

EM 4334 Revised April 1980

# **COMMERCIALY GROWN STRAWBERRIES**

**insect, disease, and  
weed control guide for  
Washington state**



COOPERATIVE EXTENSION SERVICE • COLLEGE OF AGRICULTURE • WASHINGTON STATE UNIVERSITY • PULLMAN

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Cooperative Extension Service, J. O. Young, Director

## NOTE

- Descriptions and biologies of strawberry pests are outlined in the *Strawberry Production Guide*—EM 3905.
- List of chemicals in this publication indicate legally registered materials, and sequence of listing does not indicate better performance of one material over the other.

## WHEN TO SPRAY

*The purpose of this spray schedule is to help growers know when to be on the lookout for various diseases, insect pests, and weeds—not to recommend routine sprays for all the problems listed. Some diseases and other pests of strawberries occur almost every year and require routine preventative treatments. Examples are fruit rot, certain weevils, and annual weeds. However, other problems, e.g., two-spotted spider mite, are sporadic in frequency and location and should be treated only as the need arises. This requires constant vigilance by the grower, so a problem, if it does occur, will not advance beyond remedy. However, the reward is a lower bill for pesticides and application, as well as protection of natural control agents which help to further reduce the "cost" of pesticides.*

- Note that diseases and insects are listed according to relative occurrence: rarely encountered, occasionally encountered, or commonly encountered. These terms serve as guidelines in order to prevent or avoid continuous prophylactic or preventative sprays for pests that do not occur regularly.

*Preplant Treatments.* Application of insecticides to the soil prior to planting requires only that enough water be used for even distribution, usually 50 to 100 gallons per acre. The chemicals should be incorporated as soon as possible by double-discing or rotary tillage. Soil fumigation for nematodes is best accomplished in early fall while soil temperatures are above 45 degrees F.

*Foliage Treatment.* Application of pesticides to strawberry foliage requires enough water for good coverage and sufficient pressure to cover the interior foliage. A spray of 100 gallons of water per acre with 150 pounds pressure will help accomplish this. An arrangement of one nozzle above and one low on each side of the row and angled up at the plants helps to provide good coverage over the plant, including the underside of the leaves.

## BEE POISONING

Honey bees and various species of wild bees or other insects are necessary for complete pollination of strawberry flowers. Poor pollination results in smaller and misshapen berries and, therefore, lower yields.

*Many of the insecticides recommended for the prebloom or postharvest periods are highly toxic to bees and should not be used during bloom.* The chemicals Thiodan, methoxychlor, and Metasystox-R may be used during bloom if they are applied in early morning or evening when bees are not present. None of the fungicides recommended are toxic to bees.

Contact nearby beekeepers whenever you plan to use a material hazardous to bees. This will prevent accidental bee kills and help establish better cooperation between growers and beekeepers.

## EXPLANATION OF FORMULATIONS

Many of the materials listed are presented as EC, F, or WP. EC means emulsifiable concentrate which contains a pesticide and an emulsifying agent in a suitable solvent. These are diluted with water to form an emulsion and applied as sprays. F means flowable, a formulation which contains a pesticide impregnated on small particles, such as clay, added to a small amount of liquid, such as water, to make a thick paste or cream. When added to the spray tank, a suspension is formed which can be maintained with little agitation. When preceded by a number, such as 2 EC or 2 F, this means that there are 2 pounds of actual toxicant per gallon of formulation. WP means wettable powders which are dry forms of pesticides in which the toxicant is carried on powders that can be readily mixed with water because a wetting agent has been added. These forms a suspension-type spray which must be kept agitated in a sprayer tank. When preceded by a number, such as 50 WP or 50 W, this means that there is 50 percent actual toxicant per pound of material.

DISEASE AND INSECT  
CONTROL GUIDE

Disease or Insect and Relative Occurrence	Pesticide (use one)	Amount of Formulation Per Acre*	Minimum Days Be- tween Last Application and Harvest	Remarks
<b>PREPLANT TREATMENT</b>				
Nematodes (occasional)	DD Telone Vidden D Vorlex	Follow manu- facturer's direc- tions.	Preplant only	Have nematode analysis made and base fumigation on results. It is best to fumigate in late summer or early fall before <i>anticipated planting in spring</i> .
Strawberry root weevil Black vine weevil Rough strawberry root weevil (common)	chlordane**	5 qt of 8 EC	Preplant only	Apply to soil in sufficient water for good coverage. Incorporate by discing or rotary tillage.
Woods weevil Obscure root weevil (com- mon)	No chemicals registered for pre-planting application. See post-harvest period.			
Garden symphylan (rare)	fonofos (Dyfonate)	2 qt of 4 EC 20 lb of 10% granules		Apply Dyfonate to the soil just prior to planting. Disc into soil. Will protect plants only during summer following transplanting. Fumigation as explained above for nematodes, may be used.

## ESTABLISHED PLANTINGS—HARVEST YEARS

## Dormant &amp; Prebloom Periods

Leaf Spot (common)	Bordeaux	6-6-100	See remarks	<i>Do not</i> combine Bordeaux with insecticides or other fungicides. Where leaf spot has been a problem, make initial application when growth begins and repeat at 10-14 day intervals. If Bordeaux is used, discontinue at first bloom. Fruit rot program helps control leaf spot.
	or Benomyl*** (Benlate)	1/2-1 lb of 50% WP (Apply in 100 gal water)	See remarks	

**NOTE:** All recommendations are made as formulations (the way it comes in the package); not to be confused with recommendations as active ingredient (actual pesticide) as may appear in other more technical publications.

## CONTROL GUIDE (continued)

Disease or Insect and Relative Occurrence	Pesticide (use one)	Amount of Formulation Per Acre*	Minimum Days Between Last Application and Harvest	Remarks
Powdery mildew (common)	benomyl** (Benlate)	1/2-1 lb 50% WP applied in 100 gal water.	See remarks	Begin applications in early spring and discontinue well before harvest. Sulfur dust may burn foliage in hot weather. Plant damage has been reported from northwest Washington at rates of sulfur above 2 lb/100 gal. Consult fieldman for processor regulations.
	sulfur dust	20-30 lb	See remarks	
	sulfur spray	4-6 lb applied in 100 gal water.	See remarks	
Spittlebug (common)	azinphos-methyl (Guthion)	1 lb of 50% WP	5	Apply when blossom clusters start to separate. Control is more difficult after the spittle masses are formed. Use 100 gal of water per acre.  <i>WARNING: Do not apply Guthion during bloom because of hazard to bees.</i> Apply Thiodan in evening or early morning to avoid bee poisoning.
	or			
	endosulfan	2/3 qt of 3 EC	4	
	(Thiodan)	1 qt of 2 EC	4	
		1 lb of 50% WP	4	
Aphids: (common)	Aphid sprays involve a special schedule that is aimed at the control of virus spread. Read the remarks below and refer to detailed spray schedule on page 7.			
	Metasystox-R, Guthion, and diazinon are all recommended for strawberry aphid control. Thiodan may also be used, but in many areas strawberry aphids are resistant to it. Spraying should begin in early April and be repeated at 3- to 5-week intervals until at least September. The use of Metasystox-R in Washington is restricted to three applications per season. The third application must be applied after harvest. It is suggested that two of these be applied in April and May when the aphid is multiplying most rapidly. Fields should be watched closely, and when any aphids are again seen, the field should be resprayed.			
Cyclamen mite (rare)	endosulfan	2/3 qt of 3 EC	4	Direct spray into crowns.  Apply in 100 gal of water per acre.  Apply in evening or early morning to avoid bee poisoning.
	(Thiodan)	1 qt of 2 EC	4	
		1 lb of 50% WP	4	

## CONTROL GUIDE (continued)

Disease or Insect and Relative Occurrence	Pesticide (use one)	Amount of Formulation Per Acre*	Minimum Days Between Last Application and Harvest	Remarks
<b>Bloom Period</b>				
Fruit rot (common)	Captan or	5 lb of 50% WP applied in 100 gal water.	0	Begin applications at first bloom and obtain good spray coverage.
Leaf spot (common)	benomyl** (Benlate)	1/2-1 lb of 50% WP applied in 100 gal water.		Apply Captan at about 8-day intervals or after each rainy period, but no more than 2 sprays in any 6-day period. Apply Benlate at 10-14 day intervals.
Omnivorous leaf-tier (occasional)	Methoxy-chlor  Guthion, Sevin, and other chemicals which would probably control this insect are not recommended during the bloom period because of their high toxicity to bees.	3 lb of 50% WP	14	Apply during first or second week of bloom. Reapply in 3 weeks if necessary. See Bee Poisoning section on page 2.
Aphids: (common)	See pages 4 and 7.			
Twospotted spider mite (common)	cyhexatin (Plictran) or dicofol (Kethane) or tetradifon (Tedion)	2 lb of 50% WP  1 1/2 qt of 18 1/2% EC 1 1/2 lb of 35% WP  Use as manufacturer directs.	1  2 2 3	Good coverage of undersides of leaves is essential. Tedion is most effective when used against low mite populations as its main action is against eggs and miniature mites. Do not reapply Tedion within 35 days.  In some areas, mites may be resistant to Kethane or Tedion.
<b>Harvest Period</b>				
Slugs (occasional)	metaldehyde	25-50 lb of 2-4% bait.	6	Apply when slugs appear and repeat as needed. Apply between the rows to avoid contaminating fruit or foliage. Bait must contain no other pesticide which would leave an illegal residue at harvest.  Consult your fruit buyer before using metaldehyde. In areas with a history of problems with slugs, it may be helpful to bait around margins of the fields during the year of establishment to reduce migration into the fields.

## CONTROL GUIDE (continued)

Disease or Insect and Relative Occurrence	Pesticide (use one)	Amount of Formulation Per Acre*	Minimum Days Between Last Application and Harvest	Remarks
<b>Postharvest Period</b>				
Twospotted spider mite (common)	Same as in bloom-period. Serious damage is rare at this time.			
Cyclamen mite (rare)	Same as in prebloom period			
Aphids: (common)	See pages 4 and 7.			
Strawberry leafroller (occasional) (rare)	azinphos-methyl (Guthion) or parathion	1 lb of 50% WP 1 pt of 4 EC 2 lb of 25% WP		Apply if population reaches two larvae per plant or foot of matted row. See Bee Poisoning section on page 2.
Obscure root weevil (common)	azinphos-methyl (Guthion) or carbofuran (Furadan)	1 lb of 50% WP 2 qt of 4 F		Apply Guthion in 100 gal water per acre to the foliage. Begin treatments immediately after harvest. Repeat in 2 weeks. Do not apply unless root weevils are definitely present. See below for Furadan application instructions.
Strawberry root weevils Black vine weevil Woods weevil (common)	Furadan only	Same		Apply 2 qt of 4 lb/gal. flowable Furadan in 100 gal of water per acre. Concentrate in a 12-inch wide band over the rows. Incorporate by use of 1-2 inches of water through sprinklers. Application may be between last harvest and October 1, but it is recommended that it be applied approximately August 1. Do not apply if any berries are present. Do not apply more than once per season. (See WSU EM 4046 for additional information.)

\* EC=emulsifiable concentrate; WP=wettable powder; F=flowable (see page 1).

\*\* Registration of chlordane has been suspended for this use by EPA; however, existing stocks can be used according to label directions. No substitute is registered for preplant treatment. See postharvest period.

\*\*\* Recent evidence suggests that certain fungi can build up resistance rapidly to Benlate. It is therefore suggested that Captan and Benlate sprays be alternated or used as a tank mixture.





### SPRAY COMPATIBILITY (ABILITY TO MIX) CHART FOR FUNGICIDES AND INSECTICIDES

It may be to your advantage to control several problems with one spray by combining several chemicals. *Read the label* and follow the manufacturer's directions when making these mixtures. This compatibility chart is provided to help you in preliminary planning only. Compatibilities can vary from those indicated on this chart because of change in solvents and emulsifying agents, etc. It is a good idea before making a tank mixture to mix the chemicals in a jar of water at approximately the recommended dilution rate and look for any reactions that would cause solids to form and separate out of the solution. Some mixtures may create phytotoxicity problems (plant injury), so unless a label specifies otherwise, either experiment on a few plants or avoid doing it.

	Thiodan	Tedion	Sulfur	Plictran	Parathion	Methoxychlor	Metasystox-R	Guthion	Diazinon	Captan	Benlate
Benlate		C	X								
Captan	1				1	1		1			
Diazinon											
Guthion			1							1	
Metasystox-R											
Methoxychlor			1							1	
Parathion										1	
Plictran							C				
Sulfur						1		1			X
Tedion											C
Thiodan										1	

Blank=Safe

C=Caution

X=Incompatible

1=Use wettable or soluble powder forms

## WEED CONTROL GUIDE

Chemicals will give good control of annual weeds in both new and established strawberry plantings. However, they must be used with caution. It takes accurate application, timing, and amounts to obtain good weed control without injuring the plants or reducing their yields.

### PERENNIAL WEED CONTROL

Chemicals that kill perennial weeds also damage strawberry plants. Therefore, weeds such as quackgrass, sheep sorrel, field horsetail, Canada thistle, and others that grow from old roots and stems must be killed before strawberries are planted.

To maintain an income while bringing perennial weeds under control, other crops that are resistant to perennial weedkillers can be grown. Glyphosate in corn and 2,4-D, MCPA, dicamba or glyphosate in cereal grain are a few of the ways in which weedkillers can be combined with crop production to obtain perennial weed control.

Perennial weeds also can be controlled by tillage alone. Therefore, advantages and costs of chemical applications must be weighed against costs and time spent in a clean cultivation program.

### ANNUAL WEED CONTROL

Herbicides will give selective control of germinating and seedling weeds in strawberry plantings. Since several herbicides can be used safely and effectively, the choice depends upon several interrelated factors: weed species present, management practices, age of the strawberry planting, soil type, and weather conditions.

#### Diphenamid (Enide)

Diphenamid is effective against germinating seeds of many annual weed species. It will not kill weeds that are growing at the time of treatment. It sometimes persists in the soil for as long as five months, although under most conditions its weed-killing activity lasts only 2 to 3 months. Rainfall or overhead irrigation following application is essential for effectiveness. Under dry conditions, a shallow (1 to 2 inch) soil incorporation will improve weed control.

In new plantings, apply 2-6 weeks after transplanting. Weeds that have germinated should be removed by cultivation before application. A second application can be made 6 months later. In established plantings, application can be made either after harvest following renovation of beds or in the fall (October through December).

Rate of application<sup>1</sup> depends upon soil texture. Use 4 pounds active ingredient (8 pounds of 50 WP or 4.4 pounds of 90 WP Enide) per acre in coarse soils (sand, loamy sand, sandy loam); 5 pounds active ingredient (10 pounds of 50 WP or 5.6 pounds 90 WP Enide) per acre on medium soils (loam, silt loam, sandy clay loam) and 6 pounds active ingredient (12 pounds of 50 WP or 6.6 pounds 90 WP Enide) per acre on fine soils (clay, clay loam, silty clay).

Precautions:

1. Do not apply within 60 days of harvest.
2. Do not apply within 6 months of the last application.
3. Do not plant edible crops other than Irish potatoes, sweet potatoes and strawberries within 6 months after the last application of diphenamid.
4. Do not use cover crops for food or feed.
5. Do not graze livestock on treated areas.
6. Do not use in combination with fertilizers, insecticides or fungicides.
7. Follow wettable powder precautions.<sup>2</sup>
8. Under dry soil conditions, weed control will be poor.
9. Once weeds have become established, little or no control will be obtained.

*Resistant weed species.* Black nightshade, shepherdspurse, various species of mustard, smartweed, groundsel, all *established* perennial weeds.

*Susceptible weed species.* Annual bluegrass, barnyardgrass, witchgrass, green foxtail, yellow foxtail, wiregrass, annual ryegrass, chickweed, knotweed, lambsquarters, redroot pigweed, purslane.

### Chloroxuron (Tenoran)

Chloroxuron is a soil-residual herbicide that also has foliar activity. Best results are obtained before the seedling weeds have developed the first true leaf. Rainfall or sprinkler irrigation following application is necessary to control germinating weeds. Persistence of chloroxuron activity in the soil depends on many things, but in general, spring and summer applications will last 4 to 6 weeks, fall applications 6 to 8 weeks.

In new plantings, delay application until strawberry plants are established. Annual weeds should not be past the first true-leaf stage of growth at the time of application. Chloroxuron can be applied to new plantings again in the fall (October or November) for control of fall-germinating annual weeds.

In established plantings, apply either after harvest following renovation of beds or in the fall (October or November) just after fall rains have initiated winter-annual, weed-seed germination. Chloroxuron can also be used in the spring on established plantings provided application is made 60 days before first harvest.

Rate of application<sup>2</sup> is 4 pounds active ingredient (8 pounds of 50 WP Tenoran) per acre. At this rate of application, do not add spreader-sticker to spray mix. However, during the dormant season, the addition of a spreader-sticker makes it possible to kill fully grown chickweed with no injury to the strawberries.

Precautions:

1. Do not apply more than two times during any one year.
2. Do not apply within 60 days of harvest.
3. Use other herbicides when grasses are the major weed problem; chloroxuron is a poor grass killer.
4. Will not control established perennial weeds.
5. Do not apply chloroxuron when air temperature is 75°F or higher to avoid excessive burn injury on strawberry foliage.

6. Do not apply to strawberry plants under stress.
7. Follow wettable powder precautions.<sup>2</sup>
8. Thoroughly rework soil before planting succeeding crops.

*Resistant weed species.* Annual grasses, prostrate knotweed, pineappleweed, all *established* perennial weeds.

*Susceptible weed species.* Black nightshade, chickweed, shepherdspurse, lambsquarters, redroot pigweed, smartweed, spurry, various species of mustard.

#### Diphenamid Plus Chloroxuron

This combination can be used to increase the number of weeds controlled and can be used in either new or established plantings. Use 4 pounds active ingredient per acre of diphenamid (8 pounds 50 WP or 4.4 pounds 90 WP Enide) and 3 pounds active ingredient per acre of chloroxuron (6 pounds of 50 WP Tenoran). Follow all precautions as given previously for chloroxuron alone and diphenamid alone.

#### Napropamide (Devrinol)

Napropamide can be used in Washington for weed control in new and established plantings of strawberries. It has a good margin of safety and controls many different species of annual weeds. Control of germinating weed seed has lasted as long as 8 months and sometimes longer. Rainfall or overhead irrigation following application is essential for effectiveness. The surface 2 to 4 inches of soil must be wet within one day after application during the summer and within 10 days during late fall in order to obtain good control of germinating weed seed. Since napropamide has little or no effect on emerged weeds, it should be applied before they emerge.

In new plantings, apply napropamide soon after transplanting but before weed-seed germination. In established plantings, application can be made during October through March to weed-free soil.

Rate of application <sup>1</sup> is 4 pounds active ingredient (8 pounds of 50 W Devrinol) per acre.

#### Precautions:

1. At least 1/2 inch of rainfall or irrigation within a week after application is necessary for weed control.
2. Napropamide will not control established weeds.
3. Do not apply more than once per season.
4. When applied to new plantings, the setting of runners is sometimes inhibited.
5. Follow wettable powder precautions.<sup>2</sup>
6. Do not use on soils with over 10% organic matter.
7. Weed control will be reduced when soil is heavily covered with leaves or trash.
8. Do not plant alfalfa, small grains, corn, lettuce or beets for 12 months after application.
9. Use an alternate herbicide in the last harvest year to avoid residue injury on the crop following strawberries.

A special local needs registration has been granted for this use in Washington under Section 24(c), FIFRA.

*Resistant weed species.* Shepherdspures, species of mustard, henbit, minerslettuce, black nightshade, smartweed, all *established* perennial weeds.

*Susceptible weed species.* Annual bluegrass, barnyardgrass, wild oats, chickweed, common fiddleneck, knotweed, little mallow, purslane, common sowthistle, filaree, groundsel, lambsquarters, pineapple-weed, prickley lettuce, redroot pigweed.

### Simazine (Princep)<sup>□</sup>

Simazine should only be used on established plantings. It may be applied in irrigated fields after post-harvest renovation and again during October through November. In non-irrigated fields apply it once during September through November as determined by expected weed seed germination and rainfall. Weeds that have germinated should be hoed out before application.

Rate of application<sup>1</sup> is 1 pound active ingredient (1.25 pounds of 80 WP Princep) per acre.

Precautions:

1. Rainfall or irrigation soon after application is necessary for good weed control.
2. Do not apply during late winter or in the spring.
3. Do not apply to very loose, sandy, or coarse soil.
4. Limit irrigation to 1/2 inch after postharvest renovation application.
5. Adequate control of weeds in northwestern Washington requires two applications per year.
6. Follow wettable powder precautions.<sup>2</sup>

*Resistant weed species.* All established perennial weeds, triazine resistant lambsquarters, and redroot pigweed.

*Susceptible weed species.* Annual bluegrass, chickweed, groundsel, lambsquarters, nightshade, redroot pigweed, mustard spp, and smartweed.

### Simazine plus Napropamide

This combination increases the number of weed species controlled and greatly increases the length of effective control. Apply during October through November. Do not apply in the spring. Follow all precautions as given previously for simazine and napropamide alone.

Rate of application<sup>1</sup> is 1 pound active ingredient (1.25 pounds of Princep 80 WP) plus 4 pounds active ingredient (8 pounds of Devrinol 50 W) per acre.

### Other Herbicides

Herbicides listed below are currently registered for use in strawberries; however, they have been judged unsuitable in western Washington for one or more of the following reasons: (1) a high probability of strawberry injury, (2) ineffectiveness on the weed species commonly infesting strawberries, (3) inap-

<sup>□</sup>A special local needs registration has been granted for this use in Washington under Section 24(c), FIFRA.

appropriate under the usual environmental conditions and/or managerial practices common to western Washington agriculture and, (4) availability of better and less costly alternative herbicides.

DCPA (Dacthal)  
Dinoseb (Premerge 3)  
Petroleum solvents  
2,4-D amine (several trade names)

### Methods of Application

Uniform application is absolutely necessary if herbicides are to provide the desired results.

Treatment rates are low. For example, only 1.25 pounds of 80 WP Princep are needed per acre. Such a small amount of material spreads very thinly over an acre. Variations in the spray pattern, overlap, speed of the rig, worn nozzle tips, etc., will change the application rate sufficiently to damage the crop or reduce the weed control.

*To get uniform application, be sure that your sprayer:*

1. Can apply material at low pressures, 30 to 40 pounds per square inch.
2. Can apply 40 to 60 gallons of spray per acre.
3. Has nozzles spaced evenly, 12 to 18 inches apart, along a boom that can be adjusted for height.
4. Can move at a constant ground speed between 2 and 4 miles per hour.
5. Will cover the entire area with a broadcast application.
6. Has nozzle tips that deliver the rated volume of spray (test the output of the individual tip to determine its accuracy).

<sup>1</sup> All rates of application are given in pounds active ingredient per acre; also rates of application are based on complete (overall) coverage. Reduce amounts used per acre proportionately for band or strip treatment. Rate of application per square foot treated should remain the same.

<sup>2</sup> Wettable powder formulation precautions should be observed—wetable powders go into suspension, not solution. Therefore, constant agitation is required to keep the powder in suspension for uniform spraying. Mechanical agitation is preferred over hydraulic agitation. Line and nozzle strainers should be at least 50 mesh to permit free passage of the wettable powder spray mixture through the spraying system. Since wettable powders are abrasive, sprayers should be recalibrated frequently.

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