied as soon as susceptible tissue is exposed in the spring and every 7-10 days throughout the season if scab is present on the leaves or until all primary spores are gone. The post infection approach requires accurate monitoring of orchard temperatures and the length of time the leaves remain wet. Hourly observations provide the most accurate data for determining when an infection period has occurred, and periods of leaf wetness should be added together (considered as a single wet period) if less than 8 hours of dry conditions separate them.

Materials used for preventative sprays include Captan, Benlate, and Cyprex. Of these, Benlate should be used only with caution because of possible resistance problems. Post infection chemical options presently include Cyprex, Funginex, Nova, and Rubigan. Their "reach-back" abilities range from 36 hours (Cyprex) to 96 hours (Nova).

Phytoplasma and Phytoplasma-Like-Organism (PLO) Diseases

Phytoplasmas and PLO's are very small organisms with a size between that of bacteria and viruses. Those that infect plants are spread by sucking insects such as pear psylla and leafhoppers. They often have broad host ranges (both herbaceous and woody plants, weeds, crops, and ornamentals). Fruit diseases caused by PLO's include X-disease, pear decline, and apple decline; other "yellows"-types of diseases are generally linked with PLO's and can affect a broad range of plant types.

Symptoms of PLO infection are quite varied and depend on both the specific PLO and the host plant. They can include foliar symptoms (leaf size, color, leaf rolling, and premature leaf reddening and drop), shoot growth pattern symptoms (shoot proliferation or witches broom formation), bud winter hardiness (often reduced), and general tree health (gradual dieback or even rapid tree death). Loss of fruit production is often noted and can in some cases be severe.

Control of PLO diseases is difficult. The only chemical control option identified thus far is injection of the infected plant with tetracycline; this material currently is registered only in states other than Colorado and for use only in pear and stone fruits, and the response typically lasts only a year or so. Thus other aspects must be used for effective control. These include control of the vector insects, control or removal of infected host plants (weeds, infected alternate hosts or crop plants), selection of rootstocks and cultivars that are less likely to have problems with the given PLO disease, and modification of cultural practices (irrigation and fertilization).

X-Disease of Stone Fruits

Although all stone fruits are susceptible to damage and loss from X-disease infection, crop losses are most severe in cherries (especially sweet cherries on Mahaleb rootstocks) and peaches / nectarines. Plums and apricots generally decline gradually over a long period of time and therefore can serve as a potential source of inoculum for the disease.

Sweet cherries on Mahaleb have the most rapid, severe response to infection with the X-disease PLO. Such trees are noted to suddenly collapse and die with the arrival of hot summer weather just about harvest. Additional symptoms include formation of a "zipper"-like irregularity at the graft union which develops a blackened or dark brown line as the tree collapses. This is apparently due to a tissue rejection of the X-disease PLO by the Mahaleb rootstock and the formation of a barrier at the graft union by the rootstock which cuts off the flow of water and nutrients up to the infected top part of the tree. The fruit clusters on infected trees is also characterized by a tendency to have fruit that ripens at different times, even within the same fruit cluster.

Sweet cherry on Mazzard rootstock, however, does not develop any such reaction at the graft union and does not collapse suddenly. Instead, infected trees decline gradually over a period of several years. They do exhibit irregular fruit ripening and dieback of branches and scaffolds. Fruit set is reduced and the trees quickly become non-thrifty. Infected trees can serve as a source of infection to surrounding healthy trees if left in the orchard. Quick removal of such infected trees is recommended after they have been sprayed with Sevin or some other insecticide effective on leafhoppers to kill those that might move to healthy trees and spread the disease if the tree is cut down. Treatment with tetracycline is not legal in Colorado as the materials have not been registered for use on stone fruits here.

Tart cherries are similar to sweet cherries on Mazzard rootstock in their reaction to the X-disease PLO. Their decline is generally gradual. They may exhibit some leaf chlorosis and shotholing plus some leaf drop from the shoot base toward the shoot tip. Fertilization and irrigation after such has been observed may induce shoot proliferation or witches broom formation at the shoot tips. Irregular fruit ripening is also quite common. Tart cherry can also be a source of inoculum, and infected trees should be removed using the same precautions as for the sweet cherries given above.

Peaches and nectarines infected with X-disease exhibit a series of symptoms. Initial symptoms appear after about 2 months of growth, usually on a single scaffold branch in which the infection began. Leaves on these branches begin to curl inward (looking as though they were drought stressed) and develop irregular (**not** round) pale-green to yellowish to reddish purple spots in the blade tissues. These spots soon die and drop out to give a shot-holed appearance to the leaf. As the season progresses, more spots develop and drop out of the leaf, and the newer leaves begin to show symptoms also. Eventually, the tattered leaves begin to drop from the shoots, starting at the base of the shoot and progressing toward the shoot tip. By August, the more vigorous shoots may have only a terminal tuft of leaves left while the weaker shoots usually have no leaves left. Although fruit set on affected branches may at first appear normal, final production at harvest will be lower because of premature fruit drop. Those that remain will be slower to ripen, smaller in size, and have much poorer flavor.

The infection usually takes several years to spread throughout a mature tree. Bud hardiness is reduced and affected trees experience increased winter kill and scaffold dieback over the next several years. Such trees often die gradually over four to six years. It has not yet been shown that such infected peach and nectarine trees can serve as a source of inoculum for spread of the disease, so it may not be necessary to remove such infected trees to avoid disease spread.

Apricot and plum generally exhibit few symptoms other than gradual dieback or increased winter kill. However, any trees that develop premature fall leaf colors, shortened internodal growth, or witches brooming should be checked out for possible infection.

Thus far, four leafhopper species known to serve as X-PLO vectors in other areas have been found in Colorado orchards and adjacent areas. Which leafhoppers are the actual vectors of X-disease in Colorado is not yet known. This complicates the control problems because that information is needed to identify both the hosts for the leafhopper vectors and the timing and composition of sprays needed to control them. However, all weeds should be controlled within and around the orchard. Since leafhoppers are fairly non-specific about the plants on which they feed, control of the weeds should keep leafhopper populations down at least some.

Pear Decline

Pear decline is less a problem in Colorado pear orchards now than it was during the late 1960's and 70's. This is due both to a greater attention to control of the pear psylla vector and to the removal of pear trees on oriental rootstocks. Nevertheless, the disease is seen occasionally in pear orchards on the western slopes. Because of the lower incidence of pear decline now, fruit and tree losses to this disease are not great. However, continued attention is needed on to control of the pear psylla vector in order to avoid another outbreak of the disease.

Pear decline is most easily recognized by the development of premature leaf reddening or purpling (late August to early September) on affected limbs or scaffolds. However, infected trees can also have yellowish leaf color earlier in the season, low vigor, and erratic bloom beginning the spring following infection. They frequently also have reduced shoot growth and small fruit. Infected trees on oriental or quince rootstocks usually have leaves strongly downward curled and thickened as well as a distinct brown line at the graft union; they die back rapidly over several seasons. Infected trees on other rootstocks may have a zipper-like irregularity at the graft union and gradually lose vigor over several years.

Four major aspects are involved in effective control of pear decline: vector control, modification of orchard cultural practices, selection of tolerant rootstocks, and chemical treatment. Very little pear decline is found in mature, well-cared-for trees where pear psylla is closely controlled. Attention to good orchard cultural practices helps affected trees compensate for damage done by the infection. Field observations in California have noted that increased nitrogen fertilization, more frequent irrigation, reduced crop load through heavy pruning, and good mite control all help to maintain crop quality and increase tree longevity in decline-affected orchards. Selection of decline-tolerant rootstocks in areas where such will not grow too vigorously is also beneficial. Finally, postharvest tree injections of oxytetracycline can reduce symptom severity for a year or two, but need to be repeated periodically thereafter for the life of the tree. However, such treatments historically were not as successful in Colorado pear orchards, and registration of tetracycline for pear decline tree injection in Colorado was allowed to lapse several years ago. Thus, this option is not available here at present.

Apple

PEST OR DISEASE	MATERIALS	RATE PER ACRE	RATE PER 100 GAL. (DILUTE)[1]	REMARKS
Delayed Dormant Stage (Stages 1-2)				
Rosy Apple Aphid European red mite San Jose scale Leafrollers Blister mites	Superior oil + one of the following:	4-6 gal.	1-1.5 gal.	Asana is not labeled for and may not control blister mites. Lorsban 4E - use at least 1.5 pt./acre.
	● Asana XL	4.8-14.5 fl.oz.	1.2-3.6 fl.oz.	
	● Lorsban 4E	2-4 pt.	.5-1 pt.	
	● Cygon/Dimethoate 25W	4 lb.	1-2 lb.	
	● Supracide 2E	4-8 pt.	1-2 pt.	
	● Diazinon 50W	4 lb.	1 lb.	
	● Ethion 25W	2-3 lb.	1 lb.	
	● endosulfan (Endosulfan, Thiodan) 50W	4-5 lb.	1 lb.	
Powdery Mildew	● Wettable Sulfur	8-16 lb.ai	See label	Many different sulfur product formulations are available; see the label for specific rates of these materials. Application limits per acre per season: Bayleton - 24 oz., Nova - 80 oz., Rubigan - 84 fl.oz., & Procure 64 oz. Funginex - 5 application maximum (Do NOT use after petal fall). General effective life is 7-10 days for the first four materials and 10-14 days for the other materials unless trees and fruit are growing very rapidly. Minimum spray concentration for Rubigan is 3 fl.oz./100 gal.
	● Flowable Sulfur	8-16 lb.ai	See label	
	● Bayleton 50DF	4-6 oz.	1-1.5 oz.	
	● Rubigan 1E	6-12 fl.oz.	3 fl.oz.	
	● Nova 40W	5-10 oz.	1.25-2.5 oz.	
	△ Procure 50WS	8-16 oz.	2-4 oz.	
	△ Funginex	36-40 fl.oz.	10 fl.oz	
Collar Rot	△ Ridomil 2E	----	1 qt.	Ridomil: 1-4 qts. spray/tree (See text, p. 7.9). Kocide: 4 gal. spray/ tree. Apply to a 3 ft. circle of soil around trunk before growth (in spring) and after harvest (Sept.- Oct.)
	or 50W	----	1 lb.	
	△ Kocide 101 or DF	----	4 lb.	
	△ Kocide 606	----	2.5 qt.	
Pink Stage (Stages 4-5)				
Rosy apple aphid Lygus bugs Stink bugs Leafrollers	● Diazinon 50WP	4 lb.	1 lb.	Note 101 fl.oz./Acre/Season limit for Asana.
	● dimethoate 4E,	2-4 pt.	0.5-1 pt.	
	(Cygon/Dimethoate) 25W	4 lb.	1-2 lb	
	or (Dimethoate) 2.67E	3 pt.	12 fl.oz.	
	● endosulfan (Endosulfan, Thiodan) 50W	3-4 lb.	1 lb.	
	● Asana XL	4.8-14.5 fl.oz.	1.2-3.6 fl.oz.	
	● permethrin (Ambush) 2E	13-25 fl.oz.	3.2-6.4 fl.oz.	
	or (Pounce) 3.2E	4-8 fl.oz.	1-2 fl.oz.	
	or (Ambush, Pounce) 25W	6.4-12.8 oz.	1.6-3.2 oz.	

[1]based on 400 gallons per acre with average-sized trees.

△Product not evaluated by CSU personnel under Colorado conditions, but found to be effective elsewhere.

Apple

PEST OR DISEASE	MATERIALS	RATE PER ACRE	RATE PER 100 GAL. (DILUTE)[1]	REMARKS
Pink Stage (Stages 4-6) (Continued)				
Codling moth	● Isomate-C Plus	400 dispensers		Isomate-C Plus pheromone dispensers must be in place before the first moth flight. Place within 2 feet of the top of the canopy. If the orchard has a history of codling moth problems, use one or two conventional insecticide sprays against the first generation in the first year. If a codling moth source exists nearby, use border sprays of conventional insecticides. Monitor the orchard with pheromone traps using a 10-mg lure set at mid-canopy height. If more than six moths are captured in traps, check the orchard for fruit damage or apply a conventional insecticide. If damage exceed 1% at the end of the first generation, use conventional insecticides to control the second and subsequent generations. A second application of Isomate-C Plus may be needed against the second generation if temperatures are high and damage at the end of the first generation exceeds 0.5%.
Powdery mildew	● Wettable sulfur ● Flowable sulfur ● Benlate 50W + Oil ● Bayleton 50W ● Rubigan 1E ● Nova 40W △ Procure 50WS △ Funginex	8-16 lb.ai 8-16 lb.ai 12 oz. + 1 gal. 4-6 oz. 9-12 fl.oz. 5-10 oz. 8-16 oz. 36-40 fl.oz.	See label See label 3 oz. + 1 qt. 1-1.5 oz. 2.25-3 fl.oz. 1.25-2.5 oz. 2-4 oz. 10 fl.oz.	Many sulfur products are available; see the labels for specific rates of these materials. Use the first four options at 7-10 day intervals and the other options at 10-14 day intervals. Note the following product limits per Acre/Season: Bayleton - 24 oz., Rubigan - 84 fl.oz., Nova - 80 oz., Procure - 64 oz., Funginex - 5 application maximum (Do NOT apply after petal fall). Minimum spray concentration for Rubigan is 3 fl.oz./100 gal.

[1]based on 400 gallons per acre with average sized trees.

△Product not evaluated by CSU personnel under Colorado conditions, but found to be effective elsewhere.

Apple

PEST OR DISEASE	MATERIALS	RATE PER ACRE	RATE PER 100 GAL. (DILUTE)[1]	REMARKS
Pink Stage (Stages 4-6) (Continued)				
Crown rot	△ Aliette WDG	2.5-5.0 lb.		Use low rate on 30 day interval, high rate on 60 day interval. Do not apply with, prior to, or after copper fungicides. Do not apply within 2-3 weeks of leaf senescence. Do not allow livestock to graze on treated orchards. Season limit: 20 lbs/acre. See Text (page 7.9).
Blossom Stage (Stage 7)				
Fire Blight	● Streptomycin 17W	---	8 oz.	Recommended rate is at 100 ppm concentration. Start copper sprays at 10% bloom and repeat at 5-day intervals until bloom is over.
	△ Basic Copper 53WP	2 lb.	0.5 lb.	
Calyx to Petal Fall Period (Stages 5-9)				
Powdery mildew	● Wettable sulfur	8-16 lb.ai	See label	Many sulfur products are available; see the labels for specific rates. Use the first four options at 7-10 day intervals and the other options at 10-14 day intervals. Note the following product limits per Acre/Season: Bayleton - 24 oz., Rubigan -84 fl.oz., Nova - 80 oz., Procure - 64 oz., Funginex - 5 application maximum (Not after petal fall). Minimum spray concentration for Rubigan is 3 fl.oz./100 gal.
	● Flowable sulfur	8-16 lb.ai	See label	
	△ Funginex	36-40 fl.oz.	10 fl.oz.	
	● Benlate 50W + Oil	12 oz. + 1 gal.	3 oz. + 1 qt.	
	● Bayleton 50DF	4-6 oz.	1-1.5 oz.	
	● Rubigan 1E	6-12 fl.oz.	3 fl.oz.	
	● Nova 40W	5-10 oz.	1.25-2.5 oz.	
	△ Procure 50WS	8-16 oz.	2-4 oz.	
Climbing cutworms	● Diazinon 50W	4 lb.	1 lb.	Note the 101 fl.oz./Acre season limit for Asana.
	● Asana XL	4.8-14.5 fl.oz.	1.2-3.6 fl.oz.	
	● permethrin (Pounce) 3.2E	4-8 fl.oz.	1-2 fl.oz.	
	(Ambush) 2E	13-25 fl.oz.	3.2-6.4 fl.oz.	
	or (Ambush, Pounce) 25W	6.4-12.8 oz.	1.6-3.2 oz.	
Campylomma bug, Lygus bug, Stink bug	● azinphos methyl (Azinphos-M, Guthion) 50W	2-3 lb.	8-12 oz.	Apply as needed after survey in late bloom. Season limits/acre: azinphos methyl 50W - 12 lb.
	● endosulfan (Endosulfan, Thiodan) 50W	2 lb.	8 oz.	
	● Diazinon 50W	4 lb.	1 lb.	
	● Lorsban 50W	3 lb.	12 oz.	

[1]based on 400 gallons per acre with average-sized trees.

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Apple

PEST OR DISEASE	MATERIALS	RATE PER ACRE	RATE PER 100 GAL. (DILUTE)[1]	REMARKS
Post-Petal Fall Sprays				
Aphids	● dimethoate 4E or (Cygon/Dimethoate) 25W or (Dimethoate) 2.67E ● Diazinon 50W ● endosulfan (Endosulfan, Thiodan) 50W ● Asana XL ● Provado 1.6E	2-4 pt. 4-6 lbs. 3-6 pt. 4 lb. 3 lb. 4.8-14.5 fl.oz. 8 fl.oz.	0.5-1 pt. 1-2 lbs. 12-24 oz. 1 lb. 12 oz. 1.2-3.6 fl.oz. 2 fl.oz.	Note season limits per acre: Asana - 101 fl.oz., endosulfan - 8 lb., Provado - 40 fl.oz.
Codling moth Leafrollers	● azinphos methyl (Azinphos-M, Guthion) 50W ● Imidan 50W or 70W ● Diazinon 50W ● Asana XL ● Penncap-M 2F ● Lorsban 50W	2-3 lb. 4-6 lb. 3-5 lb. 4 lb. 4.8-14.5 fl.oz. 4-8 pt. 3 lb.	8-12 oz. 1-1.5 lb. .75-1.25 lb. 1 lb. 1.2-3.6 fl.oz. 1-2 pt. 12 oz.	Timing for Codling Moth sprays may be obtained from your local Code-A-Phone Numbers. Delta and Montrose Counties: 244-1709 Mesa County: 244-1806 Note season application limits (per acre): Asana - 101 fl.oz., azinphos methyl 50W - 12 lb.
Two spotted spider mite European red mite	● Vendex 50W ● Carzol 92SP ● Morestan 25W ● Ethion 25W ● Kelthane 35W	1-3 lb. 1-2 lb. 2-4 lb. 4 lb. 5-8 lb.	4-12 oz. 4-8 oz. 8-16 oz. 1 lb. 1.25-2 lb.	Kelthane rate varies with tree size; see label. Vendex - maximum of 4 applications/season (3 between petal fall and harvest).
Tentiform leafminer	● Asana XL ● Vydate 2L ● Lannate 90SP or 2.4LV ● Provado 1.6F	4.8-14.5 fl.oz. 2-4 pt. 4 lb. 1.5-3 pt. 8 oz.	1.2-3.6 fl.oz. 0.5-1 pt. 8 oz. 6-12 fl.oz. 2 fl.oz.	Note season limits/acre: Asana - 101 fl.oz., Provado - 40 fl.oz., Vydate - 8 pt.
White Apple leafhopper	● Asana XL ● Diazinon 50W ● endosulfan (Endosulfan Thiodan) 50W ● Carzol 92SP ● Provado 1.6F	4.8-14.5 fl.oz. 4 lb. 4 lb. 1 lb. 8 fl.oz.	1.2-3.6 fl.oz. 1 lb. 1 lb. 4 oz. 2 fl.oz.	Note season limits/acre: Asana - 101 fl.oz., endosulfan - 8 lb., Provado - 40 fl.oz.
Crown rot	△ Aliette WDG	2.5-5.0 lb.		Use low rate on 30 day interval, high rate on 60 day interval. Do not apply within 2-3 weeks of leaf senescence. Do not allow livestock to graze in treated orchards. Season limit: 20 lbs/acre. See Text (page 7.9).

[1]based on 400 gallons per acre with average-sized trees.

△Product not evaluated by CSU personnel under Colorado conditions, but found to be effective elsewhere.

Apple

PEST OR DISEASE	MATERIALS	RATE PER ACRE	RATE PER 100 GAL. (DILUTE)[1]	REMARKS
Post-Petal Fall Sprays (Continued)				
Powdery mildew	● Flowable sulfur ● Benlate 50W + Oil ● Bayleton 50DF ● Rubigan 1E ●Nova 40W △ Procure 50WS	8-16 lb.ai 12 oz. + 1 gal. 4-6 oz. 6-12 fl.oz. 5-10 oz. 8-16 oz.	Various-see label 3 oz. + 1 qt. 1-1.5 oz. 3 fl.oz. 1.25-2.5 oz. 2-4 oz.	See remarks on sulfur for delayed dormant spray. Use a 7-10 day interval for Sulfurs, a 10-14 day interval for the others. Avoid use of sulfur products when daily temperatures exceed 85°F. Product limits/acre/season: Bayleton - 24 oz; Rubigan - 84 fl.oz; Nova - 80 oz.; Procure - 64 oz. Minimum spray concentration for Rubigan is 3 fl.oz./100 gal.
Fire Blight	● Streptomycin 17W	---	8 oz. (100 ppm)	Do not use later than 50 days before harvest.
Post Harvest (Leaf Fall) Sprays				
Anthracnose	△ Kocide 101 or DF △ Basic copper 53WP	12-16 lbs. 3-4 lb.	3-4 lbs. 0.75-1 lb.	Apply as aerial spray before fall rains to twigs/branches/scaffolds at 400 gal./acre.
Crown rot	△ Ridomil 2E or 50W △ Kocide 101 or DF △ Kocide 606	---- ---- ---- ----	1 qt. 1 lb. 4 lb. 2.5 qt.	Apply as a trunk or crown drench before fall rains. Ridomil: 1-4 qts./tree (see text, page 7.9); Kocide: 4 gal./tree.

[1]based on 400 gallons per acre with average-sized trees.

△Product not evaluated by CSU personnel under Colorado conditions, but found to be effective elsewhere.

Apricot

PEST OR DISEASE	MATERIALS	RATE PER ACRE	RATE PER 100 GAL. (DILUTE)[1]	REMARKS
Dormant Stage (Stage 0)				
Cytospora canker	Post-pruning wound treatment paint: ● Benlate 50W		0.5-1 Tbsp. per gallon of carrier liquid.	Apply slurry to pruning cuts with a paint brush immediately after pruning. Carrier liquid may be spray oil or interior white latex paint diluted 1 part paint to 2 parts water.
Scale Brown mite eggs Aphid eggs	● Superior Oil + Diazinon 50W	8 gal. + 4 lb.	2 gal. + 1 lb.	Will also give some suppression of twig borer.
Coryneum blight	● Bravo 500F or 720F △ Ensign 720F △ Basic Copper 53WP	4-6 pt 3-4 pt. 3.13-4.13 pt. 12-16 lb.	1.5-2 pt. 12-16 fl.oz. 1-1.38 pt. 3-4 lb.	When conditions favor high disease levels, use high rate of application once or twice in mid- to late-winter. Dilute rate for Ensign is based on 300 gal./acre.
Delayed Dormant Stage (From First Green Until Pink (Stages 1-4)				
Aphids	Superior Oil + one of the following ● endosulfan (Thiodan, Endosulfan) 50W ● Diazinon 50W	6 gal. + 4 lb. or 4 lb.	1.5 gal. + 1 lb. or 1 lb.	If a dormant oil spray has been applied, oil is not needed and there may be no need for further insect and mite control.
Coryneum blight	● Fixed coppers ● Kocide 101 or DF ● Ziram 76DF ● Bravo 500F or 720F △ Ensign 720F	--- 8-12 lb. 6 lb. 4-6 pt 3-4 pt. 3.13-4.13 pt.	See label 2-3 lb. 1.5 lb. 1.5-2 pt. 12-16 fl.oz. 1-1.38 pt.	Apply between popcorn and full bloom (stages 5-7). Do not apply copper sprays after bloom (possible spray injury). Dilute rate for Ensign is based on 300 gal./acre.
Twig borer	● Imidan 50W or 70W ● endosulfan (Thiodan, Endosulfan) 50W	4 lb. 3 lb. 4 lb.	1 lb. 0.75 lb. 1 lb.	This spray important to control overwintering forms.
Lygus bugs Stink bugs	● endosulfan (Thiodan, Endosulfan) 50W	4 lb.	1 lb.	These insects are pests of peaches and plums also.

[1]based on 400 gallons per acre with average-sized trees.

△Product not evaluated by CSU personnel under Colorado conditions, but found to be effective elsewhere.

Apricot

PEST OR DISEASE	MATERIALS	RATE PER ACRE	RATE PER 100 GAL. (DILUTE)[1]	REMARKS
Petal Fall Stage				
Powdery mildew	● Benlate 50W	2 lb.	8 oz.	Apply all sprays at petal fall and again at shuck fall 2-3 weeks later.
Lygus bugs	● endosulfan (Thiodan, Endosulfan) 50W	4 lb.	1 lb.	These insects are pests of peaches and plums also.
Shuck Split/Shuck Fall Stage				
Oriental fruit moth	● Imidan 50W or 70W	4 lb. 3 lb.	1 lb. 0.75 lb.	If parasites are being imported, eliminate the more toxic sprays.
Mites	△ Apollo 1SC	2-8 fl.oz.	0.5-2 fl.oz.	
Lygus bugs Stink bugs	● Diazinon 50W ● endosulfan (Thiodan, Endosulfan) 50W	4 lb. 4 lb.	1 lb. 1 lb.	These insects are pests of peach and plum also.
Peach twig borer	● Imidan 50W or 70W	4 lb. 3 lb.	1 lb. 0.75 lb.	
Coryneum blight	● Captan 50W ● Ziram 76DF ● Bravo 500F or 720F △ Ensign 720F	3-5 lb. 6 lb. 4-6 pt. 3-4 pt. 3.13-4.13 pt.	12-20 oz. 1.5 lb. 1-1.5 pt. 12-16 fl.oz. 1-1.38 pt.	Continue sprays annually as needed. Captan & Ziram may be applied prior to rainy periods at 7-10 day intervals after shuck fall to protect against fruit damage. Dilute rate for Ensign is based on 300 gal./acre. Captan limit: 25 lb./acre/crop cycle.
Powdery mildew	● Benlate 50W	1.5-2 lb.	6.4-8 oz.	
Summer Sprays				
Summer Peach tree (crown) borer	● endosulfan (Thiodan, Endosulfan) 50W or (Endocide) 3E ● Asana XL	--- --- ---	1.5 lb. 1 qt. 2-5.8 fl.oz.	Apply sprays only to tree trunk and soil around base. Use Approx. 1/2 gal. of spray per tree. First treatment early July. Second treatment early August. Do not contaminate fruit.
Coryneum blight	● Captan 50W ● Ziram 76DF	3-5 lb. 6 lb.	12-20 oz. 1.5 lb.	Apply prior to rainy periods at 7-10 day intervals after shuck fall to protect against fruit damage. Check Ziram Preharvest interval. Captan limit: 25 lb./acre/crop cycle.

[1]based on 400 gallons per acre with average-sized trees.

△Product not evaluated by CSU personnel under Colorado conditions, but found to be effective elsewhere.

Apricot

PEST OR DISEASE	MATERIALS	RATE PER ACRE	RATE PER 100 GAL. (DILUTE)[1]	REMARKS
Harvest period				
Rhizopus	Avoid bruising or other injuries to fruit during picking, packing and other handling operations. Bruises or other injuries provide easy points of entry for Rhizopus. Clean field crates by flushing with high pressure water hose or steam clean before picking fruit.			
Postharvest Period				
Coryneum blight	● Kocide 101 or DF	8-12 lb.	2-3 lb.	Apply immediately after leaf fall. Use these sprays in severely infected orchards, especially in wet fall weather. Use as directed on labels. Check orchard for possible need of follow-up sprays the next season. Ensign dilute rate is based on 300 gal./acre. Captan limit: 25 lb./acre/crop cycle.
	● Captan 50W	3-5 lb.	12-20 oz.	
	● Ziram 76DF	6 lb.	1.5 lb.	
	● Bravo 500F or 720F	6 pt. 3-4 pt.	1.5 pt. 12-16 fl.oz.	
	△ Ensign 720F	3.13-4.13 pt.	1-1.38 pt.	
	△ Basic Copper 53WP	12-18 lb.	3-4.5 lb.	

[1]based on 400 gallons per acre with average-sized trees.

△Product not evaluated by CSU personnel under Colorado conditions, but found to be effective elsewhere.

Cherry

PEST OR DISEASE	MATERIALS	RATE PER ACRE	RATE PER 100 GAL. (DILUTE)[1]	REMARKS
Dormant Stage (Stage 0)				
Cytospora canker	Post-pruning wound treatment paint. ● Benlate 50W		0.5-1 Tbsp. per gallon of carrier liquid.	Apply slurry to pruning cuts with a paint brush immediately after pruning. Carrier liquid may be spray oil or interior white latex paint diluted 1 part paint to 2 parts water.
Scale Brown mite eggs Aphid eggs	● Superior Oil + Diazinon 50W or Lorsban 4E	8 gal. + 4 lb. 2-4 pt.	2 gal + 1 lb. 0.5-1 pt.	Will also give some suppression of twig borer. Lorsban 4E -- use at least 1.5 pt./acre.
Delayed Dormant Stage (From First Green Until White; Stages 1-4)				
Aphids Mites Scale	● Superior Oil + endosulfan (Endosulfan, Thiodan) 50W or Diazinon 50W or Lorsban 4E	6 gal. 4 lb. 4 lb. 2-4 pt.	1.5 gal. 1 lb. 1 lb. 0.5-1 pt.	If dormant spray has been made, oil is not needed and there may not be any need for insect and mite control.
Twig borer	● azinphos methyl (Guthion, Azinphos-M) 50W ● Imidan 50W or 70W ● Diazinon 50W △ Lorsban 4E	1.5 lb. 4 lb. 3 lb. 4 lb. 2-4 pt.	6 oz. 1 lb. .75 lb. 1 lb. 0.5-1 pt.	Also occurs in some new areas on cherries. This spray important to control overwintering forms. Do not apply more than 300 gal. of mixed Guthion 50W/Acre in one spray. Season limit/acre: azinphos methyl 50W - 6 lb. Lorsban -- use at least 1.5 pt./acre.
Lygus bugs Stink bugs	● azinphos methyl (Guthion, Azinphos-M) 50W ● endosulfan (Thiodan, Endosulfan) 50W ● Diazinon 50W △ Ambush 2E or 25W	1.5 lb. 4 lb. 4 lb. 6.4-12.8 fl.oz. 6.4-12.8 oz.	6 oz. 1 lb. 1 lb. 1.6-3.2 fl.oz. 1.6-3.2 oz.	Do not apply more than 300 gal of mixed Guthion 50W/Acre in one spray. Season limit/acre: azinphos methyl 50W - 6 lb.
Powdery mildew	● Sulfur-wettable (micronized	16 lb.	4 lb.	Spray interval should not exceed 14 days. Use as directed on the label.

[1]based on 400 gallons per acre with average-sized trees.

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Cherry

PEST OR DISEASE	MATERIALS	RATE PER ACRE	RATE PER 100 GAL. (DILUTE)[1]	REMARKS
Petal Fall Stage				
Powdery mildew	● Sulfur-wettable (micronized)	16 lb.	4 lb.	Do not use sulfur during hot weather. Apply all sprays at petal fall and again 2-3 weeks later Season limit: Nova 40W - 3.25 oz./Acre.
	● Benlate 50W	2 lb.	8 oz.	
	● Nova 40W	5 oz.	1.25-2 oz.	
Aphids	Same materials as listed for aphids under delayed dormant.			
Shuck Split/Shuck Fall Stage				
Oriental fruit moth	● azinphos methyl (Guthion, Azinphos-M) 50W	1.5 lb.	6 oz.	If parasites are being imported, eliminate the more toxic sprays. See Notes under Delayed Dormant spray for twig borer.
	● Imidan 50W	4 lb.	1 lb.	
	or 70W	3 lb.	.75 lb.	
	● Diazinon 50W	4 lb.	1 lb.	
Coryneum blight	● Captan 50W	3-4 lb.	0.75-1 lb.	Continue sprays annually as needed. Captan limit: 28 lb./acre/crop cycle.
	● Ziram 76DF	6 lb.	1.5 lb.	
	△ Ensign 720F	3.13-4.13 pt.	1-1.38 pt.	
Mites	● Vendex 50W	1.5-3 lb.	6-12 oz.	
	△ Apollo 1SC	2-8 fl.oz.	.5-2 fl.oz.	
Lygus bugs Stink bugs	● Diazinon 50W	4 lb.	1 lb.	
	● endosulfan (Thiodan, Endosulfan) 50W	4 lb.	1 lb.	
Peach twig borer	● Diazinon 50W	4 lb.	1 lb.	See Notes under Delayed Dormant spray for twig borer.
	● azinphos methyl (Guthion, Azinphos-M) 50W	1.5 lb.	6 oz.	
	● Imidan 50W	4 lb.	1 lb.	
	or 70W	3 lb.	0.75 lb.	
Western cherry fruit fly	△ diazinon (AG 500) 4E	2-4 pt.	0.5-1 pt.	Wettable powder formulations may leave visible residues when applied near harvest. WARNING: multiple applications of carbaryl may cause mite problems. Malathion may cause leaf injury.
	or 50W	2-4 lb.	0.5-1 lb.	
	△ Malathion 8E	3 pt.	0.75 pt.	
	or 5EC	4 pt.	1 pt.	
	△ azinphos methyl (Guthion, Azinphos-M) 50W	1.5 lb.	6 oz.	
	△ carbaryl (Sevin XLR Plus)	4 pt.	1 pt.	
	△ Asana XL	4.8-14.5 fl.oz.	1.2-3.6 fl.oz.	

[1]based on 400 gallons per acre with average-sized trees.

△Product not evaluated by CSU personnel under Colorado conditions, but found to be effective elsewhere.

Cherry

PEST OR DISEASE	MATERIALS	RATE PER ACRE	RATE PER 100 GAL. (DILUTE)[1]	REMARKS
Summer Trunk and Ground Sprays				
Peach tree (crown) borer	● endosulfan (Thiodan, Endosulfan) 50W	----	1 lb.	Apply sprays only to tree trunk and soil around base. Use Approx 1/2 gal. of spray for tree. First treatment July 10 to 15. Second treatment August 10 to 15. Do not contaminate fruit. Lorsban can be used only once/season for this.
	or 2E	----	1 qt.	
	● Asana XL	----	2-5.8 fl.oz.	
	△ Lorsban 4E	----	1.5-3 qts.	
Other Summer Sprays				
Powdery mildew	● Benlate 50W	1.5-2 lb.	6.4-8 oz.	Early season monitoring and control application (if needed) generally will provide the best results. See text (page 7.7). Season limit/acre: Nova 40W - 3.25 lb.
	● Nova 40W	5 oz.	1.25-2 oz.	
Preharvest and Harvest Period				
Western cherry fruit fly	△ carbaryl (Sevin) 4F	4 pt.	1 pt.	Carbaryl may cause mite flare-ups.
	or (Sevin) 50WP	8 lb.	2 lb.	
Rhizopus	Avoid brushing or other injuries to fruit during picking, packing or other handling operations. Bruises or other injuries provide easy points of entry for Rhizopus. Clean field creates by flushing with high pressure water hose or steam clean before picking fruit.			
Post Harvest Period				
Pear slugs on cherry	● Diazinon 50W	4 lb.	1 lb.	This spray may be needed where/when populations of this pest build up.
Cherry leaf spot	△ Ensign 720F	3.13-4.13 pt.	1-1.38 pt.	For control of cherry leaf spot after harvest make one application to foliage. Dilute rate for Ensign is at 300 gal./acre.
Western cherry fruit fly	△ azinphos methyl (Guthion, Azinphos-M) 50WP	1.5 lb.	6 oz.	

[1]based on 400 gallons per acre with average-sized trees except where noted.

△Product not evaluated by CSU personnel under Colorado conditions, but found to be effective elsewhere.

Peach/Nectarine

PEST OR DISEASE	MATERIALS	RATE PER ACRE	RATE PER 100 GAL. (DILUTE)[1]	REMARKS
Dormant Stage (Stage 0)				
Cytospora canker	Post-pruning wound treatment paint:			
	● Benlate 50W		0.5-1 Tbsp/gal carrier 2 Tbsp/16 fl.oz. carrier	Apply slurry to pruning cuts with a paint brush immediately after pruning. The higher rate may be used only on peach while the trees are dormant; the lower rate may be used on either peach or nectarine when the trees are growing. Carrier liquid may be spray oil or interior white latex paint diluted 1 part paint to 2 parts water.
Scale Brown mite eggs Aphid eggs	● Superior Oil + Diazinon 50W or Lorsban 4E	8 gal. + 4 lb. or 2-4 pt.	2 gal. + 1 lb. or 0.5-1 pt.	Will also give some suppression of twig borer. Lorsban 4E - use at least 1.5 pt./acre.
Coryneum blight	● Bravo 500F or 720F ● Kocide 101 or DF △ Ensign 720F △ Basic Copper 53WP	6 pt. 3-4 pt. 8-16 lb. 3.13-4.13 pt. 16-20 lb.	1.5 pt. 12-16 fl.oz. 2-4 lb. 1-1.38 pt. 4-5 lb.	Ensign sprays based on 300 gal./acre.
Delayed Dormant Stage (From First Green Until Pink; Stages 1-5)				
Cytospora canker	● Benlate 50W + Oil	1-2 lb. + 1-2 gal.	8-16 fl.oz. + 1-2 qt.	
Twig borer	● azinphos methyl (Guthion, Azinphos-M) 50W ● Imidan 50W or 70W ● permethrin (Ambush) 2E or (Pounce) 3.2E or (Ambush, Pounce) 25W ● Asana XL ● Diazinon 50W △ Lorsban 4E △ *Bacillus thuringensis* (Bt) (Dipel, Biobit, Cutlass, Javelin, Agree WG)	3-4 lb. 4 lb. 3 lb. 6.5-25 fl.oz. 8-16 fl.oz. 6.4-25 oz. 4.8-14.5 fl.oz. 4 lb. 2-4 pt. 1 lb.	12-16 oz. 1 lb. 0.75 lb. 1.6-6.4 fl.oz. 2-4 fl.oz. 1.6-6.4 oz. 1.2-3.6 fl.oz. 1 lb. 0.5-1 pt. 4 oz.	This spray is important to control overwintering forms. Note season limits/Acre: permethrin 2E - 12 pts, 25W - 12 lbs., Asana - 72 fl.oz. (57.7 fl.oz. between bloom and harvest); azinphos methyl 50W - 6.75 lb. (nectarine) or 9 lbs. (peach). Lorsban 4E - use at least 1.5 pt./acre. Bts are stomach poisons, so complete coverage is VERY important for control. Two applications are usually required. Apply when forecasts predict a warm weather pattern for 3 or more days.

[1]based on 400 gallons per acre with average-sized trees.

△Product not evaluated by CSU personnel under Colorado conditions, but found to be effective elsewhere.

Peach/Nectarine

PEST OR DISEASE	MATERIALS	RATE PER ACRE	RATE PER 100 GAL. (DILUTE)[1]	REMARKS
Delayed Dormant Stage (From Green Until Pink; Stages 1-5 (Continued)				
Aphids, Mites, & Scale	Superior Oil	6 gal.	1.5 gal.	If dormant spray has been made, there may not be any need for insect and mite control. Oil should not exceed 1.25% (1.25 gal per 100 gal. spray) at first bloom. Lannate is not registered for use on nectarines.
	+ one of the following	+	+	
	● endosulfan (Thiodan, Endosulfan) 50W	4 lb.	1 lb.	
	● Asana XL	4.8-14.5 fl.oz.	1.2-3.6 fl.oz.	
	● Diazinon 50W	4 lb.	1 lb.	
	● Lannate 90SP	1-2 lb.	4-8 oz.	
	or 2.4LV	3-6 pt.	0.75-1.5 pt.	
Lygus bugs Stink bugs	● azinphos methyl (Guthion, Azinphos-M) 50W	3-4 lb.	12-16 oz.	These insects are pests of apricot and plum also. Lannate is not registered for use on nectarines.
	● endosulfan (Thiodan, Endosulfan) 50W	4 lb.	1 lb.	
	● Pounce 3.2E	8-16 fl.oz.	2-4 fl.oz.	
	or 25W	6.5-25 oz.	1.6-6.4 oz.	
	● Lannate 90SP	1-2 lb.	4-8 oz.	
	or 2.4LV	3-6 pt.	0.75-1.5 pt.	
Petal Fall Stage				
Aphids	Same materials as listed for aphids under delayed dormant, but without the oil.			
Flower thrips	● Lannate 90SP	1-2 lb.	4-8 oz.	Reduces numbers of thrips and also benefits twig borer control. Do not disturb cover crop for a period of two weeks prior to bloom. Lannate not registered for nectarine.
	or 2.4LV	3-6 pt.	0.75-1.5 pt.	
	● Diazinon 50W	4 lb.	1 lb.	
Lygus bugs	● azinphos methyl (Guthion, Azinphos-M) 50W	3-4 lb.	12-16 oz.	These insects are pests of apricot and plum also. Lannate is not registered for use on nectarines.
	● endosulfan (Thiodan, Endosulfan) 50W	4 lb.	1 lb.	
	● Lannate 90SP	1-2 lb.	4-8 oz.	
	or 2.4LV	3-6 pt.	0.75-1.5 pt.	
Peach twig borer	● azinphos methyl (Guthion, Azinphos-M) 50W	2 lb.	0.5 lb.	Bts are stomach poisons, so complete coverage is VERY important for control. Two applications are usually required. Apply when forecasts predict a warm weather pattern for 3 or more days.
	● Imidan 50W	6 lb.	1.5 lb.	
	or 70W	2.13-4.25 lb.	0.75-1 lb.	
	△ endosulfan (Thiodan, Endosulfan) 50W	4 lb.	1 lb.	
	△ *Bacillus thuringensis* (Bt) (Dipel, Biobit, Cutlass, Javelin, Agree WG)	1 lb.	4 oz.	

[1]based on 400 gallons per acre with average-sized trees.

△Product not evaluated by CSU personnel under Colorado conditions, but found to be effective elsewhere.

Peach/Nectarine

PEST OR DISEASE	MATERIALS	RATE PER ACRE	RATE PER 100 GAL. (DILUTE)[1]	REMARKS
Petal Fall Stage (Continued)				
Powdery mildew	● Sulfur-wettable 90W (micronized)	16 lb.	4 lb.	Season limit/acre: Nova 40W - 3.25 lbs. Use sulfur with caution during hot weather (temperatures above 85°F). Apply all sprays at petal fall and at 10 day intervals until pit hardening (as needed) on highly mildew susceptible varieties. See text (pages 7.6-7.8).
	● Benlate 50W	2 lb.	0.5 lb.	
	● Nova 40W	5 oz.	1.25 oz.	
Shuck Split/Shuck Fall Stage				
Oriental fruit moth	● azinphos methyl (Guthion, Azinphos-M) 50W	3-4 lb.	12-16 oz.	If parasites are being imported, eliminate the more toxic sprays. See Notes under Delayed Dormant for season limits/acre. Do not mix Imidan with Omite on late maturing varieties or injury may occur.
	● Imidan 50W	4 lb.	1 lb.	
	or 70W	3 lb.	0.75 lb.	
	● Diazinon 50W	4 lb.	1 lb.	
	● permethrin (Ambush) 2E	13-25 fl.oz.	3-6 fl.oz.	
	or (Pounce) 3.2E	8-16 fl.oz.	2-4 fl.oz.	
	or (Ambush, Pounce) 25W	6.4-25 oz.	1.8-6.4 oz.	
	● Asana XL	4.8-14.5 fl.oz.	1.2-3.6 fl.oz.	
Aphids	● Lannate 90SP	1-2 lb.	4-8 oz.	Lannate is not registered for nectarines.
	or 2.4LV	3-6 pt.	0.75-1.5 pt.	
	● endosulfan (Thiodan, Endosulfan) 50W	4 lb.	1 lb.	
	or (Endocide) 3E	2.7-3.3 qt.	22 fl.oz.	
Peach twig borer	● azinphos methyl (Guthion, Azinphos-M) 50W	3-4 lb.	12-16 oz.	See Notes on season limits/acre under Delayed Dormant. Sevin/carbaryl only lasts for 7-10 days and is very hard on mite predators and bees. Use it only with extreme caution.
	● Diazinon 50W	4 lb.	1 lb.	
	● Asana XL	4.8-14.5 fl.oz.	1.2-3.6 fl.oz.	
	● permethrin (Ambush) 2E	13-25 fl.oz.	3-6 fl.oz.	
	or (Pounce) 3.2E	8-16 fl.oz.	2-4 fl.oz.	
	or (Ambush,Pounce) 25W	6.4-25.6 oz.	1.6-6.4 oz.	
	● carbaryl (Sevin) 50W	8 lb.	2 lb.	
	or (Sevin XLR+) 4L	4 qt.	1 qt.	
Coryneum blight	● Captan 50W	8 lb.	2 lb.	Continue sprays annually as needed. Captan & Ziram may be applied prior to rainy periods at 7-10 day intervals through 6-8 wks post-shuck to protect against fruit damage. Bravo and Ensign cannot be applied after shuck split. Dilute rates for Ensign and Ziram are based on 300 gal./acre. Captan limit/acre/crop cycle: 64 lb. (peach), 48 lb. (nectarine).
	● Fixed coppers	As Directed		
	● Bravo 500F	6 pt.	1.5-2 pt.	
	or 720F	3-4 pt.	12-16 fl.oz.	
	● Ziram 76DF	6-8 lb.	2-2.5 lb.	
	△ Ensign 720F	3.13-4.13 pt.	1-1.38 pt.	

[1]based on 400 gallons per acre with average-sized trees.

△Product not evaluated by CSU personnel under Colorado conditions, but found to be effective elsewhere.

Peach/Nectarine

PEST OR DISEASE	MATERIALS	RATE PER ACRE	RATE PER 100 GAL. (DILUTE)[1]	REMARKS
Shuck Split/Shuck Fall Stage (Continued)				
Mites	● Carzol 92SP	1 lb.	4 oz.	Vendex may be applied only twice per season. PHI's for Carzol differ on peach (21 days) and nectarine (14 days).
	● Vendex 50W	1-2 lb.	4-8 oz.	
	△ Apollo 1SC	2-8 fl.oz.	0.5-2 fl.oz.	
Lygus bugs	● Diazinon 50W	4 lb.	1 lb.	Use 300 gal/acre for dilute application of Penncap-M.
	● Thiodan 50W	4 lb.	1 lb.	
	● Asana XL	4.8-14.5 fl.oz.	1.2-3.6 fl.oz.	
	△ Penncap-M	2-6 pt.	0.67-2 pt.	
Powdery mildew	● Benlate 50W	1.5-2 lb.	6-8 oz.	Season limit/acre: Nova 40W - 3.25 lb. Spray intervals for Benlate and Sulfur should not exceed 10 days between shuck split and pit hardening on cultivars susceptible to powdery mildew.
	● Sulfur - wettable 90W (micronized)	16 lb.	4 lb.	
	● Flowable sulfur	6-16 lb. ai	See label	
	● Nova 40W	5 oz.	1.25-2 oz.	
Summer Spray				
Thrips	● Lannate 90SP	1-2 lb.	4-8 oz.	Lannate is not registered for use on nectarines.
	or 2.4LV	3-6 pt.	0.75-1.5 pt.	
	● permethrin (Ambush) 2E	13-25 fl.oz.	3-6 fl.oz.	
	or (Pounce) 3.2E	8-16 fl.oz.	2-4 fl.oz.	
	or (Ambush, Pounce) 25W	6.4-25.6 oz.	1.6-6.4 oz.	
Earwigs	△ carbaryl (Sevin) 50W	1 lb.	.25 lb.	Apply only to trunk and soil to avoid mite problems
	or (Sevin XLR+) 4L	1 qt.	8 fl.oz.	
Trunk and Ground Sprays				
Peach tree (crown) borer	● endosulfan (Thiodan, Endosulfan) 50W	---	1.5 lb.	Apply sprays (approx. 1/2 gal per tree) only to tree trunk and soil around base -- do not contaminate fruit. Lorsban can be used for this only once per season.
	or (Endocide) 3E	---	1 qt.	
	● Asana XL	---	2-5.8 fl.oz.	
	● Pounce 3.2E	---	4 fl.oz.	
	or 25W	---	6.4 oz.	
	△ Lorsban 4E	---	3 qt.	

[1]based on 400 gallons per acre with average-sized trees.

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Peach/Nectarine

PEST OR DISEASE	MATERIALS	RATE PER ACRE	RATE PER 100 GAL. (DILUTE)[1]	REMARKS
Pre Harvest Period				
Coryneum blight	● Captan 50W	8 lb.	2 lb.	Apply on weekly basis beginning 3-4 wks before harvest if rainy weather is forecasted. Captan limit/acre/crop cycle: 64 lb. (peach), 48 lb. (nectarine).
Harvest Period				
Rhizopus	Avoid bruising or other injuries to fruit during picking, packing and other handling operations. Bruises or other injuries provide easy points of entry for Rhizopus. Clean field crates by flushing with high pressure water hose or steam clean before picking fruit.			
Post-Harvest Period				
Coryneum blight	● Captan 50W	5 lb.	1.25 lb.	Apply immediately after leaf fall. Use these sprays in severely infected orchards, especially in wet fall weather. Use as directed on labels. Monitor orchard in spring and summer for possible need of additional sprays. Dilute rates for Ensign and Ziram are based on 300 gal./acre. Captan limit/acre/crop cycle: 64 lb. (peach), 48 lb. (nectarines).
	● Ziram 76DF	6-8 lb.	2-2.5 lb.	
	● Kocide 101 or DF	8-16 lb.	2-4 lb.	
	● Bravo 500F	6 pt.	1.5 pt.	
	or 720F	3-4 pt.	12-16 fl.oz.	
	△ Ensign 720F	3.13-4.13 pt.	1-1.38 pt.	
	△ Basic Copper 53WP	16-20 lb.	4-5 lb.	

[1]based on 400 gallons per acre with average-sized trees.

△Product not evaluated by CSU personnel under Colorado conditions, but found to be effective elsewhere.

Pear

PEST OR DISEASE	MATERIALS	RATE PER ACRE	RATE PER 100 GAL. (DILUTE)[1]	REMARKS
Dormant Stage (Stage 0)				
Pear psylla	Superior Oil alone	4-6 gal.	1-1.5 gal.	Asana season maximum: 72 fl.oz. per acre. Higher rates of Asana only for dormant to white bud stages (stages 0-6). The lower rates of Ambush have provided only marginal control in some Colorado orchards. Lorsban - use at least 1.5 pt./acre.
	or			
	+ one of the following:			
	● Asana XL	9.6-19.2 fl.oz.	2.4-4.8 fl.oz.	
	● Pounce 3.2E	8-16 fl.oz.	2-4 fl.oz.	
	● Ambush 2E	13-25 fl.oz.	3.2-6.4 fl.oz.	
	or 25W	13-25 oz.	3.2-6.4 oz.	
	△ Lorsban 4E	2-4 pt.	0.5-1 pt.	
Scale Mite eggs	Superior Oil alone or organophosphate registered for these pests (e.g. Diazinon, Ethion, Etc.)	Consult label for correct dosage.		
Delayed Dormant Stage (Stages 1-3)				
Pear rust mite	● Superior Oil	6-8 gal.	1.5 gal.	
	+			
	endosulfan (Thiodan, Endosulfan) 50W	4 lb.	1 lb.	
Pear psylla	Asana, Ambush, or Pounce at rate listed for dormant treatment may be used if not applied previously. Excessive use will increase problems with pear psylla resistance. See text (pages 6.7-6.9). Asana maximum: 72 fl.oz./acre/Yr.			
Pre Bloom (Stages 5-7)				
Grape mealybug	Superior Oil (98%) +	6 gal.	1.5 gal.	
	Diazinon 50W	4 lb.	1 lb.	
Pear psylla	● Morestan 25WSP	6 lb.	1.5 lb.	Avoid application within 10 days of an oil spray, or injury may occur to fruit and/or foliage. Fruit set may be reduced if fruit injury occurs.

[1]based on 400 gallons per acre with average-sized trees unless otherwise noted.

△Product not evaluated by CSU personnel under Colorado conditions, but found to be effective elsewhere.

Pear

PEST OR DISEASE	MATERIALS	RATE PER ACRE	RATE PER 100 GAL. (DILUTE)[1]	REMARKS
Pre Bloom (Stages 5-7)				
Codling moth	● Isomate-C Plus	400 dispensers		Isomate-C Plus pheromone dispensers must be in place before the first moth flight. Place within 2 feet of the top of the canopy. If the orchard has a history of codling moth problems, use one or two conventional insecticide sprays against the first generation in the first year. If a codling moth source exists nearby, use border sprays of conventional insecticides. Monitor the orchard with pheromone traps using a 10-mg lure set at mid-canopy height. If more than six moths are captured in traps, check the orchard for fruit damage or apply a conventional insecticide. If damage exceeds 1% at the end of the first generation, use conventional insecticides to control the second and subsequent generations. A second application of Isomate-C Plus may be needed against the second generation if temperatures are high and damage at the end of the first generation exceeds 0.5 %.
Blossom Stage (Stages 7-8)				
Powdery mildew	● Bayleton 50DF ● Wettable sulfur ● Flowable sulfur △ Rubigan 1E △ Procure 50WS	4-6 oz. 8-16 lb. ai 8-16 lb.ai 6-12 fl.oz. 8-16 oz.	1-1.5 oz. See label See label 3 fl.oz. 2-4 oz.	Sprays begun at bloom or petal fall and continued through 4-6 wks after petal fall should provide protection against fruit russet. Sulfur products should be used on a 7-10 day spray interval while the recommended Bayleton spray interval is 10-14 days. Minimum spray concentration of Rubigan is 3 fl.oz./100 gal.
Fire blight	● Streptomycin 17W ● Kocide 101 ● Basic Copper 53WP	2 lb. 1 lb. 2 lb.	8 oz. (100 ppm) 4 oz. 8 oz.	Basic copper sprays need 4 oz. metallic copper per 100 gal to be effective. Repeat copper or Kocide sprays at 5 day intervals throughout bloom.

[1]based on 400 gallons per acre with averaged-sized trees unless otherwise noted.

△Product not evaluated by CSU personnel on this crop under Colorado conditions.

Pear

PEST OR DISEASE	MATERIALS	RATE PER ACRE	RATE PER 100 GAL. (DILUTE)[1]	REMARKS
Petalfall				
Grape mealybug	● Diazinon 50W	4-6 lb.	1-1.5 lb.	-See "Pesticide Hazards to Honey Bees" in text (page 3.9).
	△ Provado 1.6E	20 fl.oz.	5 fl.oz.	
Fire blight	● Streptomycin 17W	2 lb.	8 oz. (100 ppm)	Basic copper sprays need 4 oz. metallic copper per 100 gal. to be effective. Kocide should be applied at 5 day intervals throughout bloom.
	● Kocide 101 or DF	1 lb.	4 oz.	
	● Basic Copper 53WP	2 lb.	8 oz.	
Post Petal Fall Sprays				
Pear psylla	● Thiodan 50W	4-5 lb.	1 lb.	Pyrethroid materials (Ambush, Pounce, Asana) should be used only two or less times in a season to avoid resistance. These are also effective against codling moth. Oil should be applied as a dilute spray, preferably in evening or early morning to recently watered trees. Avoid applying to drought-stressed trees or when temperatures will exceed 90°F within 4 hours. Only two applications of Agri-Mek allowed per season.
	● Mitac 50W	1.5-3 lb.	6-12 oz.	
	● permethrin (Ambush) 2E	13-25 fl.oz.	3.2-6.4 fl.oz.	
	or (Pounce) 3.2E	8-16 fl.oz.	2-4 fl.oz.	
	or (Ambush, Pounce) 25W	6.4-12.8 oz.	1.6-3.2 oz.	
	● Asana XL	4.8-14.5 fl.oz.	1.2-3.6 fl.oz.	
	● Summer oil	4-6 gal.	1-1.5 gal.	
	△ Provado 1.6E	20 fl.oz.	5 fl.oz.	
	△ Agri-Mek 0.15E	16-20 fl.oz.	4-5 fl.oz.	
	+ horticultural oil	1 gal.	1 qt.	
Codling Moth	● azinphos methyl (Guthion, Azinphos-M) 50W	2-3 lb.	8-12 oz.	Note season limits/acre: Asana - 72 fl.oz., azinphos methyl 50W - 12 lb. Pyrethroids (Ambush, Pounce & Asana) have good activity life on pears (Approx. 21 days). However, they should be used only two or less times per season on pears to avoid development of psylla resistance to them.
	● Imidan 50W	4-6 lb.	1-2 lb.	
	or 70W	3-6 lb.	0.75-1.5 lb.	
	● permethrin (Ambush) 2E	13-25 fl.oz.	3.2-6.4 fl.oz.	
	or (Pounce) 3.2E	8-16 fl.oz.	2-4 fl.oz.	
	or (Ambush, Pounce) 25W	6.4-12.8 oz.	1.6-3.2 oz.	
	● Asana XL	4.8-14.5 fl.oz.	1.2-3.6 fl.oz.	
	● Diazinon 50W	4 lb.	1 lb.	
	△ Penncap-M 2FM	4-8 pt.	1-2 pt.	
Spider mites	● Carzol 90SP	1 lb.	4 oz.	Vendex: maximum of 4 applications per season (3 between petal fall and harvest). Oil should be applied as a dilute spray, preferably in evening or early morning to recently watered trees. Avoid applying to drought-stressed trees or when temperatures will exceed 90°F within 4 hours. Kelthane rate varies with tree size; see label.
	● Vendex 50W	1-3 lb.	4-12 oz.	
	● Kelthane 35W	4-8 lb.	1-2 lb.	
	● Summer oil	4-6 gal.	1-1.5 gal.	
	△ Apollo 1SC	4-8 fl.oz.	1-2 fl.oz.	
	△ Savey 50W	4-6 oz.	1-1.5 oz.	

[1]based on 400 gallons per acre with average-sized trees.

△Product not evaluated by CSU personnel under Colorado conditions, but found to be effective elsewhere.

Pear

PEST OR DISEASE	MATERIALS	RATE PER ACRE	RATE PER 100 GAL. (DILUTE)[1]	REMARKS
Post Petal Fall Sprays (continued)				
Pear rust mite	● Carzol 92SP	1 lb.	4 oz.	Vendex: maximum of 4 sprays per season (3 between petal fall and harvest). Do not use oil later than 1 month before harvest nor within 30 days of any sprays containing azinphos methyl or endosulfan. If oil is to be used on Anjou pears, be sure to check labels of other organo-phosphate insecticides and fungicides used for potential injury intervals. Summer oil applications can suppress pear psylla and 2-spot mite populations. Avoid applying oil to drought-stressed trees or when temperatures will exceed 90°F within 4 hours after treatment; best applied evenings or early mornings to recently watered trees. Kelthane rate varies with tree size; see label.
	● Vendex 50W	1-3 lb.	4-12 oz.	
	● Summer Oil (dilute spray only!)	4-6 gal.	1-1.5 gal.	
	● Kelthane 35W	4-8 lb.	1-2 lb.	
	△ Agri-Mek 0.15E	10-20 fl.oz.	2.5-5 fl.oz.	
Powdery mildew	● Bayleton DF	4-6 oz.	1-1.5 oz.	Sprays begun at bloom or petal fall and continued through 4-6 wks after petal fall should protect against fruit russet. Sulfur products protect for 7-10 days while Bayleton and Procure protect for 10-14 days. Avoid use of sulfur when temperatures are above 85°F and after pear fruit turn down. Minimum spray concentration for Rubigan is 3 fl.oz./100 gal.
	● Wettable sulfur	8-16 lb.ai	See label	
	● Flowable sulfur	8-16 lb.ai	See label	
	△ Rubigan 1E	6-12 fl.oz.	3 fl.oz.	
	△ Procure 50WS	8-16 oz.	2-4 oz.	
Fire blight	● Streptomycin 17W	2 lb.	8 oz.	Caution: copper or Kocide sprays may cause fruit russet. Basic Copper sprays need 4 oz. metallic copper per 100 gal. to be effective.
	● Kocide 101 or DF	1 lb.	4 oz.	
	△ Basic Copper 53WP	2 lb.	8 oz.	
Crown rot	△ Aliette WDG	2.5-5 lb.	.63-1.25 lb.	Use low rate on 30 day interval, high rate on 60 day interval. Do not apply within 2-3 weeks of leaf senescence. Do not allow livestock to graze in treated orchards. Season limit: 20 lbs/acre. See Text (page 7.9).

[1]based on 400 gallons per acre with averaged-sized trees.

△Product not evaluated by CSU personnel under Colorado conditions, but found to be effective elsewhere.

Plum

PEST OR DISEASE	MATERIALS	RATE PER ACRE	RATE PER 100 GAL. (DILUTE)[1]	REMARKS
Dormant Stage (Stage 0)				
Cytospora canker	Post-pruning wound treatment paint: ● Benlate 50W		0.5-1 Tbsp. per gallon of carrier liquid.	Apply slurry to pruning cuts with a paint brush immediately after pruning. Carrier liquid may be spray oil or interior white latex paint diluted 1 part paint to 2 parts water.
Scale Brown mite eggs Aphid eggs	● Superior Oil + Diazinon 50W or Lorsban 4E	8 gal. + 4 lb. or 2-4 pt.	2 gal. + 1 lb. or 0.5-1 pt.	Will also give some suppression of twig borer. Lorsban -- use at least 1.5 pt./ace.
Delayed Dormant Stage (From First Green Until Pink (Stages 1-4)				
Powdery mildew	● Sulfur-wettable 90W (micronized)	16 lb.	4 lb.	Spray interval should not exceed 14 days. Use as directed on the label.
Aphids	Superior Oil + one of the following ● endosulfan (Thiodan, Endosulfan) 50W ● Diazinon 50W △ Lorsban 4E	6 gal. + 4 lb. or 4 lb. or 2-4 pt.	1.5 gal. + 1 lb. or 1 lb. or 0.5-1 pt.	If a dormant oil spray has been applied, oil is not needed and there may be no need for further insect and mite control. Lorsban 4E -- use at least 1.5 pt./acre.
Twig borer	● azinphos methyl (Guthion, Azinphos-M) 50W ● Imidan 50W or 70W △ Lorsban 4E	2-4 lb. 4 lb. 3 lb. 2-4 pt.	8-16 oz. 1 lb. 0.75 lb. 0.5-1 pt.	This spray is important to control overwintering forms. Note season limit/Acre: 6.75 lbs for azinphos methyl 50W. Lorsban -- use at least 1.5 pt./acre.
Lygus bugs Stink bugs	● azinphos methyl (Guthion, Azinphos-M) 50W	2-4 lb.	8-16 oz.	See note above.
Mites	● Oil	4 gal.	1 gal.	
Petal Fall Stage				
Lygus Bugs	● azinphos methyl (Guthion, Azinphos-M) 50W	2-4 lb.	8-16 oz.	These insects also are pests of peaches and apricots. See Note on season limit for azinphos methyl under Delayed Dormant above.
Aphids	Same materials as listed for aphids under delayed dormant.			

[1]based on 400 gallons per acre with average-sized trees.

△Product not evaluated by CSU personnel under Colorado conditions, but found to be effective elsewhere.

Plum

PEST OR DISEASE	MATERIALS	RATE PER ACRE	RATE PER 100 GAL. (DILUTE)[1]	REMARKS
Petal Fall Stage (Continued)				
Powdery mildew	● Sulfur-wettable 90W (micronized)	16 lb.	4 lb.	Do not use sulfur during hot weather. Apply all sprays at petal fall and again 2-3 weeks later.
	● Benlate 50W	2 lb.	8 oz.	
Shuck Split/Shuck Fall Stage				
Oriental fruit moth	● Imidan 50W	4 lb.	1 lb.	If parasites are being imported, eliminate the more toxic sprays. See note on season limits for azinphos methyl under Delayed Dormant.
	or 70W	3 lb.	0.75 lb.	
	● Diazinon 50W	4 lb.	1 lb.	
	● azinphos methyl (Guthion, Azinphos-M) 50W	2-4 lb.	8-16 oz.	
Coryneum blight	● Captan 50W	4-6 lb.	1-1.5 lb.	Continue spray annually as needed. Dilute rate for Ensign is based on 300 gal./acre.
	● Bravo 720F	3-4 pt.	12-16 fl.oz.	
	△ Ensign 720F	3.5-4.5 pt.	1-1.6 pt.	
Mites	● Vendex 50W	1-2 lb.	4-8 oz.	
	△ Carzol 92SP	1 lb.	4 oz.	
Lygus bugs Stink bugs	● Diazinon 50W	4 lb.	1 lb.	
Peach twig borer	● azinphos methyl (Guthion, Azinphos-M) 50W	2-4 lb.	8-16 oz.	See Note on season limit for azinphos methyl under Delayed Dormant.
	● Imidan 50W	4 lb.	1 lb.	
	or 70W	3 lb.	0.75 lb.	
	● Diazinon 50W	4 lb.	1 lb.	
Trunk and Ground Sprays				
Summer Peach tree (crown) borer	● endosulfan (Thiodan, Endosulfan) 50W	---	1.5 lb.	Apply sprays only to tree trunk and soil around base. Use approx. 1/2 gal. of spray for tree. First treatment July 10 to 15. Second treatment August 10 to 15. Do not contaminate fruit.
	(Endocide) 3E	---	1 qt.	
	● Asana XL	---	2-5.8 fl.oz.	
Harvest period				
Rhizopus	Avoid bruising or other injuries to fruit during picking, packing and other handling operations. Bruises or other injuries provide easy points of entry for Rhizopus. Clean field crates by flushing with high pressure water hose or steam clean before picking fruit.			

[1]based on 400 gallons per acre with average-sized trees.

△Product not evaluated by CSU personnel under Colorado conditions, but found to be effective elsewhere.

Plum

PEST OR DISEASE	MATERIALS	RATE PER ACRE	RATE PER 100 GAL. (DILUTE)[1]	REMARKS
Postharvest Period				
Coryneum blight	● Captan 50W	5 lb.	20 oz.	Apply immediately after leaf fall. Use these sprays in severely infected orchards, especially in wet fall weather. Use as directed on labels. Check orchard in spring and summer to see if additional sprays are needed at that time. Dilute rate for Ensign is based on 300 gal./acre.
	● Bravo 720F	3-4 pt.	12-16 fl.oz.	
	△ Ensign 720F	3.13-4.13 pt.	1-1.38 pt.	
	△ Basic Copper 53WP	16-20 lb.	4-5 lb.	

[1]based on 400 gallons per acre with average-sized trees.

△Product not evaluated by CSU personnel under Colorado conditions, but found to be effective elsewhere.

WEED CONTROL

WEED CONTROL FOR POME AND STONE FRUIT ORCHARDS

At the present time the most effective and economical management of weeds in orchards is based on the use of soil-active (pre-emergence) herbicides, followed by a spot treatment of problem weeds with the foliage-applied (post-emergence) herbicides. It is recommended that the area within the tree row have as low a weed infestation as possible. Sod should be maintained within the alley in pome fruits. Weeds in sod can be suppressed by mowing and 2,4-D applications (Note: Most forms of 2,4-D are registered for apples and pears only; only the Weedar 64 formulation is registered for all tree fruit crops). Stone fruits should have annual cover crops, such as fall rye grain or legumes. These should be removed with herbicides such as glyphosate (Roundup) in early spring. Disking is recommended only if silting of furrows occurs and disking is needed to improve water penetration.

When used incorrectly, herbicides can cause serious injury to fruit trees. The safety of herbicides registered for use in orchards is based on their placement and not on a physiological tolerance of fruit trees except for the two grass herbicides (Poast and Fusilade). That is why it is critical to prevent contamination of leaves, crowns, roots, and bark of fruit trees. Even with Poast and Fusilade, the trees should not be sprayed because possible sprayer contamination with other herbicides could cause irreversible damage to the trees. See ADDITIONAL REFERENCES, Section E (page 5.6) for an excellent reference on herbicide injury symptoms.

It is believed that the majority of herbicidal injury to trees can be traced to the following factors:

1. Drift of spray droplets - especially critical with foliage active herbicides.

2. Excessive rates - incorrect sprayer calibration, low soil organic matter, light soil texture.

3. Excessive soil cracks - cracks in dry clay soils may facilitate penetration of herbicides to tree roots.

4. Cultivation of an area previously sprayed with herbicides - results in direct placement of herbicides in vicinity of roots.

5. Direct spraying of leaves, bark, exposed roots, or crowns of trees.

6. Use of herbicide sprayer for other pesticides or fertilizers - even a low concentration of herbicides can significantly decrease yield or cause serious injury if sprayed directly on trees.

The operator's safety is of primary concern; all manufacturer's recommendations should be strictly followed. Some herbicides, such as Gramoxone (paraquat) and others, are very toxic and the use of protective clothing and respirators during weighing, mixing, and application is vital.

A well designed herbicide sprayer is essential to successful chemical weed control. Rapid shut-off capability is a must for occasions where problems arise, so it should have an on/off valve within easy reach of the operator. Adequate agitation is also critical, especially for wettable powder formulations; jet agitation often is not adequate for wettable powder materials, so mechanical agitation is preferred.

Spray pressure and volume are also very important. Low spray pressures are best because pressures above 30 psi generate large numbers of small droplets and contribute to excessive spray drift. Spray volume per acre depends on the mode of action of the herbicide selected. Usually 30 gal./acre are adequate, but some herbicides (like glyphosate) are more effective with a lower spray volume/acre

(e.g. 10 gal./acre for Roundup). For such lower spray volumes, spray nozzles specifically designed for low volume/low pressure applications (similar to the XR or LP Tee Jet nozzles) are recommended.

Accurate sprayer calibration is of utmost importance. Sprayer manuals or Cooperative Extension publications are a good source of information on these procedures. Water used as carrier should be of highest purity available to avoid any decrease in product effectiveness. For example, clay and silt particles are known to decrease activity of glyphosate (Roundup) considerably.

Herbicides may be grouped by their type of activity, i.e. soil-active (pre-emergent) vs. foliage-active (post-emergent). Soil-active herbicides are most effective against germinating weed seeds, but some also suppress growing plants. Because annual weeds depend on seed germination for new plants each year, such pre-emergent herbicides are highly useful in their control; perennial weeds, except for the newly germinating seeds each year, generally are not affected. Soil-active herbicides are most successful if applied in late fall (after Nov. 1) after rain wets the soil and closes soil cracks but before the soil freezes. Peaches and nectarines may be treated somewhat earlier (just as the leaves begin to fall) IF no extensive soil cracking is present in the orchard. Warm soil temperatures should not be a problem if the leaves cover the applied materials promptly and protect them from solar breakdown. Additional rain or snow-melt will move them into the uppermost soil layer. Application to irrigation furrows that are re-marked annually should be avoided. Also, soil-active herbicides differ in the tree age at which they can first be used; several require the trees to have been established for 12 months or more prior to first use. See the label!

Foliage-active herbicides, in contrast, work best on actively growing weeds and require direct contact with plant tissues above ground in order to affect the plant. Non-ionic surfactants are often necessary to ensure effective contact. Most of the foliage-active herbicides available for orchard use are taken into the plant from the leaves and are spread within it; thus they kill the entire weed plant (including roots and rhizomes). The exceptions, paraquat and glufosinate based herbicides, are contact herbicides--that is they kill only the weed tissue to which they are applied; paraquat has been and is used for chemical mowing applications, and the new glufosinate herbicide Rely would appear to have potential for chemical mowing also. The Rely label even includes the option for use in sucker control on apples. Time of application for foliage-active herbicides is very important and depends greatly on the specific herbicide, the weed species to be controlled, and the stage of weed development. Because all foliage-active herbicides are effective through direct plant tissue contact, extreme care must be taken to avoid contact with tree foliage, green bark, and exposed roots. Any accidentally sprayed branch should be removed at once so as to prevent movement of the herbicide to other parts of the tree.

Mixtures of herbicides can be helpful in some cases. Some herbicide labels include specific instructions and rates for mixing with other herbicides. If these instructions are followed, liability for possible crop damage is assumed by the manufacturer(s). Other herbicide labels say nothing about mixing herbicides. In these cases, mixtures of such herbicides can be applied IF each of the herbicides to be mixed are registered for the crop and IF that use (or mixture) is not specifically prohibited on the label of any of the materials. However, liability is then assumed by the user rather than the manufacturer(s). For such nonlisted mixtures, the jar mix test is strongly recommended before any larger tank mix volume is prepared. See the section on compatibility of spray materials (pages 3.12-3.14) for information on the order in which materials should be added to tank mixes.

Preharvest intervals need to be strictly observed; see the remarks column in the following recommendation tables. If fruit is accidentally contaminated with any of the herbicides, it has to be destroyed. Areas treated with any of the herbicides cannot be grazed by livestock.

The following recommendation tables use the common name of the products for organization. A cross-reference list by product name is given below for some of the most commonly used products.

Table 16. Alphabetical list of some herbicide products and their active ingredient

Soil-Active		Foliage-Active	
Product	Active ingredient	Product	Active Ingredient
Caliber 90	simazine	Dalapon	dalapon
Casoron	dichlobenil	Dowpon	dalapon
Devrinol	napropamide	Envy	2,4-D amine
Goal	oxyfluorfen	Fusilade 2000	fluazifop-p-butyl
Karmex	diuron	*Gramoxone Extra or Super	paraquat
*Kerb	pronamide		
Norosac	dichobenil		
Prowl	pendimethalin	Poast	sethoxydim
Princep	simazine	Rely	glufosinate
Sinbar	terbacil	Roundup	glyphosate
Solicam	norflurazon	Weedar	2,4-D amine
Surflan	oryzalin		

*restricted use herbicides

Weed Control

SOIL ACTIVE (PRE-EMERGENCE) HERBICIDES -- Single Fall Application After Harvest Recommended[1]

MATERIAL & PRODUCT	RATE[2] (per treated acre per year)	FRUIT CROPS	REMARKS[3]
Grasses and Broadleaves			
diuron ● Karmex or Direx 80DF △ Direx 4L	(1.6-3.2 lb. a.i.) 2-4 lb. 1.6-3.2 qt.	1. Apple 2. Peach 3. Pear	Do not use on apples grafted onto full-dwarf rootstocks. Do not use on dwarf trees or on peach trees planted less than 3 years. Also do not use where soil organic matter is below 1% and/or soil texture is sandy. Application every 2 years may be sufficient. Karmex may be tank mixed with Sinbar or Surflan; See label. Split application is recommended for the 4 lb. rate of Karmex with 2 lb. in fall + 2 lb. in March.
dichlobenil ● Casoron 4G ● Norosac 4G	(4-6 lb. a.i.) 100-150 lb. 100-150 lb.	1. Apple 2. Cherry 3. Nectarine 4. Peach 5. Pear 6. Plum	Can be used in orchard 4 wks after planting, after the ground has settled and soil cracks have been filled.
napropamide ● Devrinol 50W	(4 lb. a.i.) 8 lb.	1. Apple 2. Apricot 3. Cherry 4. Nectarine 5. Peach 6. Pear 7. Plum	Do not apply within 35 days of harvest. Apply only to weed-free, non-frozen ground. Devrinol may be tank-mixed with Paraquat; see label.
norflurazon ● Solicam 80DF	(2 lb. a.i.) 2.5 lb.	1. Apple 2. Pear	Do not apply to trees planted less than 18 months.
oryzalin ● Surflan AS (4E)	(2-6 lb. a.i.) 2-6 qt.	1. Apple 2. Apricot 3. Cherry 4. Nectarine 5. Peach 6. Pear 7. Plum	Rain (.5-1") required within 21 days of application for activation. Surflan may be tank-mixed with Karmex, Sinbar, or Princep (not for peach); see label. Surflan can be used in orchard 4 weeks after planting, after the ground has settled and soil cracks have been filled.

[1]Apply after Nov. 1st, but before the soil freezes (see text, p. 9.2). Soil Active herbicides kill primarily new weed plants (whether annual or perennial) as the seeds germinate; thus they are most effective on annual weeds which depend on seed germination for plant growth each year.

[2]Rates given are per acre of tree row actually treated; those within parentheses are of active ingredient while those with no parentheses are amount of product. Actual rates also depend on soil organic matter content, soil texture, and weed species to be controlled. See the label on container.

[3]Remarks given here are intended to highlight important properties of particular herbicides rather than to substitute for the manufacturer's recommendations and warnings. **ALWAYS CONSULT THE LABEL** before use of any pesticide.

△Product not evaluated by CSU personnel under Colorado conditions, but found to be effective elsewhere.

Weed Control

SOIL ACTIVE (PRE-EMERGENCE) HERBICIDES -- Single Fall Application After Harvest Recommended[1]

MATERIAL & PRODUCT	RATE[2] (per treated acre per year)	FRUIT CROPS	REMARKS[3]
Grasses and Broadleaves (Cont.)			
oxyflourfen ● Goal 1.6E	(.5-2 lb. a.i.) 2.5-10 pt.	1. Apple 2. Apricot 3. Cherry 4. Nectarine 5. Peach 6. Pear 7. Plum	Dormant application only. Goal can be mixed with some other herbicides as directed on the label.
pendimethalin △ Prowl	(2-4 lb. a.i.) 2-4 qt.	1. Apple 2. Apricot 3. Cherry 4. Nectarine 5. Peach 6. Pear 7. Plum	**Non-bearing orchards only.** Apply only to weed-free soil. Delay application until soil has settled and no cracks are present. Lower rate for 4-month control; higher rate for 6-8 months control. Treatments most effective if rainfall or irrigation received within 7 days after application. Controls most germinating annual grasses and some annual broadleaf weeds.
pronamide ● Kerb 50W	(1-4 lb. a.i.) 2-8 lb.	1. Apple 2. Cherry 3. Nectarine 4. Peach 5. Pear 6. Plum	Restricted use pesticide. One application per season. Do not apply to seedling trees less than 1 year old or to transplanted trees until 6 months after planting. Gives some postemergence control of grasses. Do not allow livestock to graze treated areas.
simizine (2-4 lb. a.i.) ● Princep 4L ● Princep 80W ● Caliber 90 (90W)	 2-4 qt. 2-4 lb. 2.2-4.4 lb.	1. Apple 2. Sour Cherry 3. Pear	Do not apply to trees planted less than 12 months. Application every 2 years may be sufficient in Colorado. Princep may be tank-mixed with Surflan; see label.
terbacil ● Sinbar 80W	(1.6 lb. a.i.) 2 lb.	1. Apple 2. Peach	Do not apply under trees less than 3 years old. Application every 2 years may be sufficient in Colorado. Sinbar may be tank-mixed with Karmex or Surflan; see label.

[1]Apply after Nov. 1st, but before the soil freezes (see text, p. 9.2). Soil Active herbicides kill primarily new weed plants (whether annual or perennial) as the seeds germinate; thus they are most effective on annual weeds which depend on seed germination for plant growth each year.

[2]Rates given are per acre of ground actually treated; those within parentheses are of active ingredient while those with no parentheses are amount of product. Actual rates also depend on soil organic matter content, soil texture, and weed species to be controlled. See the label on container.

[3]Remarks given here are intended to highlight important properties of particular herbicides rather than to substitute for the manufacturer's recommendations and warnings. **ALWAYS CONSULT THE LABEL** before use of any pesticide.

△ Product not evaluated by CSU personnel under Colorado Conditions, but effective elsewhere.

Weed Control

FOLIAGE ACTIVE (POST-EMERGENCE) HERBICIDES -- Applied to Growing Plants[1]

MATERIAL & PRODUCT	RATE[2] (a.i. per treated acre)	FRUIT CROPS	REMARKS[3]
Grasses, Annual & Perennial			
fluazifop-p-butyl ● Fusilade Dx + surfactant[4] or spray oil	(0.25-0.38 lb. a.i.) 16-24 fl.oz. + 8 fl.oz./100 gal. or 1 qt./100 gal.	1. Apple 2. Pear	**Non-bearing trees only.** Always add oil or non-ionic surfactant, but do NOT mix with other pesticides. Do not use more than 72 fl.oz. per acre per season.
● Fusilade Dx + surfactant[4] or spray oil	8-12 fl.oz. + 8 fl.oz./100 gal. or 1 qt./100 gal.	1. Apricot 2. Cherry 3. Nectarine 4. Peach 5. Plum 6. Prune	NOTE: 14 day preharvest interval. Always add oil or non-ionic surfactant, but do NOT tank mix with other pesticides. Season limit: 72 fl.oz. per acre per season.
sethoxydim ● Poast 1.5E + oil	(0.3-0.5 lb. a.i.) 1.5-2.5 pt. + 2 pt.	1. Apple 2. Apricot 3. Cherry 4. Nectarine 5. Peach 6. Pear 7. Plum	Use beneath **non-bearing trees only;** a 1 year interval is required between last application and harvest. Do NOT tank mix with other pesticides.
Broadleaves, Annual & Perennial			
2,4-D amine △ Weedar 64 or 64 TF (for spot treatments, use solutions of 0.52-0.78%)	(1-1.4 lb. a.i.) 3 pt.	1. Apple 2. Apricot 3. Cherry 4. Nectarine 5. Peach 6. Pear 7. Plum	Weedar 64 users must have a copy of the new Supplemental Label for fruit crops in their possession at the time of use on apples and/or pears. Check label for new Worker Protection and handling requirements. Use only beneath vigorous trees planted at least 12 months. Do not apply during bloom or within 3 days of irrigation; do not apply to bare, dry soil nor to tree foliage, limbs, or trunks. Be very careful to eliminate drift, especially near grapes and/or irrigation ditches; do NOT apply through irrigation equipment! Any sprayed fruit must be destroyed. Bindweed is controlled by 2,4-D best through fall application after the first mild frost. Maximum of 2 applications per year.

[1]Apply during the growing season to actively growing weeds that are not stressed for water. Foliage-active herbicides, except for paraquat, are absorbed by foliage and translocated to all parts of the plant. Paraquat, however, kills only the foliage on which it is sprayed. See text (p. 9.2) and "REMARKS" column for additional information.

[2]Rates given are per acre of surface actually treated; those in parentheses are of active ingredient while those with no parentheses are of product. Actual rates also depend on the weed species to be controlled. See the Label.

[3]Remarks given here are intended to highlight important properties of particular herbicides rather than to substitute for the manufacturer's recommendations and warnings. **ALWAYS CONSULT THE LABEL** before use of any pesticide.

[4]Non-ionic surfactant should contain at least 75% surface active ingredients.

△ Product not evaluated by CSU personnel under Colorado Conditions, but effective elsewhere.

Weed Control

FOLIAGE ACTIVE (POST-EMERGENCE) HERBICIDES -- Applied to Growing Plants[1]

MATERIAL & PRODUCT	RATE[2] (a.i. per treated acre)	FRUIT CROPS	REMARKS[3]
Both Grasses & Broadleaves, Annual & Perennial			
glyphosate ● Roundup 4L, -normal applic. -high vol. hand held equip. -wiper applic.	(.75-3 lb. a.i.) 1-4 qt. 1-2% sol. 33% sol.	1. Apple 2. Apricot 3. Cherry 4. Nectarine 5. Peach 6. Pear 7. Plum	Kills entire plant (including roots). Use only under trees planted at least 8 months. Do not apply 3 days prior to irrigation nor within 14 days before harvest. A surfactant may be helpful. Addition of 8.5-17 lbs ammonium sulfate fertilizer per 100 gal spray also can increase effectivity -- see label. Glyphosate is absorbed rapidly by tree leaves and bark, so all suckers should be removed before application and any contaminated branches should be removed immediately. Be very careful of drift. Best timing: when grasses are less than 6" tall and broadleaves are close to bloom.
paraquat Non-ionic Surfactant[4] + one of following: ● Gramoxone Extra (2.5 lb.ai/gal) ● Gramoxone Super (1.5 lb.ai/gal)	(0.6-0.9 lb. a.i.) 0.5-1 pt./50 gal. + 2-3 pt. 2.5-5 pt.	1. Apple 2. Apricot 3. Cherry 4. Nectarine 5. Peach 6. Pear 7. Plum	Kills foliage only (used for chemical mowing). Restricted Use Pesticide. Wear full protective clothing and respirator while weighing, mixing, and spraying this herbicide. Do not spray trunks of young trees; do not mow treated areas before rain as paraquat-contaminated dust is a potential hazard to people. Do not graze livestock in treated areas. Destroy any contaminated fruit.
glufosinate ▵ Rely 1E (for spot treatments, use solutions of 1.5-4 fl.oz. per gallon of water)	(.75-1.5 lb. a.i.) 3-6 qt.	1. Apple	Apply to actively growing weeds. Use only beneath vigorous trees planted at least 12 months. Does not provide residual weed control because it kills only the actively growing plant parts to which it is applied; it may be tank mixed with other soil active herbicides to provide longer control, especially for germinating weed seeds. See label. This material is not a Restricted Use product (in contrast to paraquat) and may provide a safer alternative to paraquat. Maximum of 18 qts./acre/12 months.

[1]Apply during the growing season to actively growing weeds that are not stressed for water. Foliage-active herbicides, except for paraquat and glufosinate, are absorbed by foliage and translocated to all parts of the plant. Paraquat and glufosinate, however, kill only the foliage on which they are sprayed. See text (p. 9.2) and "REMARKS" column for additional information.

[2]Rates given are per acre of surface actually treated; those in parentheses are of active ingredient while those with no parentheses are of product. Actual rates also depend on the weed species to be controlled. See the Label.

[3]Remarks given here are intended to highlight important properties of particular herbicides rather than to substitute for the manufacturer's recommendations and warnings. **ALWAYS CONSULT THE LABEL** before use of any pesticide.

[4]Nonionic surfactant should contain at least 75% surface active ingredients.

GROWTH REGULATION & THINNING

TREE GROWTH REGULATION AND THINNING

Growth regulating chemicals are used to obtain a wide range of responses in trees. These responses vary with the vigor and stage of development of the tree. It is important to know the effects that are needed and any potential side effects before using these materials.

The final result of the chemical may change according to the degree of absorption and the condition (vigor) of the trees. Factors such as cool weather, slow drying conditions, and good vigorous foliage will increase the uptake of the chemical and thereby increase the response. Poor foliage generally reduces absorption, but weak trees tend to be overly sensitive to growth regulators. This apparent interaction between environmental factors and tree vigor indicates that growth regulators must be used cautiously until experience shows what effect may be anticipated.

CHEMICAL THINNING: SUGGESTIONS FOR USE

Because no single recommendation will fit all varieties in all seasons, or under all climatic conditions, it is suggested that these thinning materials be used only on a trial basis for the first year. When the factors indicate a reduced fruit set, caution should be taken so that excessive thinning and yield reduction will not occur.

Use only one application of a given material. Direct most of the spray at the top 1/3 of the tree. Inside and lower limbs are less vigorous and easier to thin. Lower nozzles on airblast sprayers should be closed; handgun spraying is preferable for hormonal materials (NAA, NAD) on large trees. Use of concentrate sprays greatly reduces the margin for error.

Timing of post bloom sprays is often based on days after full bloom. This works in many years, but fruit size is a better guide in atypical years. Research suggests that temperature is even more critical than fruit size for the postbloom thinners. The forecast should be for daytime temperatures above 50° F following NAA and Amide-Thin W sprays, and for 70° F following carbaryl (Sevin) sprays. Sevin rates should be reduced if the forecast is for 80° F or warmer. Timing sprays by days after bloom or fruit size may not work if it is too cold.

It is preferable, although not essential, to precede NAA or Amide-Thin W sprays with a blossom thinner (when one becomes available). Jonathan and Rome strains are an exception in that they are thinned better using carbaryl than NAA. If two sprays are used, one of them should be carbaryl.

The effectiveness of NAA or Amide-Thin W doubles when using the surfactant Regulaid. Use of the term "surfactant" in the chemical thinning tables refers to Regulaid or its equivalent. Otherwise, higher rates of NAA or Amide-Thin W should be used (see the label). The surfactant is deleted when these are used in a tank mix with carbaryl.

Types of Chemical Thinners

Blossom Thinners: The target in using blossom thinners is the removal of 50% of the flowers at bloom for both apples and peaches. While Elgetol is no longer available, Wilthin is now registered for this use on apple and peach. It is highly caustic and requires great care in its use.

Amide-Thin W (NAD, Napthalene Acetamide): Apply Amide-Thin W at 7 to 14 days past full bloom with a wetting agent. Without wetting agent, higher concentrations are needed. When the weather is cool after bloom, delay applications until the largest fruit are 6-8 mm in diameter and temperatures after spraying are forecasted to be above 50° F. NAD is not effective when temperatures are below 50° F. NAD may be applied with Sevin to increase the amount of thinning.

CAUTION: Do not apply to Delicious, as NAD may cause small or pygmy fruit.

NAA (Napthaleneacetic Acid): Apply NAA with a wetting agent at 15 to 25 days past full bloom. Use a higher concentration when applied without a wetting agent. NAA may be applied with Sevin to increase the amount of thinning. It (NAA) is not effective when temperatures are below 50° F. Therefore, delay applications until the largest fruits are 10-15 mm in diameter and daytime temperatures are likely to rise above 50° F within the next 5 days. NAA formulations available include 3.1WP (Fruitone-N), NAA-200 (K Salt Fruit Fix 200), and NAA-800 (K Salt Fruit Fix 800).

Sevin (Carbaryl): Sevin is an insecticide which can be applied to apple as a chemical thinner any time from 10 to 25 days after full bloom. Rate, use, and time of application depend on the variety, fruit set and degree of thinning desired, presence of bees in or near the orchard, and the potential effect on mites.

Because Sevin is effective up to 25 days after full bloom, it has been used to treat trees not adequately thinned with other materials. When applied earlier with NAA or Amide-Thin W, the amount of thinning is greater than when either material is used alone. When the weather is cool after bloom, delay applications of Sevin until the largest fruit are 10-15 mm in diameter and forecasted temperatures after spraying are likely to be above 70° F. Unless the daytime temperature rises above 70° F within 5 days after application, poor thinning and small seedless fruit may result. But do NOT use if temperatures are likely to exceed 90° F within 5 days after application.

Sevin may be applied with Amide-Thin W (NAD) or NAA. The combination may increase the amount of thinning over that of separate applications. For best response, apply the combination of Sevin and NAA, or Sevin and NAD, earlier than with Sevin alone. Fruit size may be a good indicator of when to apply the combination. When the largest fruit is 10 mm in diameter, apply the combination of Sevin and NAA or Sevin and NAD. After the fruit is 15 mm in diameter, overthinning can occur if daytime temperatures rise above 80° F.

CAUTION: Sevin is highly toxic to bees. Delay application if the orchard has late bloom on trees or has weeds or other crops in bloom. Formulations such as Sevin XLR Plus are also safer. Apply in late evening when bees are not out.

Sevin also is highly toxic to predator mites, and application therefore may increase the harmful mite populations. Reduce the hazard of injury to predator mites by directing spray toward the tops of trees, by keeping sprays off the trunk and lower limbs, and by applying Sevin earlier in the season.

Ethephon: Ethephon may be applied with Amide-Thin W to increase fruit thinning and to promote greater return bloom. Also see the following section, OTHER GROWTH-REGULATOR USES FOR APPLE.

Varietal Considerations

Apples: Golden Delicious is one of the most difficult varieties to adequately thin. Regulation of crop size from one season to another is also a serious problem. Whenever snowball bloom occurs, severe alternate bearing can develop the following year. Snowball bloom often develops one season after a light bloom or a severe frost year.

To overcome this problem and maintain annual production, a series of sprays is usually required. Start with a blossom thinner (when one becomes available) at bloom, followed by Amide-Thin W (NAD) and an application of Sevin. Even greater thinning will occur in the second application by combining NAD and Sevin in a single spray. The highest rates of Sevin should only be used 20-25 days after full bloom.

When both greater thinning and increased return bloom are desired, Ethephon can be used in combination with NAD in place of NAD and Sevin.

Spur-type red Delicious varieties are usually more difficult to thin than other red Delicious types. When a high percentage of spurs bloom in a single season, adequate thinning is more likely to be obtained by starting with a blossom thinner (when one becomes available) in the bloom period and followed by Sevin or NAA rather than by increasing the concentration and rate of Sevin or NAA.

Pears: The chemical thinning of pears is not as common or as generally satisfactory as with apples. Problems with inadequate fruit set are more common. Delay application of thinning sprays until fruit set can be adequately appraised. During cool seasons when the bloom period has been prolonged, delay application until 21 days from bloom. Greater thinning should be anticipated with earlier applications.

NAD has been used successfully to thin Bartlett pears. Inadequate thinning is more likely to be a problem than overthinning at the recommended rates. Rates of 18 ppm and 36 ppm + surfactant both caused overthinning in a 1984 trial at the Orchard Mesa Research Center.

Apply NAD 15 to 21 days after bloom. Use a wetting agent to improve its effectiveness. Use higher rates on vigorous trees. Avoid spraying weak trees.

NOTE: NAD may cause a "flattening" of leaves, but this does not adversely affect tree performance. Rates of NAD which thin Bartlett pears are likely to overthin other varieties.

OTHER GROWTH-REGULATOR USES FOR APPLES

To Promote Spurs and Side Branching

Young apple trees can be slow to develop side branches and fruiting spurs. As a result, they become leggy and difficult to bring into heavy fruiting. This is a particular problem with trees on vigorous rootstocks planted in deep fertile soils.

To promote more lateral bud break, a single application of Promalin or Promalin-latex paint spot application may be made in spring. Spray should be applied when new growth is 1-3 inches long while Promalin-latex paint spot treatment should be applied in spring when terminal buds begin to swell but before buds break and shoots emerge. Applications after bud-break can injure the tender shoot tips and fail to promote shoot growth from them. Applications can begin in the second year after planting, depending on tree growth the first season. Low rates are necessary to promote development of spurs and side branches without a major reduction in terminal growth.

To Promote Bloom

Nonbearing Trees: Several growth regulators can be used to improve development and fruiting of young apple trees. The selection of materials and rates depends on the age and condition of the trees.

CAUTION: Avoid the use of Ethephon both for weak trees and for trees on "M.9" size dwarfing rootstocks because of possible excessive blossom bud set and stunting of tree growth. Also avoid using higher rates on moderately vigorous trees.

Bearing Trees: Young trees which are slow to bear and mature trees which produce only a limited number of blossoms in "off years" can be helped by applications of Ethephon. Application of Ethephon should be delayed until after the beginning of June drop (about five to six weeks after bloom) in order to avoid excessive fruit thinning.

Alternate-year bearing on older, mature trees (particularly Golden Delicious) can occur when a high percentage of the spurs blossom in any one season. Although some of these blossoms may not set fruit or are chemically thinned, there still may not be adequate return bloom the following season. In this situation, an application of Ethephon should be made in the year of heavy bloom. Trees with snowball bloom will require an especially thorough chemical thinning program plus the use of Ethephon sprays.

CAUTION: Applications of Ethephon can reduce fruit size and flatten the fruit. Early applications of ethephon can cause excessive fruit thinning. Use of ethephon on weak trees can cause excessive flowering and stunt tree growth.

To Promote Color

Ethephon can be applied 7 to 14 days before expected harvest to enhance color. Applications advance maturity 3 to 5 days, may reduce fruit size, and may shorten storage life of fruit if fruit are not harvested at proper maturity. Ethephon may not improve color on poor-coloring, older strains and is less effective on poorly exposed inside fruit. Avoid use on Golden Delicious and other yellow varieties.

CAUTION: Because ethephon promotes abscission and fruit drop, use in combination with a preharvest stop drop spray.

To Control Preharvest Drop

NAA may be used to prevent preharvest drop of apples. NAA does not tighten up the fruit; it only prevents further loosening. Experimental evidence shows that this spray is best applied alone and is most effective at the specified concentration (20 ppm) applied as a dilute spray of 200-500 gal per acre. These sprays should thoroughly wet the foliage and fruit. Lower application volumes of 20 ppm spray should only be used on very small structured trees (extremely dwarfing root stocks) and the volumes applied should still be sufficient to insure good wetting of the trees.

NAA becomes effective 2-3 days after application and remains effective for 2-3 weeks. Due to the difference in stage of maturity of Delicious and Winesap, a single spray of NAA at one date will not be effective on both varieties.

Aerial application of NAA can be done if orchard conditions will not allow ground application. Concentrations and amounts of spray for aerial application differ from the above. See the label of the NAA product for specifics. The amounts of NAA active ingredient applied per acre by aircraft usually will be approximately 67% of the maximum applied by ground. Ground applications usually apply 1.7 oz (50 grams) or less of active NAA per acre for apple; aerial applications usually apply 1.13 oz (34 grams) of active NAA per acre. The rates for stop drop on pear are half this.

To Improve Typiness

Promalin, applied when the king blossoms are fully open, will increase the fruit length/diameter (L/D) ratio. Some thinning may follow its application.

To Suppress Fruit Russet

Pro-Vide can help prevent russet on Golden Delicious caused by unusually wet weather during the 30 days after petal fall if multiple sprays of this material are applied during that period.

OTHER GROWTH REGULATOR USES FOR PEARS

To Promote Spurs and Side Branching

Young pear trees can be slow to develop side branches and fruiting spurs. Lateral branching and tree development can be encouraged in non-bearing pears by a single application of promalin.

To Control Preharvest Drop

NAA is equally effective in preventing preharvest drop of Bartlett pears and apples. See the discussion above under Apples.

GROWTH REGULATOR PROGRAMS FOR STONE FRUITS

To Delay Flowering of Young Trees -- Sweet and Tart Cherries

The new gibberellic acid (GA) formulation, Pro-Gibb, is used at relatively high rates. Do not use in the year of planting, however. Heavier soils should cause the trees to respond at the lower rates.

To Extend Harvest -- Sweet Cherries

The normal harvest period for sweet cherries can be extended by use of GA (gibberellic acid, Pro-Gibb). However, see note at the end of this sub-section.

GA applied three weeks before harvest delays maturity 5-7 days. It gives larger and much firmer fruit, bright green stems, and much longer storage life.

NOTE: GA can reduce soluble solids and slightly reduce fruit bud set the following year.

To Delay Bloom -- Sweet Cherries

Fall applications of Ethephon can delay bloom 3-7 days in the following spring. Apply about September 15. Gumming and twig dieback have been observed with Ethephon under some conditions.

Chemical Thinning

FRUIT VARIETY	MATERIALS	CONCENTRATION OF A.I.[1]	RATE PER 100 GALS(DILUTE)[2]	REMARKS
Bloom Sprays:				
APPLES	monocarbamide dihydrogensulfate ● Wilthin		 2-3 pt.	May be used only once per season. Apply at 80-90% full bloom as dilute spray only; DO NOT USE AS A CONCENTRATE SPRAY. Do not mix with any other materials other than Regulaid. Shut off lower nozzles to avoid overthinning of weaker blossoms on the lower and inside portions of the tree. Highly corrosive; use of eye protection is essential! See label for other cautions/ limitations.
PEACHES/ NECTARINES	monocarbamide dihydrogensulfate ● Wilthin		 3-6 qt./acre (see notes)	May be used only once per season. Apply at 90-95% full bloom in 100 to 250 gal/acre. Do not mix with any other materials. Shut off lower nozzles to avoid overthinning of weaker blossoms on the lower and inside portions of the tree. Highly corrosive; use of eye protection is essential! See label for other cautions/ limitations.
Postbloom Sprays: (Avoid killing bees on cover crops in bloom[3]				
APPLE: Delicious, Braeburn	NAA (any one + surfactant**) ● K Salt Fruit Fix 200 ● K Salt Fruit Fix 800 ● Fruitone-N	2-5 ppm " " 2 ppm	 .5-1 fl. oz. .1-.3 fl. oz. .8 oz	Apply NAA 15-25 days after full bloom, carbaryl once 10 - 25 days after full bloom. Combinations of carbaryl and NAA increase thinning on spur-type red Delicious. The XLR+ and 4F formulations of carbaryl are less hazardous to bees.
	carbaryl[3] ● (Carbaryl, Sevin XLR+) 4L ● Sevin 50W	150-300 ppm " "	 4-8 fl. oz. 4-8 oz.	

[1]Concentration of active ingredient to be used.

[2]Spray to Run-Off, to the point of visible drip from leaves (=400 gal/acre of large trees).

[3]Sevin is highly toxic to bees and predator mites. See text, pages 3.11.

**Use surfactant (e.g., Regulaid) according to manufacturer's recommendations, but not more than 1 pint per 100 gallons of spray.

NOTE: For easier and more accurate measurement of small amounts of liquids, dilute them first. For example, make a 10 to 1 dilution by putting 1 part in 9 parts water. From this stock solution, measure out and use 10 times the amount shown in the table.

Chemical Thinning

FRUIT VARIETY	MATERIALS	CONCENTRATION OF A.I.[1]	RATE PER 100 GALS(DILUTE)[2]	REMARKS
Postbloom Sprays: (Cont'd.)[3]				
APPLE: Jonathan, Rome	NAA (any one + surfactant**)	3-5 ppm		Apply NAA 15-25 days after full bloom, carbaryl once 10-25 days after full bloom. NAA is less effective on Jonathan and Rome. The XLR+ and 4F formulations of carbaryl are less hazardous to bees.
	● K Salt Fruit Fix 200	"	.7-1 fl. oz.	
	● K Salt Fruit Fix 800	"	.2-.3 fl. oz.	
	● Fruitone-N	3 ppm	1.2 oz.	
	carbaryl[3]	300-600 ppm		
	● (Carbaryl, Sevin XLR+) 4L	"	8-16 fl. oz.	
	● Sevin 50W	"	8-16 oz	
APPLE: Golden Delicious, Granny Smith, Gala, Fuji, Jonagold	NAD (+ surfactant**)	17-34 ppm		Apply Amid-Thin W at 3-14 days, carbaryl at 3-25 days, NAA at 15-25 days after full bloom when the largest fruit is 10-15 mm in diameter. For greater thinning, use lower rates of NAA or NAD with carbaryl. NAD plus ethephon gives greater thinning and return bloom. The XLR+ formulation of Sevin is less hazardous to bees.
	● Amid-Thin W	"	3-5 oz.	
	NAA (any one + surfactant**)	3-5 ppm		
	● K Salt Fruit Fix 200	"	.7-1 fl. oz.	
	● K Salt Fruit Fix 800	"	.2-.3 fl. oz.	
	● Fruitone-N	"	1.2-2.0 oz.	
	carbaryl[3]	300-450 ppm		
	● (Carbaryl, Sevin XLR+) 4L	"	8-12 fl. oz.	
	● Sevin 50W	"	8-12 oz.	
	Combination NAD + ethephon			
	NAD	17-34 ppm		Overthinning can occur if daytime temperatures exceed 90°F.
	●Amid-Thin W	"	2.7-5.4 oz.	
	+		**+**	
	ethephon	300-450 ppm		
	● (Ethrel, Ethephon) 2E	"	1-1.5 pt.	
	Combination carbaryl + either NAD **or** NAA			
	carbaryl[3]	300-450 ppm		
	● (Carbaryl, Sevin XLR+) 4L	"	8-12 fl. oz.	
	● Sevin 50W	"	8-12 oz.	
	+		**+**	
	NAD	17 ppm		
	● Amid-Thin W	"	2.7 oz.	
	or		**or**	
	NAA (any one)	3 ppm		
	● K Salt Fruit Fix 200	"	.7 fl. oz.	
	● K Salt Fruit Fix 800	"	.2 fl. oz.	
	● Fruitone-N	"	1.2 oz.	

[1]Concentration of active ingredient to be used.

[2]Spray to Run-Off, to the point of visible drip from leaves (based on 400 gallons per acre of large trees).

[3]Sevin is highly toxic to bees and predator mites. See text, pages 3.11.

**Use surfactant according to manufacturer's recommendations, but not more than 1 pint per 100 gallons of spray.
△Product not evaluated by CSU personnel under Colorado conditions, but found to be effective elsewhere.

Chemical Thinning

FRUIT VARIETY	MATERIALS	CONCENTRATION OF A.I.[1]	RATE PER 100 GALS(DILUTE)[2]	REMARKS
Postbloom Sprays: (Cont'd.)[3]				
APPLE: Winesap	NAD (+ surfactant**)	17 ppm		Apply Amid-Thin W at 7-14 days after full bloom, carbaryl once 10-25 days after full bloom, or NAA 15-25 days after full bloom. The XLR+ and 4F formulations of carbaryl are less hazardous to bees.
	● Amid-Thin W	"	2.7 oz.	
	NAA (any one + surfactant**)	2-5 ppm		
	● K Salt Fruit Fix 200	"	.5-1 fl. oz.	
	● K Salt Fruit Fix 800	"	.12-.3 fl. oz.	
	● Fruitone-N	"	.8-2 oz.	
	carbaryl[3]	150-300 ppm		
	● (Carbaryl, Sevin XLR+) 4L	"	4-8 fl. oz.	
	● Sevin 50W	"	4-8 oz.	
PEARS: Bartlett	NAD	10-15 ppm		Apply 15-21 days after full bloom. Amid-Thin W may overthin varieties other than Bartlett.
	● Amid-Thin W (+ surfactant)	"	1.6-2.4 oz.	
	NAA	10-15 ppm		
	△ NAA 200 (+ surfactant) 2.4-3.6 fl. oz.	"		

[1]Concentration of active ingredient to be used.

[2]Spray to Run-Off, to the point of visible drip from leaves (based on 400 gallons per acre of large trees).

[3]Sevin is highly toxic to bees and predator mites. See text, pages 3.11.

**Use surfactant according to manufacturer's recommendations, but not more than 1 pint per 100 gallons of spray.
△Product not evaluated by CSU personnel under Colorado conditions, but found to be effective elsewhere.

Growth Regulators

EFFECT	MATERIALS	CONCENTRATION OF A.I.[1]	RATE PER 100 GALS (DILUTE)[2]	REMARKS
APPLES -- Young, Non-Bearing Trees (Spray to Run-Off)				
To promote spur development	giberellic Acid ● Promalin ● Promalin + latex paint	 125-500 ppm 5000-7500 ppm	 .25-1 pt/5 gal .2-.33 pt + 1 pt.	Apply when new shoots are 1-3 inches long, about 1 week after bloom. Rate depends on conditions and tree vigor (see text p. 11.4). Avoid use on weak trees or M.9 rootstocks.
To promote bloom the following year	ethephon (+ surfactant**) ● (Ethrel, Ethephon) 2E	300-600 ppm "	 1-2 pt.	Apply 4-5 weeks after bud break. Delay application until 5-6 weeks after bloom if fruit is present. Avoid double coverage or use on low-vigor trees. Material and rate depend on conditions. See text p. 11.4.
APPLES -- Bearing Trees (Spray to Run-Off unless noted otherwise).				
To promote bloom the following year	ethephon (+ surfactant**) ● (Ethrel, Ethephon) 2E	300 ppm "	 1 pt.	Avoid use on low-vigor trees. Apply ethephon sprays 5-6 weeks after full bloom. To avoid excess thinning, delay application until June drop begins. See text, pages 11.3-11.4.
Promote typiness of Delicious apples	gibberellic Acid: ● Promalin (incl. BA)	 25 ppm	 1 pt.	Apply as a fine mist application at a rate of 200 gal/A when king blossoms are fully open. See text, page 11.5

[1]Concentration of active ingredient to be used.

[2]Spray to Run-Off, to the point of visible drip from leaves (based on 400 gallons per acre of large trees).

**Use surfactant according to manufacturer's recommendation, but not more than 1 pint per 100 gallons of spray.

Growth Regulators

EFFECT	MATERIALS	CONCENTRATION OF A.I.[1]	RATE PER 100 GALS (DILUTE)[2]	REMARKS
APPLES -- Bearing Trees (Spray to Run-Off unless noted otherwise).				
Suppress fruit russet in Golden Delicious	gibberellic Acid: ● Pro-Vide	15-20 ppm "	 10-13 fl.oz.	Apply at 100-200 gal/A as a post bloom spray; 2-4 applications per season.
To promote red color	ethephon (+ surfactant**) ● (Ethrel, Ethephon) 2E	300 ppm "	 1 pt.	Apply ethephon 7-14 days before expected harvest.
CAUTION: Use ethephon in combination with stop-drop spray. May not improve color under adverse weather conditions and on poor coloring varieties and strains or on heavily shaded fruit. Can shorten storage life of fruit if not harvested at proper firmness and maturity. See text, page 11.5.				
To prevent preharvest fruit drop.	NAA (any one) ● K Salt Fruit Fix 200 ● K Salt Fruit Fix 800 ● Fruitone-N	20 ppm " " "	 4.8 fl.oz. 1.2 fl.oz. 8 oz.	Do not use NAA sprays more than twice. The pre-harvest interval for NAA is 5 days.
PEARS -- Spray to Run-Off				
To increase side branching and improve branch angles	gibberellic Acid ● Promalin	250-1000 ppm "	 .5-2 pts per 5 gal	Non bearing pears only. Single foliar application after trees have reached the height at which side branching is desired.
To prevent preharvest fruit drop (Bartlett)	NAA (any one) ● K Salt Fruit Fix 200 ● K Salt Fruit Fix 800 ● Fruitone-N	10 ppm " " "	 2.0 fl.oz. 0.6 fl.oz. 4 oz.	Do not use more than twice. Application timing varies between 5 and 10 days before harvest. Preharvest interval for NAA is 5 days.

[1]Concentration at active ingredient to be used.

[2]Spray to Run-Off, to the point of visible drip from leaves (based on 400 gallons per acre of large trees).

**Use surfactant according to manufacturer's recommendation, but not more than 1 pint per 100 gallons of spray.

For easier and more accurate measurement of small amounts of liquids, make a 10 to 1 dilution by putting 1 part material in 9 parts water. From this stock solution, measure out and use 10 times the amount shown in the table.

Growth Regulators

EFFECT	MATERIALS	CONCENTRATION OF A.I.[1]	RATE PER 100 GALS (DILUTE)[2]	REMARKS
SWEET CHERRY -- Spray to Run-Off				
Delay fruit maturity, increase size, provide a brighter colored, firmer fruit.	gibberellic Acid ● Pro-Gibb (GA 4%L)	10-20 ppm "	 4-8 fl.oz.	Apply when fruit is light green to straw colored; thoroughly wet entire tree. Delays maturity 3-5 days. Improves fruit firmness and storage life. Do not apply within 7 days of harvest.
To increase side branching and improve branch angles.	gibberellic Acid ● Promalin ● Promalin + latex paint	 250-1000 ppm 5000-7500 ppm	 .5-2 pts per 5 gal .2-.33 pt. + 1 pt. paint	Promalin spray: single application, Non-bearing sweet cherry only, after trees have reached a height at which branching is desired. Promalin paint: apply only before bud break (between bud swell and bud break). Orchard trees only for paint treatment.
Prevent flowering of young trees	gibberellic Acid ● Pro-Gibb (GA 4%L)	50-100 ppm "	 20-40 fl.oz.	Apply 2-4 weeks after bloom at approx. 1 qt. spray per tree. Do not spray trees in their first year.
Delay bloom and increase blossom hardiness	ethephon (+surfactant**) ● (Ethrel, Ethephon) 2E	300 ppm "	 1 pt.	Apply September 15 to delay blossoming the following spring.

[1]Concentration at active ingredient to be used.

[2]Spray to Run-Off, to the point of visible drip from leaves (based on 400 gallons per acre of large trees).

**Use surfactant according to manufacturer's recommendation, but not more than 1 pint per 100 gallons of spray.

For easier and more accurate measurement of small amounts of liquids, dilute them first. For example, make a 10 to 1 dilution by putting 1 part in 9 parts water. From this stock solution, measure out and use 10 times the amount shown in the table.

Growth Regulators

EFFECT	MATERIALS	CONCENTRATION OF A.I.[1]	RATE PER 100 GALS (DILUTE)[2]	REMARKS
TART CHERRY -- Spray to Run-Off				
Prevent flowering of young trees.	gibberellic Acid ● Pro-Gibb (GA 4%L)	50-100 ppm "	20-40 fl.oz.	Apply 2-4 weeks after bloom at approx. 1 qt. spray per tree. Do not spray trees in their first year.
Maintain and extend high fruiting capacity of bearing tart cherry trees; reduce occurrence of "blind" nodes.	gibberellic Acid ● Pro-Gibb (GA 4%L)	10-20 ppm "	4-8 fl.oz.	Apply foliar spray at 14-28 days after full-bloom (or 14 days after shuck split).

[1]Concentration of active ingredient to be used.

[2]Spray to Run-Off, to the point of visible drip from leaves (based on 400 gallons per acre of large trees).

**Use surfactant according to manufacturer's recommendation, but not more than 1 pint per 100 gallons of spray.

For easier and more accurate measurement of small amounts of liquids, dilute them first. For example, make a 10 to 1 dilution by putting 1 part in 9 parts water. From this stock solution, measure out and use 10 times the amount shown in the table.

NUTRIENT SPRAYS

Of the various nutrients that can be limiting in Colorado orchards, usually zinc, iron, copper, manganese, calcium, magnesium, nitrogen, and boron can be successfully corrected with sprays. Zinc deficiencies are most successfully corrected through dormant sprays, while the most effective responses to the other nutrients are through soil applications. Iron sprays are not effective on peaches nor, possibly, pears. 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. Researchers in Utah have reported a summary of their studies on the effect of foliar nutrient sprays on sour cherries and apples (see ADDITIONAL INFORMATION SOURCES, reference H.2.c, page 5.6). Further information may be obtained by contacting Dr. Gaus (Rogers Mesa Res. Center, 970-872-3387).

CAUTION: Nutrient sprays can cause injury if not applied correctly 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). Pyrethroid insecticides are rapidly deactivated at low pH values, especially those around 3.5-4.0.

Boron: Leaf analysis results show some boron deficiencies in peaches and apples. However, pears are the fruit crop which most often show 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 prebloom applications are recommended.

CAUTION: Do not confuse "blossom blast" with such diseases as fire blight.

Calcium: Spray applications of calcium can only 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 bitter-pit, 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 chelates are much more effective than foliar sprays, but need to be protected from breakdown by the sunlight. For soil applications, apply 2-4 oz. Sequestrene 138 Fe or Ferriplus 138 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 Colorado. 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 (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.

Nutrient Sprays

NUTRIENT	USE ANY ONE OF THE LISTED MATERIALS OR COMBINATIONS	RATE PER 100 GAL.(DILUTE)[1]	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.	See precautions in text, page 13.2
	● Zinc sulfate .5 lb./gal.LC	0.5 gal.	2 gal.	
	△ TechFlo Zeta Zinc	8 fl.oz.	1 qt.	
	△ Zn 50	1.25 lb.	5 lb.	
Zinc deficiency	● Zinc sulfate 36% crystals	10 lb.	40 lb.	See precautions in text, page 13.2
	● Zinc sulfate 1.2 lb./gal. LC	3 gal.	12 gal.	
	△ TechFlo Zeta Zinc	1 qt.	4 qt.	
	△ Zn 50	2.5 lb.	10 lb.	
PRE-PINK OR PINK SPRAY				
Boron maintenance	● Solubor 20.5WP	10 oz.	2.5 lb.	Do not apply over 5 lb. per acre per year. See labels for further details.
	△ Borosol 10	8-32 fl.oz.	1-4 qt.	
Boron deficiency	●Solubor 20.5WP	1.25 lb.	5 lb.	Do not apply over 5 lb. per acre per year. See labels for further details and precautions in text, page 13.1.
	△ Borosol 10	8-32 fl.oz.	1-4 qt.	
FOLIAGE SPRAY - After bloom and before harvest				
Boron maintenance	● Solubor 20.5WP	10 oz.	2.5 lb.	Do not apply over 5 lb. Solubor per acre per year. Multiple applications at low rates are most effective; see label.
	△ Borosol 10	8 fl.oz.	1 qt.	
Boron deficiency	● Solubor 20.5WP	1.25 lb.	5 lb.	Do not apply over 5 lb. Solubor per acre per year. Best applied after harvest or before bloom on pears. See precautions in text, page 13.1. Multiple applications at low rates are most effective; see label.
	△ Borosol 10	8-16 fl.oz.	1-2 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		Follow manufacturer's directions. All chelates break down rapidly under ultra-violet (sun) light. Spray chelates in evening or on cloudy days. See Text, page 13.2.

[1]Low concentrations, in 400 gallons per acre with average-sized trees, are generally recommended to prevent damage.

△Product not evaluated by CSU personnel under Colorado conditions, but found to be effective elsewhere.

Nutrient Sprays

NUTRIENT	USE ANY ONE OF THE LISTED MATERIALS OR COMBINATIONS	RATE PER 100 GAL.(DILUTE)[1]	RATE PER ACRE	REMARKS
FOLIAGE SPRAY -- After bloom and before harvest (Cont'd.)				
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.	See precautions in text, page 13.2.
	● Zinc sulfate 1.2 lb./gal. LC	0.5-1 gal.	2-4 gal.	
	△ TechFlo Zeta Zinc	0.25-1 pt.	1-4 pt.	
Zinc deficiency bearing trees	△ Zn50	0.5-2.5 lb.	2-10 lb.	Caution: certain varieties of plums, peaches, and apricots are susceptible to zinc excesses.
	△ TechFlo Zeta Zinc	0.25-1 pt.	1-4 pt.	
Magnesium deficiency	● epsom salts (magnesium sulfate)	10-20 lb.	40-80 lb.	Apply in 3 sprays at 14 day intervals beginning at petalfall.
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.
POSTHARVEST - Fall application near leaf drop				
Boron maintenance	● Solubor 20.5WP	0.5 lb.	2.5 lb.	See labels and text, p. 13.1.
	△ Borosol 10	8 fl.oz.	1 qt.	
Boron deficiency	● Solubor 20.5WP	1 lb.	5 lb.	See labels and text, p. 13.1.
	△ Borosol 10	1-2 pt.	2-4 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!** See text, p. 13.2
	△ TechFlo Zeta Zinc	.25 qt.	1 qt.	
	△ Zn50	1.25 lb.	5 lb.	
Zinc deficiency	● zinc sulfate 36%	2.5-5 lb.	10-20 lb.	**Not on apricots!** See text, p. 13.2
	△ TechFlo Zeta Zinc	1 qt.	4 qt.	
	△ Zn50	2.5 lb.	10 lb.	

[1]Low concentrations, in 400 gallons per acre with average-sized trees, are generally recommended to prevent damage.

△Product not evaluated by CSU personnel under Colorado conditions, but found to be effective elsewhere.

SAFETY RULES FOR PESTICIDE USE

1. READ ENTIRE LABEL BEFORE USING PRODUCT.
2. Observe all precautions each time a material is used.
3. Store chemical under lock and key out of reach of children and pets and away from food and feed.
4. Keep chemicals in their original containers.
5. Dispose of unused chemicals and empty containers in such a way that they are no longer hazardous.
6. Follow directions pertaining to residual tolerances on edible plants; allow the specified time interval between last application and harvest.
7. Use chemicals only on crops specified at the correct rate and schedule.
8. Do not eat or smoke while applying pesticides.
9. Wear protective clothing and masks when directed on the label.
10. Bathe and change to clean clothing right after spraying or dusting. Wash clothing before reuse.
11. If chemicals are spilled on the skin or clothing, change clothing immediately and wash thoroughly.
12. If illness develops during or after a spraying or dusting operation, call a physician or take patient to hospital immediately. **Take a copy of the label with you.**
13. Avoid chemical injury to plants; use separate equipment for herbicides.
14. Rates of application have been carefully computed; do not use more than recommended.
15. Do not spray or dust on a windy day; avoid drift that would injure plants on adjacent property.

☞For Emergency Phone Numbers, See Inside Front Cover ☜