



# **2001 Commercial Small Fruit Spray Schedules**

# NOT FOR USE IN HOME PLANTINGS

## Disclaimer Statement

PESTICIDES RECOMMENDED IN THIS PUBLICATION WERE REGISTERED FOR THE PRESCRIBED USES INsofar as we were able to ascertain when printed. PESTICIDE REGISTRATIONS ARE CONTINUOUSLY BEING REVIEWED, AND OFTEN CHANGE. IF ANY INFORMATION IN THIS PUBLICATION DISAGREES WITH THE LABEL, SUCH INFORMATION MUST BE DISREGARDED, BECAUSE THE LABEL TAKES PRECEDENCE OVER THESE RECOMMENDATIONS. ANY PERSON USING PRODUCTS LISTED IN THIS PUBLICATION ASSUMES FULL RESPONSIBILITY FOR THEIR USE IN ACCORDANCE WITH CURRENT LABEL DIRECTIONS OF THE MANUFACTURER. THE LEGAL LIMITATIONS IN THE USE OF THE PESTICIDES IN THIS PUBLICATION SHOULD BE STRICTLY OBSERVED TO PREVENT EXCESSIVE RESIDUES IN OR ON HARVESTED FRUIT. MAINTAINING FRUIT RESIDUES BELOW THE TOLERANCE LIMITS IS THE GROWER'S RESPONSIBILITY, EVEN WHEN UNUSUAL CONDITIONS OCCUR THAT CAN CAUSE RESIDUES TO REMAIN LONGER THAN NORMAL.

Use of trade or brand names in this publication is for clarity and information; it does not imply approval of the product to the exclusion of others which may be of similar, suitable composition, nor does it guarantee or warrant the standard of the product.

## Precautionary Statement

To protect people and the environment, pesticides should be used safely. This is everyone's responsibility, especially the user. Read and follow label directions carefully before you buy, mix, apply, store or dispose of a pesticide. According to laws regulating pesticides, they must be used only as directed by the label.

## PESTICIDE EMERGENCY TELEPHONE NUMBERS

Medical information on treatment of pesticide or other kinds of poisoning can be obtained by calling the following poison control centers:

Chattanooga . . . . .	778-6100	Johnson City . . . . .	461-6572
Columbia . . . . .	381-1111	Knoxville . . . . .	544-9400
Cookeville . . . . .	526-4818	Memphis . . . . .	528-6048
Jackson . . . . .	426-6000 or 322-6435	Nashville . . . . .	322-6435

# 2001 Tennessee Commercial Small Fruit Spray Schedules

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Available on the Internet at <http://web.utk.edu/~extepp/pubs/pb1197.pdf>

## Table of Contents

Pesticide Safety . . . . .	4
<b>Blackberry and Raspberry Insect Control</b> . . . . .	5
<b>Blackberry Disease Control</b> . . . . .	6
Table 1. Restrictions for blackberry and raspberry pesticides . . . . .	6
<b>Raspberry Disease Control</b> . . . . .	7
Table 2. Effectiveness of fungicides for control of bramble diseases . . . . .	8
<b>Blueberry Spray Schedule</b> . . . . .	9
Table 3. Restrictions for blueberry pesticides . . . . .	10
<b>Weed Control in Brambles and Blueberries</b> . . . . .	11
<b>Grape Spray Schedule</b> . . . . .	13
Table 4. Restrictions for grape pesticides . . . . .	16
Table 5. Effectiveness of fungicides for control of grape diseases . . . . .	17
<b>Weed Control in Grapes</b> . . . . .	18
<b>Strawberry Spray Schedule</b> . . . . .	21
Table 6. Restrictions for strawberry pesticides . . . . .	25
Table 7. Effectiveness of fungicides for control of strawberry diseases . . . . .	26
<b>Weed Control in Strawberries</b> . . . . .	27
Table 8. Signal words and restricted-entry intervals for herbicides . . . . .	29
Vertebrate Management . . . . .	30
Calibrating Herbicide Sprayers . . . . .	32
Spray Solution pH . . . . .	33
Table 9. Pesticide Classification for Resistance Management . . . . .	34
Spray Record Sheet . . . . .	35
Table 10. Weed Response to Herbicides . . . . .	36

## PESTICIDE SAFETY

Pesticides are potentially hazardous to handlers and operators. Pesticide toxicities vary, but proper precautions should always be followed when using these materials.

- READ THE LABEL BEFORE USING PESTICIDES AND FOLLOW THE SAFETY DIRECTIONS.
- Wear proper protective equipment according to instructions on the pesticide label. Always wear a respirator.
- Comply with the Worker Protection Standard (WPS). Follow all label instructions on re-entry times for pesticides.
- Equip storage area with clean-up materials required by the WPS. Clean up spilled chemicals promptly and properly.
- Store pesticides in original containers under lock and key, out of the reach of children and animals, and away from food, feed and personal protection equipment. Mark the storage facility with a warning sign.
- Comply with the Right-To-Know law. Have complete product labels readily available for workers to see. Have the Material Safety Data Sheet (MSDS) for each product available for workers to see and for rescue or fire personnel to use in case of emergency.
- Apply pesticides so they do not endanger humans, livestock, crops, beneficial insects (such as bees), fish and wildlife.
- For safety's sake, do not spray alone, especially when using organophosphates or carbamates.
- If handling organophosphate insecticides regularly, you should go to your doctor periodically for blood cholinesterase determinations.
- Avoid contacting skin or clothing with spray materials. If an accident occurs, wash immediately with soap and water. If a pesticide is swallowed or gets in your eyes, follow the first-aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on the skin or clothing, remove the clothing immediately and wash skin thoroughly.
- Mix only as much pesticide as you will need for an application. If you mix too much, apply the material in the recommended manner to one of the crops listed on the label. Do not dump pesticides on the ground or pour them down sinks or other drains.
- Rinse empty pesticide containers three times with water, and pour the rinse water into the spray tank. Dispose of empty containers according to recommendations.
- Purchase or application of restricted-use pesticides requires certification. See your county Extension agent for certification or recertification.
- Maintain accurate spray records. Detailed records are required by law for restricted-use pesticides. See your county Extension agent for suggested forms to use.

## BLACKBERRY AND RASPBERRY INSECT CONTROL

The rates expressed as product/gal are based on a spray volume of 100 gal/acre. Spoonful measures are level, not heaping.

Pests	Pesticide	Product/Acre	Product/Gal	Minimum Days to Harvest
<b>Aphid, thrips</b>	malathion 57%EC	1.5 pt	1.5 tsp	1
<b>Red-necked cane borer</b>	Methoxychlor 4L	1 - 1.5 qt	2 tsp - 1 Tbsp	14
<p>Remarks: If you have a known problem with red-necked cane borer, apply 4 weekly sprays beginning the first week of May. This will probably be during bloom. Concentrate sprays on the primocanes and generally keep the insecticide "knee-high" and lower. <b>KEEP INSECTICIDE OFF BLOOMS AND FRUIT!</b> Spray late in the day or during the evening to give your bees additional protection. Larval tunneling causes gall-like swellings. The adult bronzed, blue-black beetle is about 1/3 inch long.</p>				
<b>Raspberry crown borer</b>	Guthion 2L	2 pt	--	14
<p>Remarks: Apply 200 gallons spray per acre as a spray on crown area and lower canes, in the spring before buds break. Larva hollows out roots and crown for two years before emerging as moth in July and August. Eggs are laid on foliage and larvae overwinter in a silken case (hibernacula) on roots and crowns, usually 1 to 3 inches below ground. In the spring, the larvae leave the hibernacula to enter the roots and crowns of canes.</p>				
<b>Raspberry cane borer</b>	Methoxychlor 4L	1 - 1.5 qt	2 tsp - 1 Tbsp	14
<p>Remarks: Remove and burn portions of canes infested with raspberry cane borer. The adult, a 1/2 inch long black beetle with a yellow thorax, appears from June to August. Female lays egg in cane, then girdles cane 1/4 inch above and below egg puncture, causing shoot tip to wilt and die. Larva tunnels down and overwinters near point of girdling. The next season, larva tunnels to crown, where it overwinters.</p>				
<b>Japanese beetle</b>	Methoxychlor 4L or carbaryl (Sevin 80WSP) or malathion 57%EC	1 - 1.5 qt 1.25 - 2.5 lb 1.5 pt	2 tsp - 1 Tbsp 1 - 2 Tbsp 1.5 tsp	14 7 1
<p>Remarks: Foliar spray for adult beetles as needed. Adults begin to emerge in late May and peak in early July.</p>				
<b>Raspberry sawfly</b>	carbaryl (Sevin 80WSP)	2.5 lb	2 Tbsp	7
<p>Remarks: Foliar sprays for larvae as needed. Look for this occasional pest in May and June.</p>				
<b>Spider mites</b>	malathion 57%EC	1.5 pt	1.5 tsp	1
<b>Strawberry weevil (clipper)</b>	Methoxychlor 4L	1 - 1.5 qt	2 tsp - 1 Tbsp	14
<p>Remarks: The weevil adult is small (3mm long) and brown with black areas on the side of each wing cover. The weevil feeds on the blossom buds and lays its eggs in the feeding punctures. It then partially cuts the stem so that the bud wilts, falls over and eventually falls off. The immature stages develop by mid-summer in the bud on the ground. Spray the foliage when the weevils are present.</p>				

## BLACKBERRY DISEASE CONTROL

The rates expressed as product/gal are based on a spray volume of 100 gal/acre. Spoonful measures are level, not heaping.

Disease	Pesticide	Product/Acre	Product/Gal	Min. Days to Harvest
<b>Anthracnose, cane blight</b>	liquid lime-sulfu	10 gal	12 fl oz	--
	Benlate 50W	12 oz	1 Tbsp	3

Remarks: If these diseases are confirmed by lab, apply lime-sulfur at delayed dormant, but prior to 3/4-inch shoot stage, to avoid leaf burn. Apply Benlate at early bloom, full bloom, and up to 3 subsequent applications at 14-day intervals.

<b>Gray mold (Botrytis)</b>	Rovral 50W o	1 - 2 lb	1 Tbsp	0
	Benlate 50W	12 oz	1 Tbsp	3

Remarks: Harvest period is the critical time, but only if weather is wet. Labels allow 2 applications during bloom and up to 3 subsequent applications through harvest. Over-use of either product can result in build-up of resistant Botrytis strains.

<b>Orange rust</b>	Nova 40W	1.25 - 2.5 oz	0.33 - 0.67 tsp	0
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Remarks: In infected plantings or plantings at risk of infection, begin applications in spring, before orange pustules appear on undersides of leaves. Continue at 10- to 14-day intervals until early summer. Nova does not benefit systemically-infected plants.

<b>Rosette (Double blossom)</b>	Benlate 50W or	12 oz	1 Tbsp	3
	Bordeaux mixture	4-4-50	1.25 oz	0

Remarks: Very good control obtained when applied at critical times. In severe cases, up to 5 applications following the bloom period, at 14-day intervals, are needed. The Benlate label limits its use to 3 applications after the bloom period. Bordeaux mixture, which consists of 4 lb bluestone and 4 lb spray lime per 50 gal water, can be used to extend the protection period. To mix, dissolve the bluestone in one-half tank of water with constant agitation. Then add the lime as the tank fills. Bordeaux mixture will cause leaf burn if applied on very hot days or if combined with insecticides. Pruning rosettes out before they bloom in the spring aids in control, but chemical sprays may still be needed.

**Table 1. Restrictions for blackberry and raspberry pesticides.**

Material	Re-entry Interval	Preharvest Interval (days)	Remarks
<b>FUNGICIDES</b>			
Aliette	12 hours	60	Do not make more than 4 applications per acre per year. Do not mix with copper compounds, adjuvants, or folia fertilizers. If applied prior to or after copper compounds, raise the spray pH to 6.0 or above with an alkaline buffer.
basic copper sulfate	24 hours	0	
Benlate	24 hours	3	Do not make more than 5 applications per crop per season. Do not use after a crop is turned into a "U-Pick" operation.
Nova	24 hours	0	Do not apply more than 10 oz per acre per growing season.
Ridomil Gold EC	48 hours	45	Not for blackberries. Make 1 application in the spring and another in the fall after harvest.
Ronila	12 hours	9	Not for blackberries. Do not apply more than 8 lb per acre per season.

<b>Material</b>	<b>Re-entry Interval</b>	<b>Preharvest Interval (days)</b>	<b>Remarks</b>
Rovral	24 hours	0	Do not make more than 4 applications per acre per season.
<b>INSECTICIDES AND MITICIDES</b>			
Guthion	48 hours/ 4 days	14	REI is 48 hours for mowing, irrigating, and scouting only; 4 days for all other purposes. Do not make more than 2 applications per acre per season. Application by backpack or hand-wand sprayers is prohibited.
Malathion	12 hours	1	
Methoxychlor	12 hours	14	
Sevin	12 hours	7	Do not apply more than 12.5 pounds of Sevin 80WSP per acre per crop.

## RASPBERRY DISEASE CONTROL

The rates expressed as product/gal are based on a spray volume of 100 gal/acre, with the exception of basic copper sulfate (see remarks). Spoonful measures are level, not heaping.

<b>Disease</b>	<b>Pesticide</b>	<b>Product/Acre</b>	<b>Product/Gal</b>	<b>Min. Days to Harvest</b>
<b>Anthracnose</b>	liquid lime-sulfu	10 gal	12 fl oz	--
	Benlate 50W	12 oz	1 Tbsp	3
Remarks: If anthracnose is confirmed by lab, apply lime-sulfu at delayed dormant, but prior to 3/4-inch shoot stage, to avoid leaf burn. Apply Benlate at early bloom, full bloom, and up to 3 subsequent applications at 14-day intervals.				
<b>Gray mold (Botrytis)</b>	Ronilan 50EG or	1 - 2 lb	1 Tbsp	9
	Rovral 50W o	1 - 2 lb	1 Tbsp	0
	Benlate 50W	12 oz	1 Tbsp	3
Remarks: Apply at early bloom, full bloom, and up to 3 subsequent applications through harvest. Bloom and harvest periods are the most critical. Alternate Benlate with Rovral or Ronilan to discourage fungal resistance.				
<b>Phytophthora root rot</b>	Ridomil Gold EC o	See remarks		45
	Aliette 80W	5 lb	3.5 Tbsp	60
Remarks: Use only if needed. The Ridomil GoldEC label reads: "Apply 1/4 pt/1000 linear feet of row to the soil surface in a 3-foot band over the row. Make one application in the spring and another in the fall after harvest. Use the formula in the General Information section of this label to calculate the amount of Ridomil GoldEC needed per acre." Aliette can be applied to the foliage up to 4 times per year at 45-60 day intervals, beginning after bud break and ending 30 days prior to leaf drop.				
<b>Leaf spot (Septoria)</b>	basic copper sulfate 53W o	4 lb	0.67 Tbsp	0
	Nova 40W	1.25 - 2.5 oz	0.33 - 0.67 tsp	
Remarks: Begin sprays in late spring or earlier, if disease appears earlier. Use copper at 2 lb per acre (0.67 Tbsp per gal) in spring, increasing gradually to 4 lb per acre as plant canopy increases in size, but do not concentrate the product greater than 2 lb (1 lb metallic copper) per 100 gal water (0.67 Tbsp per gal). A 10-14 day schedule may be needed throughout the growing season if weather conditions remain favorable (warm, wet) for disease. Very destructive disease on some varieties.				
<b>Powdery mildew</b>	Nova 40W	1.25 - 2.5 oz	0.33 - 0.67 tsp	0
Remarks: Not a common problem in Tennessee. In infected plantings, make first application at white blossom bud stage and repeat 10 to 14 days later.				

**Table 2. Effectiveness of fungicides for control of bramble diseases (0-3 scale).**

<b>Fungicide</b>	<b>Septoria Leaf Spot (R)</b>	<b>Phytophthora Root Rot (R)</b>	<b>Botrytis Gray Mold (R,B)</b>	<b>Anthracoze (B,R)</b>	<b>Rosette (B)</b>	<b>Cane Blight (B)</b>
Aliette	--	1	--	--	--	--
Benlate	--	--	2	2	2	1
copper	1	--	--	1	2	--
lime sulfu	--	--	--	1	--	1
Nova	3	--	--	--	--	--
Ridomil	--	2	--	--	--	--
Ronila	--	--	3	--	--	--
Rovral	--	--	3	--	--	--

R (raspberry) and B (blackberry) refer to types of brambles on which the diseases occur.

-- = not effective; 1 = slightly effective; 2 = moderately effective; 3 = highly effective.

## BLUEBERRY SPRAY SCHEDULE

**Note:** Diseases and insects are not often a major problem in blueberry and spraying according to a schedule may not be necessary. Use scouting and previous years' pest problems to assist in selection of pesticides and timing of applications.

Name/Time	Pest	Material and Rate Per Acre	Notes
Dormant	Scales	2 - 3 gal Dormant oil (70 sec.)	
Green Tip through Early Bloom-- See labels for timing.	Mummy berry, twig blight	3 lb ziram 76DF or 1 lb Benlate 50WP plus 5 lb captan 50WP	1
Full Bloom	Twig blight, anthracnose fruit rot, mummy berry	1 lb Benlate 50WP plus 5 lb captan 50WP	1
Petal Fall	Plum curculio, cranberry fruitworm, cherry fruitworm	2.8 - 3.2 pt malathion 57%EC per 200 gal or 2 - 3 pt Guthion 2L, or 1.875 - 2.5 lb Sevin 80WSP	2
	Twig blight, anthracnose fruit rot	Same as Full Bloom	
10 - 14 days late	Same as Petal Fall	Same as Petal Fall	
After adults have been observed fo 2 - 3 consecutive weeks and every 7 - 10 days during egg laying. Observe harvest restrictions.	Blueberry maggot	2 - 3 pt Guthion 2L, or 1 lb diazinon 50WP per 100 gal, or 0.25 - 0.5 lb Lannate 90SP, or 1.875 - 2.5 lb Sevin 80WSP	3
Immediately after harvest and repeat 6 to 8 weeks later.	Bud mite	2 qt Thiodan 3EC per 300 gal, or 2 gal Superior oil	4
2 weeks, 4 weeks and 3 months after harvest	Leafhoppers	1.25 - 2.5 lb Sevin 50WP, or 0.5 lb Lannate 90SP	

### NOTES

1. Benlate plus captan is preferred where twig blight, anthracnose, or mummy berry has been a problem.
2. Watch for mite buildup when using Sevin.
3. Adults usually appear last week of May, but do not lay eggs until seven to 10 days later.
4. Do not apply Thiodan after buds are well formed.

**Phytophthora root rot:** Ridomil Gold EC can aid in the control of Phytophthora root rot. The label reads as follows: Established plantings: Apply 1/4 pt/1000 lineal ft of row in a 3-ft band over the row before plants start growth in the spring. One additional application may be made to coincide with periods most favorable for root rot development. New plantings: Apply in 18-inch band over the row at broadcast rate of 3.6 pt/A at or after the time of planting. One additional application should be made to coincide with periods most favorable for root rot development.

Aliette WDG can also be used for Phytophthora control. Aliette is applied at 5 lb product per acre as a foliar spray, beginning at the pink bud stage and repeating every 14 - 21 days, up to 4 applications. Aliette also provides some control of anthracnose fruit rot and Phomopsis twig blight.

## Blueberry (continued)

**Table 3. Restrictions for blueberry pesticides.**

Material	Re-entry Interval	Preharvest Interval (days)	Remarks
<b>FUNGICIDES</b>			
Aliette	12 hours	0	Do not make more than 4 applications per year. Do not mix with copper compounds, adjuvants, or foliar fertilizers. If applied prior to or after copper compounds, raise the spray pH to 6.0 or above with an alkaline buffer.
Benlate	24 hours	21	Do not make more than 3 applications per acre per season. Do not use on container-grown blueberries. Do not use after a crop is turned into a "U-Pick" operation.
captan	4 days	0	Do not apply more than 35 lb a.i., e.g. 70 lb of Captan 50WP, per acre per season.
Ridomil Gold EC	48 hours	--	No time limit. On new plantings, do not apply more than 0.9 gal per acre broadcast during the 12 months before harvest.
ziram	48 hours	*	*Do not apply later than 3 weeks after full bloom.
<b>INSECTICIDES AND MITICIDES</b>			
Diazinon	24 hours	7	Allow 14 days between applications. Do not apply more than 1 lb a.i. per acre per season.
Guthion	48 hours/ 4 days	7	REI is 48 hours for mowing, irrigating, and scouting only 4 days for all other purposes. Do not make more than 3 applications per crop season. Allow at least 10 days between applications. Application by backpack or hand-wand sprayers is prohibited.
Lannate	48 hours	3	Do not apply more than 3.6 lb a.i. per acre per crop. Do not make more than 4 applications per crop. Do not apply during bloom.
Malathion	12 hours	1	
Methoxychlor	12 hours	14	
Sevin	12 hours	7	Do not apply more than 12.5 lb of Seven 80WSP per acre per crop.
Thiodan	24 hours	*	*Post-harvest applications only. Do not apply after buds are well formed. Do not make more than 2 applications per year.

## WEED CONTROL IN BRAMBLES AND BLUEBERRIES

HERBICIDE	<u>RATE PER ACRE (Broadcast)</u> Active Ingredient (lbs.)	Formulation	DIRECTIONS AND PRECAUTIONS
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**Note:** To further assist you with herbicide selection, refer to **WEED RESPONSE TO HERBICIDES** at the back of the spray schedule.

### Postemergence control: Annual and Perennial Grasses

Clethodim - SELECT 2EC	0.09 - 0.12	6 - 8 fl. oz.	<b>Do not apply within one year of harvest.</b> For postemergence control of annual and perennial grasses. Use low rate for annual grasses. Use high rate for perennial grasses including rhizome johnsongrass and bermudagrass. Add crop oil concentrate (containing at least 15% emulsifier) at 1% volume/volume. Repeat application is dependent on re-growth.
Fluazifop - FUSILADE DX-2E	0.09 - 0.19	6 - 12 fl. oz.	<b>Do not apply within one year of harvest.</b> For postemergence control of annual and perennial grasses. Use low rate for annual grasses. Use high rate for perennial grasses. Add either crop oil concentrate (1% volume/volume) or nonionic surfactant (0.5% volume/volume). Repeat application is dependent on re-growth.
Sethoxydim - POAST 1.5E	0.19 - 0.38	16 - 32 fl. oz.	For postemergence control of annual and perennial grasses. Use low rate for annual grasses. Use high rate for perennial grasses. <b>Blackberries:</b> Do not apply within one year of harvest. <b>Raspberries:</b> Do not apply within 45 days of harvest. <b>Blueberries:</b> Do not apply within 30 days of harvest. Add crop oil concentrate at 1% volume/volume.

### Postemergence Control: Grasses and Broadleaf Weeds

Paraquat - GRAMOXONE EXTRA 2.5L	0.6 - 0.9	2.0 - 3.0 pts.	Apply as a post-directed or shielded spray before new canes emerge. Provides non-selective control of established annual broadleaf and grass weeds. Suppresses perennial weeds. Repeat application is dependent on regrowth. Paraquat has contact not systemic activity. Can be mixed with certain pre-emergence herbicides for residual control. Requires the addition of either non-ionic surfactant or crop oil concentrate.
<b>Restricted-Use Pesticide</b>			
Glyphosate - ROUNDUP ULTRA 4L	1.0 - 5.0	1.0 - 5.0 qts.	<b>Post-directed or shielded application only. Do not allow spray to contact new canes, established green canes, bark or foliage.</b> Crop injury can result as glyphosate is systemic. Use should be limited to a winter application when dormant. Provides non-selective control of annual and perennial grass and broadleaf weeds.

### Preemergence (Residual) Control:

Dichlobenil - CASORON 4G	4 - 6	100 - 150 lbs.	Do not apply to first year plantings. Do not apply more than 100 lbs. per acre to brambles. Apply when dormant (do not apply during new shoot emergence). Provides pre-emergence and limited postemergence activity towards annual and perennial grass and broadleaf weeds. Apply in fall or early spring (pre-bud break).
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## WEED CONTROL IN BRAMBLES AND BLUEBERRIES

HERBICIDE	RATE PER ACRE (Broadcast)		DIRECTIONS AND PRECAUTIONS
	Active Ingredient (lbs.)	Formulation	
Napropamide - DEVRINOL 50DF - DEVRINOL 10G	4.0	8.0 lbs. 40 lbs.	Apply post-directed to weed-free soil. Provides preemergence control of most grasses, pigweed and ragweed. Can be used in newly planted or established crop. Shallow incorporation or irrigation (soil wet 2-4" deep) should be performed if rainfall is not received within 24 hours after herbicide application.
Norflurazon - SOLICAM 80DF	2.0 - 4.0	2.5 lbs. 5.0 lbs.	Apply as a directed spray from fall to early spring when the plants are dormant. Provides preemergence control of annual grasses and certain broadleaf weeds. <b>Brambles</b> must be established for at least 12 months. <b>Blueberries</b> must be established 6 months.
Oryzali - SURFLAN 4A.S.	2.0-4.0	2.0-4.0 qts.	Can be applied to first year plantings. Apply as directed spray to weed-free soil. Provides pre-emergence control of grasses and certain broadleaf weeds. Will not control emerged weeds. Use high rate for long-term weed control (6 to 8 months) and low rate for short-term control (2 to 4 months).
Simazine - PRINCEP 90WDG - PRINCEP 4L	2 - 4	2.2 - 4.4 lbs. 2.0 - 4.0 qts.	Apply post-directed at the full rate in the spring or a split application of ½ rates in the spring (before bud break) and in the fall (after harvest). Provides residual preemergence control of many annual grass and broadleaf weeds. Will not control established weeds. Do not apply more than 1 lb a.i. per acre to newly planted brambles.
Terbacil - SINBAR 80WP	0.4 - 1.6	1.0 lb. 2.0 lbs.	Do not apply to first year plantings. Do not apply to sand or loamy sand soils with less than 3% organic matter. Use only the lowest rate for brambles. Apply in the spring before or shortly after weeds emerge or apply in the fall after harvest.

## GRAPE SPRAY SCHEDULE

Name/Time	Pest	Material and Rate Per Acre	Notes
<b>Dormant</b> (before buds swell)	Scale insects, mites	4 gal Dormant Oil (70 sec.)	1,2
	Anthracnose	10 gal liquid lime sulfur (if needed)	
<b>Bud Break</b> (when new shoots are about 1 inch long)	Black rot, Phomopsis cane and leaf spot, downy mildew	11 fl oz Abound 2F, or 2.0 oz Flint 50WG, or 3.2 oz Sovran 50WG, or 2 lb captan 50WP, or 2 lb mancozeb 80WP, or 2 lb maneb 80WP, or 3 lb ziram 76DF	6,7,8
<b>1<sup>st</sup> New Shoot Spray</b> (when new shoots are 3-5 inches long)	Grape berry moth, flea beetles, plant bugs, grape phylloxera	2-3 lb Thiodan 50WP, or 3 pt malathion 5 EC, or 1-2 pt Diazinon AG500 (4E), or 2-3 lb Imidan 50-WP, or 1.33-2.12 lb Imidan 70-WP	11
	Black rot, Phomopsis cane and leaf spot, downy mildew	11-15.4 fl oz Abound 2F, or 2.0 oz Flint 50WG, or 3.2-4.8 oz Sovran 50WG, or 3 lb mancozeb 80WP, or 3 lb maneb 80WP, or 3-4 lb ziram 76DF	6,7,8
<b>2<sup>nd</sup> New Shoot Spray</b> (when new shoots are 8-10 inches long)	Same as 1 <sup>st</sup> New Shoot Spray	Same as 1 <sup>st</sup> New Shoot Spray	
<b>3<sup>rd</sup> New Shoot Spray/Pre-bloom</b> (just before bloom)	Grape berry moth, rose chafer, flea beetles, leafhopper	3 pt malathion 5 EC, or 1.5-2 lb Guthion 50WP, or 0.5-1 lb Lannate 90SP, or 1-2 pt Diazinon AG500 (4E), or 2-3 lb Imidan 50-WP, or 1.33-2.12 lb Imidan 70-WP	3,4,5
	Grape berry moth	10.67 fl oz Danitol 2.4EC	
	Leafhopper	5.33-10.67 fl oz Danitol 2.4EC	
	Black rot, powdery mildew	2-6 oz Bayleton 50DF, or 4 oz Elite 45DF, or 3-5 oz Nova 40WP	7
	Black rot, Phomopsis cane and leaf spot, downy mildew	2 lb/100 gal ferbam 76WG, or 3-4 lb mancozeb 80WP, or 3-4 lb maneb 80WP, or 2.5 lb Ridomil Gold MZ, or 3-4 lb ziram 76DF	7

*continued*

## Grape (continued)

Name/Time	Pest	Material and Rate Per Acre	Notes
<b>3<sup>rd</sup> New Shoot Spray/Pre-bloom</b> (continued)	Black rot, Phomopsis cane and leaf spot, downy mildew, powdery milde	11-15.4 fl oz Abound 2F, or 2.0 oz Flint 50WG, or 3.2-4.8 oz Sovran 50WG	8
<b>Bloom</b>	Botrytis bunch rot	10 oz Vanguard 75WG, or 1 lb Elevate 50WG, or 1.0-2 lb Rovral 50WP, or 1-1.5 lb Benlate 50WP	13
<b>Petal Fall</b> (immediately after bloom)	Same as Pre-bloom Spray, plus Japanese beetle, grape rootworm	Same as Pre-bloom Spray	
<b>For grape root borer control, see Note 10.</b>			
<b>Cover Sprays</b> (every 10-14 days until no longer needed. Refer to Table 1 for harvest restrictions.)	Leafhopper, grape berry moth, Japanese beetle, grape root bore	3 pt malathion 5 EC, or 4 lb Sevin 50WP, or 1.5-2 lb Guthion 50WP, or 2-3 lb Imidan 50-WP, or 1.33-2.12 lb Imidan 70-WP	14
	Grape berry moth, Japanese beetle	10.67 fl oz Danitol 2.4EC	
	Leafhoppe	5.33-10.67 fl oz Danitol 2.4EC	
	Spider mites	2.5 lb Kelthane 50WSP, or 1-2.5 lb Vendex 50WP	12
	Botrytis bunch rot	10 oz Vanguard 75WG, or 1 lb Elevate 50WG, or 1.5-2 lb Rovral 50WP	13
	Black rot, powdery mildew, downy milde	Apply one of the following two choices: (1) A strobilurin-type fungicide, applied alone: 11-15.4 fl oz Abound 2F, or 2.0 oz Flint 50WG (do not apply to Concord), or 3.2-4.8 oz Sovran 50WG O (2) A tank-mix of a multi-site inhibitor* such as: 4 lb captan 50WP, or 3-4 lb ziram 76DF plus a sterol inhibitor: 3-5 oz Nova 40WP, or 2-3 oz Bayleton 50DF, or 4 oz Elite 45DF, or 4-8 oz Procure 50WS, or 6 oz Rubigan 1EC	8  9
<b>Post-Harvest</b>	Downy mildew, powdery milde	Same as Cover Spray fungicides for downy mildew and powdery mildew.	

\* Multi-site inhibitors are fungicides that affect the pathogen at several sites in its metabolic pathway. This feature makes it high

## Grape (continued)

unlikely that a fungal pathogen will develop resistance to any of these products. They may be used alone or in tank mixes with fungicides that are prone to the development of resistance. Multi-site inhibitors include several classes of compounds, and include the products captan, ferbam, ziram, and copper. For additional information, see the Pesticide Classification for Resistance Management section of this publication.

### NOTES

1. Do not apply dormant spray if freezing temperatures are expected within 24 hours. Dormant oils have a viscosity of about 70 seconds. Do not substitute crop oil concentrate.
2. Remove old, dead bark before spraying in order to get insects.
3. A clean vineyard will greatly reduce pest problems. Keep weeds and tall grass under control. Remove or cover trash under trellis for at least 15 days before and after bloom.
4. Get pests under control during the early part of the season to avoid having to spray close to harvest. Spray thoroughly. Late sprays can leave objectionable color residues on grapes.
5. Lannate and Guthion are extremely toxic. A total of 3 applications of Guthion 50 WP may be applied per crop season. Allow at least 14 days between applications.
6. For varieties very susceptible to powdery mildew, a fungicide for powdery mildew control (see Table 5) may be needed in the early sprays. If so, choose a fungicide or a tank mix that also provides good black rot control.
7. The early-season sprays are critical for black rot control. Captan can be used during this time, but may not provide adequate control if used alone when black rot becomes very active. Bayleton, Elite, or Nova can be used in the early-season sprays, but should be tank-mixed with captan, mancozeb, or maneb for Phomopsis control.
8. A resistance management program is recommended for the strobilurin fungicides (Abound, Flint, Sovran). Refer to Table 4 and the product label for information. SEE THE ABOUND LABEL REGARDING THE PHYTOTOXICITY OF THIS PRODUCT TO APPLE TREES.
9. Including a broad-spectrum fungicide such as Abound, Flint, Sovran, captan, ferbam, ziram, or copper in the cover sprays broadens the range of disease control and helps to discourage fungal resistance to the other fungicides. Do not mix copper fungicides with Nova. Under conditions for severe downy mildew development, higher rates of Flint (4 oz per acre) and Sovran (4-6.4 oz per acre) will be needed for adequate control.

### PESTS

10. **Grape root borer:** Mix 4.5 pints of Lorsban 4E with 100 gallons of water and apply 2 quarts of the diluted spray mixture to the soil surface on a 15-square foot area around the base of each vine. Do not allow spray to contact fruit or foliage. Apply before the pest emerges. Do not make more than 1 application per season or apply within 35 days before harvest.
11. **Phylloxera:** Thiodan is the most effective material. Do not use Thiodan on Baco Noir, Baco No. 1, Concord, Seibel 7053 (Chancellor), Colobel, Cascade varieties, as severe injury is likely to occur.
12. **Mites:** Treat when mites first appear and before serious bronzing occurs.
13. **Bunch rot (Botrytis):** Control needed on certain varieties (especially French hybrids or Vinifera) in rainy weather. Vanguard is applied at early bloom and at berry touch, veraison, or preharvest. Rovral and Elevate may be applied at early to midbloom, prior to bunch closing, beginning of ripening, and prior to harvest, if needed. Benlate is applied at first bloom and may be repeated 14 days later.
14. **Japanese beetle:** If using Imidan 50-W or Imidan 70-W, the higher rates are needed for control of Japanese beetle.

## **Grape (continued)**

## Grape (continued)

**Table 4. Restrictions for grape pesticides.**

Material	Re-entry Interval	Preharvest Interval (days)	Remarks (Refer to product label for details)
<b>FUNGICIDES</b>			
Abound	4 hours	14	Do not make more than 4 applications per year. Do not make more than 3 consecutive applications before alternating to fungicides with a different mode of action (see Table 9). Avoid spray drift to apple trees, and do not use spray equipment that has been previously used to apply Abound to spray apple trees.
Bayleton	12 hours	14	Do not apply more than 18 oz per acre per year
Benlate	24 hours	50	Do not apply more than 6 lb per acre per year
captan	4 days	1	Do not apply more than 12 lb a.i., e.g. 24 lb of Captan 50WP, per acre per year.
copper, fixed	24 - 48 hours	0 - 14	Do not use on copper-sensitive varieties. Copper is especially likely to cause injury under cool temperatures and slow drying conditions.
Elevate	4 hours	0	Do not apply more than 3 lb per acre per year
Elite	12 hours	14	Do not apply more than 2 lb per acre per year
ferbam	24 hours	7	Do not make more than 3 applications per acre per year.
Flint	12 hour	14	Do not apply to Concord variety. Do not apply more than 8 oz or 4 applications per acre per year. Do not make more than 3 consecutive applications before alternating to fungicides with a different mode of action (see Table 9).
mancozeb, maneb	24 hours	66	Do not apply more than 19.2 lb a.i. per acre per year.
Nova	24 hours	14	Do not apply more than 18 oz per acre per year. Do not mix with copper.
Procure	12 hours	7	Do not apply more than 32 oz per acre per year
Ridomil Gold MZ	48 hours	66	Do not make more than 4 applications per acre per year.
Ridomil Gold Coppe	48 hours	66	Do not make more than 4 applications per acre per year.
Rovral	48 hours	7	Do not make more than 4 applications per acre per year.
Rubigan	12 hours	30	Do not apply more than 19 fl oz per acre per year
Sovran	12 hours	14	Do not make more than 3 consecutive applications before alternating to fungicides with a different mode of action (see Table 9) for at least 2 applications. Do not make more than 4 applications per acre per year.
sulfur	24 hours	0	May cause injury on certain varieties such as Concord and other American types. Do not use if temperatures during or immediately after spraying will exceed 85 F.
Vanguard	12 hours	7	Do not apply more than 20 oz per acre per year
ziram	48 hours	21	Do not apply more than 28 lb per acre per year
<b>INSECTICIDES AND MITICIDES</b>			
Danitol	24 hours	21	Do not exceed 2.67 pt per acre per season. Allow at least 7 days between applications.
Diazinon	24 hours	28	
Guthion	48 hours/ 4 days	10	REI is 48 hours for mowing, irrigating, and scouting only; 4 days for all other purposes. Do not make more than 3 applications per acre per year. Allow at least 14 days between applications. The minimum dosage specified may be applied up to harvest. With higher rates, allow at least 10 days between last application and harvest. Application by backpack or hand-wand sprayers is prohibited.

<b>Material</b>	<b>Re-entry Interval</b>	<b>Preharvest Interval (days)</b>	<b>Remarks (Refer to product label for details)</b>
Imida	24 hours	14	Incompatible with alkaline materials such as spray lime, lime sulfur and Bordeaux mixture, which will reduce the insecticidal activity of Imidan, as will a spray solution pH of 7 or higher.
Kelthane	48 hours	7	Do not make more than 2 applications per season.
Lannate	7 days	1 (fresh & raisin) 14 (wine grapes)	Do not make more than 5 applications per acre per year. Do not apply more than 4.5 lb a.i. per acre per year
Malathion	12 hours	3	Injury may occur on Almeria, Cardinal, Italia and Ribier varieties if Malathion 5EC is applied after clusters appear.
Methoxychlor	12 hours	14	
Sevin	12 hours	7	Do not make more than 5 applications per acre per year. Allow at least 7 days between applications.
Thiodan	24 hours	7	Do not use on Concord variety. Do not make more than 3 applications per acre per year. Do not exceed a maximum of 3.0 lb a.i. (i.e., 6 lb of Thiodan 50WP) per acre per year
Vendex	48 hours	28	Do not make more than 2 applications per acre per year. Do not apply more than 4 lb per acre per year. Allow at least 21 days between applications.

**Table 5. Effectiveness of fungicides for control of grape diseases (0-3 scale)**

<b>Fungicide</b>	<b>Black Rot</b>	<b>Bitter Rot</b>	<b>Botrytis Rot</b>	<b>Downy Mildew</b>	<b>Phomopsis Cane and Leaf Spot</b>	<b>Powdery Mildew</b>
Abound	3	--	1	3	2	3
Bayleton	3	0	0	0	0	2
Benlate	2	1	2	0	2	3 <sup>a</sup>
Captan	2	3	1	3	3	0
Elevate	0	0	3	0	0	0
Elite	3	0	0	0	0	3
Ferbam	3	2	0	1	1	0
Flint	3	--	1	2	1	3
Fixed copper and lime	2	1	1	3	1	2
Mancozeb, maneb	3	3 <sup>a</sup>	0	3 <sup>a</sup>	3	0
Nova	3	1	0	0	0	3
Procure	2	0	0	0	0	3
Ridomil Gold MZ	3	3 <sup>a</sup>	0	3 <sup>a</sup>	3	0
Ridomil Gold Coppe	1	1	1	3 <sup>a</sup>	1	2
Rovral	0	0	3	0	0	0
Rubigan	1	0	0	0	0	3
Sovran	3	--	1	2	2	3
Sulfur	0	0	0	0	1	3
Vanguard	0	0	3	0	0	0
Ziram	3	0	1	3	2	0

<sup>a</sup>The lengthy preharvest interval for this material may result in lower effectiveness against this disease than the rating given. 3=highly effective. 2=moderately effective. 1=slightly effective. 0=not effective. --=unknown.

**Note:** The above ratings may be reduced by the label restrictions of a fungicide, such as preharvest interval and number of applications allowed. Degree of control can also be affected by environmental conditions, varietal susceptibility, and resistant strains of the fungus.

## WEED CONTROL IN GRAPES

HERBICIDE	RATE PER ACRE (Broadcast)		DIRECTIONS AND PRECAUTIONS
	Active Ingredient (lbs.)	Formulation	
<b>Note: To further assist you with herbicide selection, refer to WEED RESPONSE TO HERBICIDES at the back of the spray schedule.</b>			
<b>Postemergence control: Annual and Perennial Grasses</b>			
Clethodim - SELECT 2EC	0.09 - 0.12	6 - 8 fl. oz.	<b>Do not apply within one year of harvest.</b> For postemergence control of annual and perennial grasses. Use low rate for annual grasses. Use high rate for perennial grasses including rhizome johnsongrass and bermudagrass. Add crop oil concentrate (containing at least 15% emulsifier) at 1% volume/volume. Repeat application is dependent on re-growth.
Fluazifop - FUSILADE DX-2E	0.09 - 0.19	6 - 12 fl. oz.	<b>Do not apply within one year of harvest.</b> For postemergence control of annual and perennial grasses. Use low rate for annual grasses. Use high rate for perennial grasses. Add either crop oil concentrate (1% volume/volume) or nonionic surfactant (0.5% volume/volume). Repeat application is dependent on re-growth.
Sethoxydim - POAST 1.5E	0.19 - 0.38	16 - 32 fl. oz.	For postemergence control of annual and perennial grasses. Use low rate for annual grasses. Use high rate for perennial grasses. Add crop oil concentrate at 1% volume/volume.
<b>Postemergence Control: Grasses and Broadleaf Weeds</b>			
Paraquat - GRAMOXONE EXTRA 2.5L	0.6 - 0.9	2.0 - 3.0 pts.	Apply as a post-directed or shielded spray (low pressure with coarse droplet size) to avoid contact with foliage or bark less than one year old. Provides non-selective control of established annual broadleaf and grass weeds. Suppresses perennial weeds. Repeat application is dependent on regrowth. Paraquat has contact not systemic activity. Can be mixed with certain pre-emergence herbicides for residual control. <b>Do apply if sucker growth is greater than 8 in. in length.</b> Requires the addition of either non-ionic surfactant or crop oil concentrate.
<b>Restricted-Use Pesticide</b>			
Glufosinate - RELY 1L	0.75 - 1.5	3 - 5 qts.	Apply as a post-directed or shielded spray (do not allow spray to contact green foliage or bark) for post-emergence control of annual weeds and limited control or suppression of perennial weeds. Repeat application is dependent on re-growth. Can be mixed with certain preemergence herbicides. For sucker control (less than 12 in. length), apply a split application of approximately 4 wks apart at 4 qts. per acre.
Glyphosate - ROUNDUP ULTRA 4L	1.0 - 5.0	1.0 - 5.0 qts.	<b>Post-directed or shielded application only. Do not allow spray to contact foliage, green bark or any new growth.</b> Crop injury can result as glyphosate is systemic. Use should be limited to a winter application when dormant. Provides non-selective control of annual and perennial grass and broadleaf weeds.

## WEED CONTROL IN GRAPES

HERBICIDE	RATE PER ACRE (Broadcast)		DIRECTIONS AND PRECAUTIONS
	Active Ingredient (lbs.)	Formulation	
Sulfosate - TOUCHDOWN 5LC	1.0 - 3.0	1.6 - 5.3 pts.	<b>Post-directed or shielded application only. Do not allow spray to contact foliage, green bark or any new growth.</b> Use should be limited to winter application when dormant. Cannot be mixed with PROWL, or SURFLAN (see label for preemergence mix partners). Requires addition of non-ionic surfactant (50% or greater active ingredient) at 0.5% volume/volume.
<b>Preemergence (Residual) Control:</b>			
Dichlobenil - CASORON 4G	4 - 6	100 - 150 lbs.	Can be used in the first year, but, not before 4 wks after transplanting. Provides pre-emergence and limited postemergence activity towards annual and perennial grass and broadleaf weeds. Use high rate for activity towards existing perennial weeds. Apply in winter or early spring (pre-bud break).
Diuron - KARMEX 80DF	1.6 - 2.4	2 - 3 lbs.	<b>Vines must be established for at least three years. Do not apply to soils with less than 3% clay or organic matter.</b> Apply as a directed spray from fall to early spring (prior to bud break). Provides preemergence and limited early postemergence (with addition of surfactant) control of annual grass and broadleaf weeds.
Napropamide - DEVRINOL 50DF - DEVRINOL 10G	4.0	8.0 lbs. 40 lbs.	Can be used in the first year. Apply post-directed to weed-free soil. Provides preemergence control of most grasses, pigweed and ragweed. Can be used in newly planted or established crop. Shallow incorporation or irrigation (soil wet 2-4" deep) should be performed if rainfall is not received within 24 hours after herbicide application.
Norflurazon - SOLICAM 80DF	2.0 - 4.0	2.5 lbs. 5.0 lbs.	<b>Vines must be established for at least two years prior to application. Do not apply to coarse textured soils.</b> Apply only to sandy loam or finer textured soils. Apply as a directed spray from fall to early spring when vines are dormant (prior to bud break). Provides preemergence control of annual grasses and certain broadleaf weeds.
Oryzali - SURFLAN 4A.S.	2.0-4.0	2.0-4.0 qts.	Can be applied to first year plantings. Apply as directed- or shield- spray. Do not apply when fruit is present. Provides pre-emergence control of grasses and certain broadleaf weeds. Will not control emerged weeds. Use high rate for long-term weed control (6 to 8 months) and low rate for short-term control (2 to 4 months).

## WEED CONTROL IN GRAPES

HERBICIDE	RATE PER ACRE (Broadcast)		DIRECTIONS AND PRECAUTIONS
	Active Ingredient (lbs.)	Formulation	
Oxyfluorfen - GOAL 2XL	1.2 -2.0	5.0 -8.0 pts.	<p><b>Do not apply to vines less than three years old, unless vines are on the trellis wire a minimum of 3 ft above the soil surface.</b></p> <p><b>Plants must be dormant</b> (prior to bud break). Apply as a directed- or shielded- spray. Provides preemergence grasses and broadleaf weeds and early postemergence control of broadleaf and certain grass weeds.</p>
Pendimethalin PROWL 3.3EC	2.0 -4.0	2.4 - 4.8 qts.	<p>To new plantings with dormant plants, appl after the soil has settled (do not apply to non-dormant plants). To plantings established at least one year, apply when dormant (prior to bud break). For older vines, do not apply in bearing years. Apply as a directed- or shield-spray. Provides preemergence control of grass weeds and certain broadleaf weeds.</p>
Propamide - KERB 50WP	1 - 4	2 -8 lbs.	<p><b>Do not apply to vines less than one year old.</b> Apply as a directed spray after harvest, and before soil freeze-up. Provides preemergence and early postemergence control of certain winter annual grass and broadleaf weeds.</p>
Simazine - PRINCEP 90WDG - PRINCEP 4L	2 - 4	2.2 - 4.4 lbs. 2.0 - 4.0 qts.	<p><b>Do not apply to vines less than 3 years old.</b> Apply post-directed at the full rate in the spring or a split application of ½ rates in the spring (before bud break) and in the fall (after harvest). Provides residual preemergence control of many annual grass and broadleaf weeds. Will not control established weeds.</p>

## STRAWBERRY SPRAY SCHEDULE

Name/Time	Pest	Material and Rate Per Acre	Notes
<b>SETTING YEAR (MATTED ROW)</b>			
<b>Before setting --</b> During soil preparation	White grubs, strawberry rootworms, ants, wireworms, strawberry leaf beetle	Methyl bromide plus chloropicrin (various formulations, rate depends on formulation)	8
<b>After setting --</b> Begin at first warm period, three applications	Strawberry crown bore	2 - 4 lb Sevin 50WP, or 2.5 lb Sevin 80S, or 1 - 2 qt Sevin 4F	5
<b>Spring applications --</b> Apply at 10-14 da intervals until insects are controlled	Strawberry crown borer, strawberry leafrolle	2 - 4 lb Sevin 50WP, or 2.5 lb Sevin 80S, or 1 - 2 qt Sevin 4F	4,5
	Strawberry rootworm	1 - 1.5 qt Methoxychlor 4L	3,4
	Strawberry leafrolle	1.5 - 2.5 pt malathion 57%EC, or 1 lb Guthion 50WP, or 6.4 - 32 oz Brigade 10WSB	
<b>HARVEST YEARS</b>			
<b>Pre-bloom --</b> In March during first warm period	Strawberry crown borer, strawberry weevil (clipper), strawberry leafrolle	2 - 4 lb Sevin 50WP, or 2.5 lb Sevin 80S, or 1 - 2 qt Sevin 4F	4,5
	Strawberry weevil (clipper)	1 - 1.5 qt Methoxychlor 4L, or 1 qt Lorsban 4E, or 6.4 - 32 oz Brigade 10WSB	4
	Strawberry leafrolle	1.5 - 2.5 pt malathion 57%EC, or 1 lb Guthion 50WP, or 6.4 - 32 oz Brigade 10WSB	
	Strawberry rootworm	1 - 1.5 qt Methoxychlor 4L	3
	Catfacing insects (plant bugs, stink bugs)	1.5 - 3 pt malathion 57%EC, or 1.33 qt Thiodan 3 EC, or 10.7 fl oz Danitol 2.4EC, or 6.4 - 32 oz Brigade 10WSB	10
	Leaf spots (if needed)	See Bloom Spra	7

## Strawberry (continued)

Name/Time	Pest	Material and Rate Per Acre	Notes	
<b>Bloom --</b> Every 7-10 days (except where noted) from 5-10% bloom until most petals fallen	Insects	Save the bees! Do not apply insecticides during bloom.	3,4,5	
	Botrytis	1.5 lb Elevate 50WG alone, or a tank mix as shown below for "Botrytis, anthracnose, leaf spots"	For help with fungicide selection, see Notes 7 & 12 & Table 7.	
	Botrytis, anthracnose, leaf spots	3 lb Captan 50WP <b>PLUS</b> 1.0 lb Elevate 50WG, or plus 1 lb Benlate 50WP, or plus 1 lb Topsin-M 70WP or 6 lb Captan 50WP alone, or 3.4 - 4.4 lb Thiram 75WG alone		
	Powdery mildew, leaf spots (if needed)	2.5 - 5.0 oz Nova 40W every 14 - 21 days		
	Leather rot, red stele (if needed)	See Notes section for timing of applications.	11	
<b>Post-Bloom through Harvest --</b> Fungicides: Apply every 7-10 days, except where noted. Insecticides: Appl as needed. Follow all harvest restrictions.	Spittlebugs	10.7 fl oz Danitol 2.4EC, or 1.33 qt Thiodan 3EC, or 1.5 - 3 pt malathion 57%EC, or 1 lb Guthion 50WP, or 6.4 - 32 oz Brigade 10WSB		
	Aphids	1.33 qt Thiodan 3EC, or 1.5 - 3 pt malathion 57%EC, or 1 pt Diazinon AG500 (4E)		
	Two-spotted spider mites	16 - 21.33 fl oz Danitol 2.4EC, or 1 - 2 lb Kelthane 50WSP, or 16 fl oz Agri-Mek 0.15EC, or 16 - 32 oz Brigade 10WSB		
	Cyclamen mites	3 - 4 lb Kelthane 50WSP		
	Slugs	10 lb Sevin 5% Bait, or 5 lb metaldehyde 5% bait		
	Sap beetles	2 - 4 lb Sevin 50WP, or 6.4 - 32 oz Brigade 10WSB or 16 - 21.33 fl oz Danitol 2.4EC Keep fruit picked to avoid attracting sap beetles.		
	Whiteflies, strawberry rootworm, leafrollers	1.5 - 2.5 pt malathion 57%EC, or 1 lb Guthion 50WP		
	Leafrollers	6.4 - 32 oz Brigade 10WSB		
	<i>continued</i>	Flea beetles	1 - 1.5 qt Methoxychlor 4L	

## Strawberry (continued)

Name/Time	Pest	Material and Rate Per Acre	Notes
<b>Post-Bloom through Harvest</b> <i>continued</i>	Botrytis, anthracnose, leaf spots	Same as Bloom Sprays. Do not use Benlate during harvest in U-Pick fields.	7,12
	Leather rot, red stele (if needed)	See Notes section for timing of applications.	11
	Powdery mildew, leaf spots (if needed)	2.5 - 5.0 oz Nova 40W every 14 - 21 days	
<b>Post-Harvest --</b> Every 10-14 days, as needed	Root weevils	1.5 - 2.5 pt malathion 57%EC, or 8 - 32 oz Brigade 10WSB	2
	Leafrollers, strawberry crown borers, strawberry rootworm	1.5 - 2.5 pt malathion 57%EC, or 2 - 4 lb Sevin 50WP, or 1 lb Guthion 50WP,	
	Leafrollers	6.4 - 32 oz Brigade 10WSB	
	Leaf spots, anthracnose	3 lb Captan 50WP <b>PLUS</b> 0.5 lb Benlate 50WP or plus 0.5 lb Topsin-M 70WP	
	Powdery mildew, leaf spots (if needed)	2.5 - 5.0 oz Nova 40W every 14 - 21 days	

### NOTES

#### PESTS

1. **Spider Mites:** Applications should be made when tiny mites, webbing or bronzing is first noticed. Repeat as needed. Two-spotted mite populations build up on host plants in borders in April and May, then migrate to the planting.
2. **Root Weevils:** In June the black weevils emerge, feed on foliage at night, and in a couple weeks begin depositing eggs near the crowns of the plants. The larvae that enter the soil to feed on roots are white, c-shaped, legless grubs with brown heads. Insecticide treatments should be targeted toward adult weevils soon after emergence to prevent egg laying and migration by their crawling to other plantings.
3. **Strawberry rootworm:** The presence of many small, roundish holes in leaves indicates rootworm adults (small brown beetles with four darker areas on the wing covers). The larvae of the rootworm (small grubs) destroy and tunnel the root system. If a heavy infestation of adults exists, this usually means that the roots are also infested. Preplant soil treatments can prevent buildup. If a heavy infestation exists it is possible to control by continuously controlling adults. Make applications to control rootworms when two larvae per plant are found. Do not apply insecticides during bloom.
4. **Strawberry Weevil (Clipper):** If this pest was a problem last year, make the first insecticide application when buds emerge and a second spray just before bloom. If previous damage from this pest didn't occur, apply insecticides at first sign of damage to flower buds (buds clipped). Weevils are a sporadic pest usually found around field margins. Do not apply insecticides during bloom. Lorsban 4E pre-bloom only. Do not make more than two applications per season or apply within 21 days before harvest. Phytotoxicity may occur when applied to strawberries experiencing high temperature and drought stress.
5. **Strawberry Crown Borer:** Begin treatments in the spring (April) when adults or numerous holes appear in the leaves. Make two applications at weekly intervals starting when buds first appear. Do not treat during bloom. Lorsban 4E pre-bloom sprays as for strawberry weevil will aid in controlling strawberry crown borer. Make two to three applications of Sevin, Malathion or Guthion at two-week intervals in post-harvest period if there is tunneling damage to the crown by the white, legless, grublike larvae (1/5 inch long) which can stunt or even kill plants. Carbaryl (Sevin) may injure Earlidawn and Sunrise varieties.

## Strawberry (continued)

6. **Slugs:** Scatter baits along beds at dusk. Do not contaminate fruit.

7. **Diseases**

**Botrytis gray mold** -- The critical period for control with fungicides is during bloom, but additional applications may be needed during the harvest period. Botrytis is present in all plantings.

**Anthracnose** -- Tennessee has had a Section 18 label for the use of Quadris for the last two years, and is applying for another such label in 2001. Contact your county Extension office or your dealer for information on the status of the label. An intensive spray schedule that includes captan, thiram, or Quadris is needed during harvest in anthracnose fields. Control of the runner rot phase during the summer in matted row plantings is not very effective.

**Angular leaf spot** -- Some fields, mostly plasticulture, have experienced this bacterial disease, which causes marketability problems. Fixed copper sprays provide some control if begun early, but their benefit may be offset by the phytotoxicity they can cause.

**Phytophthora crown rot** -- Also known as vascular collapse, this soil-borne disease has begun appearing in some plasticulture fields. For known infested plantings, apply Ridomil as for red stele (see Note 11).

### SPRAY MATERIALS

8. **Methyl bromide:** Inject 6 to 8 inches below the soil surface, when the soil temperature is 55 F, all plant residue is fully decayed and the soil is at a good workable moisture.
9. **Agri-Mek:** Make two applications seven to 10 days apart when mites first appear. Do not repeat treatment within 21 days of second application. Do not exceed 64 fl oz per acre in a growing season. Three-day pre-harvest interval.
10. **Thiodan:** When using Thiodan for catfacing insects, do not reapply within 15 days or more than twice within a 35-day period when fruit are present.
11. **Ridomil and Aliette:** Ridomil Gold EC is labeled for control of red stele and leather rot at 1 pt per treated acre. Apply in sufficient water to move the fungicide into the root zone of the plants, or incorporate with 1/2 inch irrigation. Up to 2 applications may be made in the spring. Make the first application after the ground thaws but before bloom. For improved leather rot control, an additional application may be made during fruit set or harvest, but only if an earlier application has been made. For red stele control, apply again in the fall.

Aliette is applied at 2.5-5 lb per acre as a foliar spray. For red stele control, apply in the spring when plants start active growth. If disease conditions persist or reoccur, make additional applications on 30-60 day intervals. For leather rot control, begin applications between 10% bloom and early fruit set and continue on 7-14 day intervals as long as conditions are favorable for disease development.

12. **Fungicide resistance management:** In planning a fungicide spray schedule, consider that Benlate, Topsin-M, and Elevate can lose their effectiveness against Botrytis due to resistance if they are used too often. Use these materials in a resistance management program: Do not apply Benlate or Topsin-M alone or in alternation with each other. Always tank-mix with captan or thiram. Elevate can be used alone, but never for more than 2 consecutive applications before alternating to another Botrytis fungicide (Table 7) for 2 applications. For more information on this subject, see the section on Pesticide Classification for Resistance Management, in this publication.

## Strawberry (continued)

**Table 6. Restrictions for strawberry pesticides.**

<b>Material</b>	<b>Re-entry Interval</b>	<b>Preharvest Interval (days)</b>	<b>Remarks (Refer to product label for details)</b>
<b>FUNGICIDES</b>			
Aliette	12 hours	0	Do not apply more than 30 lb per acre per year. Do not mix with copper. If Aliette is to be applied to foliage with copper residues, raise the spray pH to 6.0 or above with an alkaline buffer.
Benlate	24 hours	1	Do not apply more than 5 lb per acre per year. Use only as a tank mix or in alternation with a labeled non-benzimidazole fungicide, e.g. not with Topsin M. Benlate cannot be used once the crop is turned into a U-Pick operation.
captan	24 hours	0	Do not apply more than 24 lb a.i., e.g. 48 lb of Captan 50WP, per acre per year.
copper, fixed	48 hours	0	
Elevate	4 hours	0	Do not apply more than 6 lb per acre per season. Do not make more than 2 consecutive applications. Use an alternative Botrytis material for 2 consecutive applications before reapplying Elevate.
Nova	24 hours	0	Do not apply more than 30 oz per acre per year. 30-day plantback interval between last application and planting new crops.
Ridomil Gold EC	12 hours	0	Do not apply more than 1.5 qt per acre per year.
Rovral	24 hours	*	* Do not apply after first flower, no more than 1 application per season.
Thiram	24 hours	3	Has rabbit and deer repellence.
Topsin M	12 hours	1	Do not apply more than 5 lb per acre per year. Use only in as a tank-mix or in alternation with a labeled non-benzimidazole fungicide, e.g. not with Benlate.
sulfur	24 hours	0	Do not use on sulfur-sensitive varieties.
<b>INSECTICIDES AND MITICIDES</b>			
Agri-Mek	12 hours	3	Do not repeat treatment within 21 days of second application.
Brigade	12 hours	0	Do not apply more than 80 oz per acre per season.
Danitol	24 hours	2	Apply as pests appear before mite counts exceed 20 per leaflet (eggs + motiles). A second application can be made with a retreatment interval of no less than 30 days. Do not make more than two applications totaling 2.67 pints of Danitol per acre to the same planting in 12 consecutive months.
Diazinon	24 hours	5	Do not make more than three foliar applications per season. Do not apply more than 2 lb of product per acre per application and no more than 8 lb of product per acre per season.
Guthion	48 hours/ 4 days	5	REI is 48 hours for mowing, irrigating or scouting only; 4 days for all other purposes. Limit of four applications per crop per season. Allow at least five days between applications. Application by backpack or hand wand sprayers is prohibited.
Kelthane	48 hours	3	Do not make more than 2 applications per season.
Lannate	48 hours	3 (fresh) 10 (processing)	Do not apply more than 4.5 lb a.i. per acre per crop. Do not make more than 10 applications per crop.
Lorsban	24 hours	21	For pre-bloom use only. Limit of two applications per season.
Malathion	12 hours	3	Do not combine emulsifiable liquids with wettable powders in the same spray tank unless previous use of the materials being combined has proven them to be physically compatible.
Methoxychlor	12 hours	14	

Material	Re-entry Interval	Preharvest Interval (days)	Remarks (Refer to product label for details)
Sevin	12 hours	7	May injure Earlidawn and Sunrise varieties. Apply up to a total of five times but not more often than once every seven days.
Thiodan	24 hours	4	At lower rate, do not repeat application within 15 days or more than twice during a 35 day period when fruit are present. At higher rate, do not apply at intervals less than 35 days when fruit are present. Do not make more than three applications per year.
Vendex	48 hours	1	Apply when mites first appear. Make no more than two applications per season and no more than 4 lb per acre per season.

**Table 7. Effectiveness of Fungicides for Control of Strawberry Diseases**

Fungicide	Anthracnose		Botrytis	Leaf Blight	Leaf Spot	Leaf	Leather	Powdery
	Coll. acut. <sup>a</sup>	Coll. gloeo. <sup>a</sup>	Gray Mold	(Phomopsis)	(Common)	Scorch	Rot	Mildew
Aliette	0	0	0	0	0	0	+++	0
Benlate, Topsin-M	0	+	+++ <sup>b</sup>	++	++	++	0	+
Captan	+	+	++	+	++	++	+	0
Elevate	0	0	+++ <sup>b</sup>	0	0	0	0	0
Nova	0	0	0	+++	+++	?	0	+++
Thiram	+	+	++	+	++	++	+	0
Ridomil	0	0	0	0	0	0	+++	0

+++ = highly effective; ++ = moderately effective; + = somewhat effective; 0 = not effective

<sup>a</sup> *Colletotrichum acutatum* and *Colletotrichum gloeosporioides* (fungal species that cause anthracnose)

<sup>b</sup> If these fungicides are not used properly, Botrytis can develop resistance to them, reducing their control effectiveness. Refer to Note 12 for information on how to avoid resistance development.

All of these ratings apply to the use of these materials on a regular, preventive schedule begun before the onset of disease. These ratings apply to commonly used rates of the products, applied so that the plants are adequately covered.

## WEED CONTROL IN STRAWBERRIES

	<u>RATE PER ACRE (Broadcast)</u>		
<b>HERBICIDE</b>	<b>Active Ingredient (lbs.)</b>	<b>Formulation</b>	<b>DIRECTIONS AND PRECAUTIONS</b>

**Note:** To aid in herbicide selection, refer to **WEED RESPONSE TO HERBICIDES** at the back of this spray guide.

### MATTED ROW (or Perennial) TYPE PRODUCTION

Methyl bromide plus chloropicrin (VARIOUS Formulations)	Product Dependent	Weed control by pre-plant soil fumigation with these products is an option. However, use is restricted to certified applicators. In addition, use of methyl bromide is currently being phased out. For pre-plant fumigation, prepare soil to fine tilth with no clods or plant residue. Soil temperature at 6 inches depth should be at least 50 F. Immediately after or during application, cover soil with a gas-proof plastic making sure all edges are properly sealed. Allow at least 48-72 hours before removing plastic. After removal of plastic, allow at least 2 weeks before transplanting. See label and certified applicator for further instructions.
<b>Restricted-Use Pesticide</b>		

### Post-emergence Control: Annual and Perennial Grasses

Clethodim - SELECT 2EC	0.09 - 0.12	6 - 8 fl. oz.	<b>Do not apply in fruiting years.</b> For postemergence control of annual and perennial grasses including bermudagrass and rhizome johnsongrass. Add crop oil concentrate (containing at least 15% emulsifier) at 1% volume/volume. Repeat application is dependent on regrowth.
Fluazifop - FUSILADE DX-2E	0.09 - 0.19	6 - 12 fl. oz.	<b>Do not apply in fruiting years.</b> For postemergence control of annual and perennial grasses. Use low rate for annual grasses. Use high rate for perennial grasses. Add either crop oil concentrate (1% volume/volume) or non-ionic surfactant (0.5% volume/ volume). Repeat application is dependent on regrowth.
Sethoxydim - POAST 1.5E	0.30-0.5	1.5-2.5 pts.	Can be used in fruiting years. For postemergence control of annual and perennial grasses. Use low rate for annual grasses (3 -8 inches tall). Use high rate for perennial grasses (e.g. bermudagrass or johnsongrass 6-10" new growth). Add crop oil concentrate at 1.0% volume/volume (or 1 qt. per acre). Do not tank mix with other chemicals. Do not apply within 7 days of harvest. Repeat application is dependent on regrowth.

## WEED CONTROL IN STRAWBERRIES

HERBICIDE	<u>RATE PER ACRE (Broadcast)</u> Active Ingredient (lbs.)	Formulation	DIRECTIONS AND PRECAUTIONS
<b>Post-emergence: Broadleaf Weeds</b>			
2,4-D Amine - FORMULA 40 4L	0.5-1.0	1.0-1.5 qts.	Essentially the only herbicide for post-emergence control of broadleaf weeds in matted row production. Apply to well established crop after harvest and before runners form, or when the crop is dormant (do not apply during budding, flowering or fruit stage).
<b>Preemergence (Residual) Control</b>			
Napropamide - DEVRINOL 50DF - DEVRINOL 10G	4.0	8.0 lbs. 40 lbs.	Essentially, the only herbicide for pre-emergence or residual weed control in matted row production. Provides preemergence control of most annual grasses and certain broadleaf weeds including pigweed and ragweed. In the fall, delay application until desired number of daughter plants become established. In the spring, do not apply from bloom through harvest. Apply ahead of a rain or apply ½ inch of over-head irrigation if rainfall is not received within 24 hours after application.
<b>Postemergence Non-selective Control</b>			
Paraquat - GRAMOXONE EXTRA 2.5L	0.5	1.5 pts.	Apply between rows with a shielded sprayer for the control of annual grasses and broadleaf weeds. Avoid contact with desired foliage as injury will result. Requires the addition of either a non-ionic surfactant or crop oil concentrate.
<b>Restricted-Use Pesticide</b>			
<b>PLASTICULTURE (or annual) TYPE PRODUCTION</b>			
Methyl bromide plus chloropicrin (VARIOUS Formulations)		Product Dependent	Plasticulture production normally involves pre-plant bed fumigation with a methyl bromide based product. However, plasticulture production is in a state of transition as currently use of methyl bromide is being phased out. Use is restricted to certified applicators. For pre-plant bed fumigation, prepare soil to fine tilth with no clods or plant residue. Soil should be of good moisture for optimum fumigation and bed shaping. Inject to 4 to 6 inches deep and immediately cover with plastic row cover. Allow a minimum of two wks prior to transplanting for the fumigating gas to move through the soil and pass through the plastic row cover.
<b>Restricted-Use Pesticide</b>			

## WEED CONTROL IN STRAWBERRIES

HERBICIDE	<u>RATE PER ACRE (Broadcast)</u> Active Ingredient (lbs.)	Formulation	DIRECTIONS AND PRECAUTIONS
<b>Post-emergence Control: Annual and Perennial Grasses</b>			
Sethoxydim - POAST 1.5E	0.30-0.5	1.5-2.5 pts.	For postemergence control of annual and perennial grasses. Use low rate for annual grasses (3 -8 inches tall). Use high rate for perennial grasses (e.g. bermudagrass or johnsongrass 6-10" new growth). Add crop oil concentrate at 1.0% volume/volume (or 1 qt. per acre). Do not tank mix with other chemicals. Can also be used to control established grasses in the row middles. Do not apply within 7 days of harvest. Repeat application is dependent on regrowth.
<b>Control in the Row Middles</b>			
Napropamide - DEVRINOL 50DF	4	8 lbs.	Apply as a shielded application banded to the row middles for preemergence control of certain annual grass and broadleaf weeds. Apply ½ inch of overhead irrigation within 24 hrs. of application to activate the herbicide. Tank mix with GRAMOXONE to gain control of established weeds (shielded application only).
Paraquat - GRAMOXONE EXTRA 2.5L	0.5	1.5 pts.	Apply as a shielded application banded to the row middles for control of established weeds. Requires the addition of either non-ionic surfactant or crop oil concentrate.

**Table 8. Signal Words and Restricted-entry Intervals (REI) for Herbicides.**

Herbicide	Signal Word	REI (hours)	Herbicide	Signal Word	REI (hours)
Casoron	caution	12	Prowl	caution	12
Devrinol	caution	12	Rely	warning	12
Fusilade	caution	12	Roundup	warning	12
Goal	warning	24	Sinbar	caution	12
Gramoxone	danger	12	Solicam	caution	12
Karmex	caution	12	Surflan	caution	12
Poast	caution	12	Touchdown	caution	12
Princep	caution	12	2,4-D	caution	48
Select	warning	12			

# VERTEBRATE MANAGEMENT

## White-tailed deer (*Odocoileus virginianus*)

Deer are attracted to nearly all species of fruit. They are “selective browsers or grazers” and move slowly through the planting feeding on leaves, twigs and fruits or on ground covers. They are frequently seen browsing in early summer, late summer and fall when food is most scarce. The most common damage comes from eating emerging leaves and shoots in spring and summer. In late summer to early winter, fruits and nuts make up a large part of their diet. Deer have no upper incisor teeth. They pinch their food with their lower incisors against a tough pad in their upper jaw and leave ragged edges at the point of detachment. This type of damage is most devastating in young plantings.

Deer are creatures of habit and won't return to a predominantly forest diet once more nutritious plants have been found. While damage from deer browsing is most severe on young plants, significant economic losses can occur on mature ones. The severity of damage varies from slight to extreme depending on population, weather, alternate food sources and tree size. Damage generally varies season to season and year to year.

Their home range tends to be quite limited - often as little as one square mile. Heavy hunting pressure, dogs and seasonal changes in food supply can cause deer to shift their use areas within their home range. Bucks increase their movements slightly in the fall mating season.

### Management

Effective management begins by anticipating the extent of possible damage and then responding with appropriate control measures. Consider the severity of deer damage during the previous year and reports of deer density in your area as indicators of potential problems. Compare the cost of control versus the cost of damage. In new plantings, browsing damage may set back the development and subsequent fruiting for several years. In extreme situations, damage may prevent a planting from ever reaching its potential.

Several methods for limiting deer damage might be considered. Each of them, or combinations of them, may prove to be effective. They include:

1) habitat modification. Deer prefer early successional forests that are in the shrub-tree sapling stage. They are also abundant in agricultural areas where field crops and orchards are interspersed with forest habitat. Converting forest areas adjacent to plantings to cropland or pastures may somewhat limit movement of deer into them.

2) hunting. Encourage hunting on your farm. Non-hunted areas may serve as refuges during hunting season. Hunters should be encouraged to harvest doe deer to keep the population in check.

3) shooting. Check with wildlife officers in your area regarding permission to shoot deer out-of-season if they become a problem. Lethal control methods often are temporary in nature.

4) repellents. Repellents vary in their effectiveness. They are affected by population, feeding habits and environmental conditions. They may be effective if damage is light to moderate, if small acreages are involved and if few applications will be needed for adequate control. **Repellents will not work satisfactorily in high-pressure situations.**

Two different types of repellents are available. The first type is an area repellent and includes things such as tankage (putrified meat scraps), ammonium soaps, bone tar oil, blood meal, human hair and bar soap. These repellents should be applied close to or on the plants needing protection. In some cases, putting them on the side of the planting from which the deer enter is effective in keeping deer out. However, it may be necessary to disperse repellents throughout the planting. The other general type is a contact repellent. It works by taste and should be applied directly to plants during the dormant season and on dry days when temperatures are above freezing. Expect some feeding damage when taste repellents are used. Repellents in this category include putrescent egg solids, thiram, and hot pepper sauce. Reapplication is frequently necessary as rainfall will wash the repellents off. When using commercial repellents, always follow label directions.

### **COMMERCIAL DEER REPELLENTS USED IN FRUIT CROPS**

<u>Common Name</u>	<u>Product Name</u>	<u>EPA Registration Number</u>
13.8% Ammonium Soap	Hinder	4-152
	(Application to apples under hot, humid conditions may result in fruit-finish problems such as spray burn ring)	
37% Egg Solids	Rockland Deer Guard	4866-10
20% Thiram	Chew-Not	358-105
11% Thiram, 11% Acrylic Polymers	Bonide Rabbit-Deer Repellent	4-136
2.5% Capsaicin	Hot Sauce Animal Repellent	72-574

### NON-COMMERCIAL DEER REPELLENTS

Soap Bars     Drill a 1/4 inch hole through the center of small soap bars. Leave the wrapper on to prevent excessive weathering. Hang the bars away from the trunk on a wire or string and about 30 inches aboveground. Bar soap has no EPA registration. The cost of materials plus the substantial amount of labor involved in putting the soap bars on trees may render this treatment economically impractical.

5) fencing. In areas having a high deer population, fencing may well be the only viable control method. Electric fences offer an effective, less expensive option when compared to conventional fences.

A single strand of high-tensile wire at 30 inches aboveground can be quite effective if it is visible so the deer will "investigate." Treat the wire with a 50/50 mixture of peanut butter and vegetable oil or drape aluminum foil strips with peanut butter on them over the wire to attract deer. Decorating the wire with flagging will further increase effectiveness. Highly visible fences having very conspicuous wire (wire impregnated tape) are visible to deer and are effective without an attractant. Once deer get shocked from the fence, they tend to avoid the area unless they are being chased.

In extreme pressure situations, the Pennsylvania five-wire fence might be justified. It is constructed with five high-tensile strength wires stretched to 250 pounds tension and is charged using a high voltage/low impedance "New Zealand type" energizer. Wires are charged so as to shock deer from wire to wire. Put the lowest wire 10 inches aboveground and space the others 12 inches apart. Baiting the middle wire with peanut butter may increase the effectiveness of the fence. Control weeds along fences to avoid shorting them out.

Individual young trees may be protected from bucks rubbing their antlers against the trunk by setting three fence posts placed one to two feet apart in an equilateral triangle around each tree.

Unelectrified fences for deer exclusion need to be at least eight feet high to be effective. They are much more costly than electric fences.

## CALIBRATING HERBICIDE SPRAYERS FOR FRUIT CROPS

Three factors must be known or determined to properly calibrate a sprayer for spraying most fruit crops. These factors are: the width of the band being sprayed, speed of travel and rate of spray delivery.

Width of the band being sprayed is one-half of the total strip to be treated since only one side of the row is being sprayed at a time. Band width may vary from three to four feet on young plants up to six or eight feet or more for large trees.

Speed of travel must remain constant to insure uniform spray application. Tractor speed should be checked with a stop watch or a watch with a sweep second hand to determine exactly how long it takes to travel a given distance. Speedometers or tachometer on tractors should not be relied upon to supply this information. Check tractor speed over terrain similar to where the spraying will actually be done. The relationship between miles per hour and feet per minute is as follows: (1 mph = 88 ft/min).

Speed (mph)	ft/mi
2.00	176
2.25	198
2.50	220
2.75	242
3.00	264
3.25	286
3.50	308

Rate of spray delivery is determined by nozzle size, pressure at the nozzle and several other factors. Consult manufacturer's specifications to determine nozzle size and pressure required to obtain the desired spray rate per acre. Actual rate of delivery should be checked by measuring output from the nozzle(s) in a given period of time. With the sprayer running at a constant pressure, check the time needed to collect a gallon of water. The delivery rate (gal./min.) may be calculated by dividing one by the number of minutes necessary to catch a gallon of water. Times required to collect one gallon of water at various delivery rates are as follows:

Delivery Rate (gal/min)	Time to Collect 1 gal
0.40	2 min, 30 sec
0.50	2 mi
0.60	1 min, 40 sec
0.70	1 min, 26 sec
0.80	1 min, 15 sec
1.00	1 mi
1.20	50 sec
1.60	38 sec
2.00	30 sec

Decide upon the conditions under which you want to apply the herbicides and then equip and operate the sprayer to meet these conditions. The following example will illustrate this procedure:

Desired rate of application . . . . . 30 gallons per acre  
 Band width to be sprayed . . . . . 3 feet  
 Travel speed . . . . . 3 mph (264 ft/min)

Nozzle discharge rate required to meet these conditions is determined below.

1. Determine area sprayed per minute: band width (3 feet) x speed = 792 square feet sprayed per minute.
2. Determine time required to spray one acre of area: 43,560 square feet/acre ÷ area sprayed per minute = 55 minutes to spray one acre.
3. Determine gallons per minute required: gal/acre (30) ÷ minutes/acre (55) = .54 gal/min.
4. Consult manufacturer's guide for nozzle and pressure required (assume that the nozzle wanted is rated to deliver 0.5 gal/min. at 30 psi).
5. Install the nozzle and adjust the pressure to obtain a measured output of 0.5 gal/min.
6. Repeat this procedure for each nozzle of a different size. Collect water from each nozzle of the same size to check for wear and to insure uniform application rates.
7. Mix herbicides required for treating an acre of area in 30 gallons of water.

Before mixing herbicides, determine the amount of spray needed to treat the planting. To do this, calculate what part of the total floor is to be sprayed. If an 8-foot wide strip is to be treated (4 feet each side of the row) where rows are spaced 24 feet apart, then 8/24 (one-third) of the total orchard floor will be treated (one acre will be sprayed for each 3-acre section). If the desired application rate is 30 gallons per acre, then  $1/3 \times 30 = 10$  gallons of spray solution will be needed for each acre. Mix only the amount of spray needed.

## **SPRAY SOLUTION pH**

As a rule, most pesticides work best in a slightly acidic solution. Unfortunately, water used for sprays frequently will be alkaline. This may dramatically shorten the effective half-lives of many pesticides. Acidifying spray solutions may be worthwhile in this case.

Litmus paper may be used to determine the acidity or alkalinity of water or spray solutions. It is not accurate enough to give a true reading of pH. This may be determined with a pH meter. Portable units are available. Buffer solutions should be used to make sure the meter is giving accurate readings. It may also be possible to have samples tested at water treatment facilities.

Commercial products are available to acidify spray solutions. Follow label recommendations to obtain the desired results. Vinegar and granulated, food grade citric acid may also be used. It may be necessary to use a trial and error method to determine rates to be used. Start out using one quart of vinegar per 100 gallons of spray solution or two ounces of citric acid per 100 gallons. Check solution pH and modify the amount of acidifying agent necessary to achieve the desired response.

Do not attempt to acidify solutions containing Bordeaux, fixed copper or other copper compounds.

## PESTICIDE CLASSIFICATION FOR RESISTANCE MANAGEMENT

All fruit growers should practice pesticide resistance management, which reduces the chances of pests becoming resistant to the pesticides used. If resistance develops in a pest population to one product of a class of pesticides, then the pest is also resistant to other products in that class. This development causes that group of pesticides to be less effective against that disease or insect.

An important element of resistance management is rotating pesticide classes, which are groups of pesticides that are related to each other. Rotating these classes means not using members of the same class in combination. Instead, members of different classes should be used in tank mixes or consecutive sprays.

Resistance is more of a threat to some types of pesticides than others. The fungicides in the table below are divided into moderate- to high-risk groups and low- to no-risk groups. Rotation of fungicide classes is not necessary for the low-risk types, but is needed for the high-risk types. Fungicides that are at-risk should be either tank-mixed or rotated with members of other classes of fungicides. Rotation is the preferred method for the strobilurin fungicides.

**Table 9a. Classification of fruit fungicides.**

Class	Products
<b>At Risk for the Development of Resistance</b>	
anilinopyrimidines	Vanguard (cyprodinil)
benzimidazoles	Benlate (benomyl) Topsin M (thiophanate methyl)
demethylation inhibitors (DMI's), also known as sterol inhibitors (SI's)	Bayleton (triadimefon) Elite (tebuconazole) Indar (fenbuconazole) Nova (myclobutanil) Orbit (propiconazole) Procure (triflumizole) Rubigan (fenarimol)
dicarboximides	Ronilan (vinclozolin) Rovral (iprodione)
hydroxyanilides	Elevate (fenhexamid)
organophosphates	Aliette (fosetyl-Al)
phenylamides	Ridomil Gold (mefanoxam)
strobilurins	Abound, Quadris (azoxystrobin) Flint (trifloxystrobin) Sovran (kresoxim-methyl)
<b>Low Risk for the Development of Resistance*</b>	
several classes	Captan (captan) coppers (various brand names) Carbamate (ferbam) Dithane, Manzate (mancozeb) Maneb, Manex (maneb) Thiram (thiram) Ziram (ziram)

**Table 9b. Classification of fruit insecticides and miticides.**

Class	Products
biologically based	Agri-Mek (abamectin)
carbamates	Lannate (methomyl) Sevin (carbaryl)
organochlorines	Kelthane (dicofol) Methoxychlor (methoxychlor) Thiodan, Phaser (endosulfan)
oganophosphates	Diazinon (diazinon) Dyfonate (fonofos) Guthion (azinphos-methyl) Imidan (phosmet) Lorsban (chlorpyrifos) Malathion (malathion)
organotins	Vendex (hexakis)
synthetic pyrethroids	Brigade (bifenthrin) Danitol (fenpropathrin)

\* These fungicides are multi-site inhibitors, which means that they affect the pathogen at several sites in its metabolic pathway. Because of this, there is little to no risk that a fungal pathogen will develop resistance to any of these products.



## FRUIT CROP WEED RESPONSE TO PREEMERGENCE HERBICIDES

KEY TO RESPONSE RATINGS: 0 = no control; 10 = 100%; --- = data not available								
Ratings are based on application of labelled rates of each herbicide, applied at the optimum timing for each weed.								
HERBICIDES	KARMEX	DEVRIKOL	SOLICAM	PROWL	SURFLAN	PRINCEP	SINBAR	GOAL
TIME OF APPLICATION								
<b>BIENNIAL AND PERENNIAL WEEDS</b>								
bermudagrass	0	0	0	0	0	0	6	0
briars	1	0	0	0	0	0	---	0
dallisgrass	3	3	3	2	2	2	---	6
dogfennel	6	---	9	4	4	6	8	7
horsenettle	2	1	0	0	0	0	6	0
johnsongrass (rhizome)	0	0	0	4	4	4	---	0
musk thistle	8	6	8	0	8	9	4	4
nutsedge/yellow	0	0	6	0	0	3	6	5
plantains	0	2	8	4	4	8	8	5
wild garlic/onion	4	0	8	1	1	---	8	2
<b>ANNUAL GRASSES</b>								
barnyardgrass	8	8	8	8	8	6	8	7
crabgrass	8	8	8	9	9	7	8	9
fall panicum	6	8	8	8	8	6	9	6
goosegrass	8	8	8	9	9	8	8	8
johnsongrass (seedling)	5	6	7	8	7	3	9	6
signalgrass, broadleaf	6	1	7	8	6	4	8	5
<b>ANNUAL BROADLEAF WEEDS</b>								
nightshades (various)	7	0	8	2	3	6	9	---
chickweed (common)	8	9	9	9	6	8	9	9
cocklebur	6	1	5	---	---	6	6	2
evening primrose	7	8	---	4	4	8	9	9
galinsoga	8	8	8	1	3	8	8	8
horseweed	7	6	8	0	0	8	9	---
jimsonweed	7	0	5	2	2	7	5	---
lambquarters	8	8	8	5	5	8	9	7
morningglories	7	1	2	5	4	8	9	0
pigweeds	8	8	8	8	8	9	9	8
prickly sida (teaweed)	5	3	8	2	2	8	9	5
ragweed, common	9	8	8	2	3	9	9	9
wild radish/mustards	8	8	8	4	4	9	9	8

## FRUIT CROP WEED RESPONSE TO POSTEMERGENCE HERBICIDES

KEY TO RESPONSE RATINGS: 0 = no control; 10 = 100%; --- = data not available								
Ratings are based on application of labelled rates of each herbicide, applied at the optimum timing for each weed.								
HERBICIDES	RELY	POUNDUP	TOUCHDOWN	GRAMOXONE	2,4-D Various	FUSILADE	POAST	SELECT
TIME OF APPLICATION	POST-DIRECTED					OVERTOP OR DIRECTED		
BIENNIAL AND PERENNIAL WEEDS								
bermudagrass	3	7	7	1	0	7	5	5
briars	8	5	5	2	3	0	0	0
dallisgrass	8	9	9	8	0	6	6	6
dogfennel	---	9	9	1	7	0	0	0
horsenettle	5	5	5	6	2	0	0	0
johnsongrass (rhizome)	8	8	8	3	0	7	6	6
musk thistle	8	9	9	3	9	0	0	0
nutsedge/yellow	9	6	6	4	0	0	0	0
plantains	---	9	9	4	8	0	0	0
wild garlic/onion	8	6	6	3	7	0	0	0
ANNUAL GRASSES								
barnyardgrass	8	9	9	7	0	8	8	8
crabgrass	9	9	9	9	0	9	9	9
fall panicum	9	9	9	9	0	9	9	9
goosegrass	9	9	9	8	0	7	7	7
johnsongrass (seedling)	9	9	9	9	0	9	9	9
signalgrass, broadleaf	8	9	9	8	0	7	8	8
ANNUAL BROADLEAF WEEDS								
nightshades	9	9	9	9	9	--	0	0
chickweed (common)	9	9	9	9	5	0	0	0
cocklebur	9	9	9	9	9	0	0	0
eveningprimrose	8	9	9	7	9	0	0	0
galinsoga	9	9	9	9	7	0	0	0
horseweed	5	9	9	5	7	0	0	0
jimsonweed	8	9	9	9	9	0	0	0
lambquarters	8	9	9	9	9	0	0	0
morningglories	---	8	8	7	8	0	0	0
pigweeds	9	9	9	9	8	0	0	0
prickly sida (teaweed)	9	9	9	7	7	0	0	0
ragweed, common	9	9	9	9	9	0	0	0
wild radish/mustards	9	9	9	7	9	0	0	0