

Crop Profile for Strawberries in Oregon

Prepared, July 2002

General Production Information

Production Facts (3, 4, 5, 8)

Oregon ranks third nationally in strawberry production. Two percent of the nation's strawberries are grown in Oregon.

- In 2001, Oregon growers produced 40.2 million pounds of strawberries on 3,100 acres, with a farm-gate value of \$15,164,000.
- Approximately 95% of the crop is processed, with the remainder being sold for fresh market. Fresh market berries are generally sold locally while processed berries are sold and used nationally and internationally.
- Yield per acre varies from year to year, depending on weather and incidence and severity of disease and insect pests. Average yield is about 10,000 pounds per acre although in 2001, the state average was 13,000 pounds per acre.
- Production costs for established strawberries are approximately \$3,500 per acre.

Production Regions (8, 9):

Almost all of Oregon's strawberries are grown west of the Cascade Mountains in the Willamette Valley. Fertile soils, mild winters and cool summers allow growers to produce high quality berries with good flavor, color and texture. Marion County has the most strawberry acreage in the state (47%), followed by Washington County (22%). Other Willamette Valley counties producing strawberries include Benton, Clackamas, Columbia, Lane, Linn, Multnomah, Polk, and Yamhill. There is also some small acreage in the north central and southwestern parts of the state.

Cultural Practices

Oregon strawberries are grown as a perennial, with fields remaining productive for two to four years. Many fields are productive for only two seasons due to declining plant vigor, which is commonly a result of root rot disease or root weevil larvae feeding. Plants do not produce a marketable crop in the planting year, but will bear fruit in subsequent years. Harvest generally begins in early June and lasts for about three weeks. The fruit is harvested by hand, with the cap (calyx and stem) being removed from the berry if the berries are destined for processing. A very small amount of acreage is devoted to producing day-neutral strawberries, which bear fruit continuously from June until early fall, and are sold for fresh market.

Perennial weeds are controlled prior to planting with a non-selective herbicide, such as glyphosate, in the fall or early spring. Soil fumigation for weed and disease control is sometimes used but is not common due to the high costs associated with this practice. In preparation for planting, the soil is disked and cultivated to produce a smooth surface. Some growers create and plant on raised beds, which can help reduce incidence of root rot and fruit rot diseases; however, raised beds are more difficult to maintain and are not common.

Strawberry crowns are planted in the spring. A preemergence herbicide is applied either pre-plant or post-transplant. Irrigation is necessary after planting and weekly, thereafter until rainfall begins in early fall. During the establishment year, plants are fertilized at planting and then again in mid-summer. A preemergence herbicide is again applied in the fall.

In established strawberry fields, it takes approximately 30 to 40 days for the plant to progress from bloom to harvest (7). Fruit rot caused by *Botrytis cinerea* is common and fungicides are applied during bloom period. Two to four weeks after the last fruits are harvested, the strawberry field is renovated. Renovation involves mowing the plants to just above the crown, disking between the rows, fertilizing and irrigating; a preemergence herbicide is often applied after renovation.

The predominant processing cultivar is Totem, which is firm, sweet and has good internal red color. Other processing cultivars include Hood, Benton, Redcrest, and Puget Reliance.

Insect Pests

Root weevils are the most widespread and damaging insect pest in Oregon strawberries (5). The larvae feed on roots during fall, winter and spring, causing reduced vigor and yield, and, in some cases, plant death (11). Aphids, also, are a serious pest in strawberries because they can vector viruses that can reduce plant vigor and yield, and the life of a planting (10). About 75% of all strawberry acreage is treated with an insecticide or miticide at least once for control of pests such as root weevils, aphids, cyclamen mites, twospotted spider mites, spittlebugs and strawberry crown moth (1). Nearly 30% of all acreage is treated with a molluskicide for control of slugs or snails (1), which can render the berries

unmarketable due to feeding on ripening fruit or evidence of mollusk slime residues.

Aphids

Shallot aphid (Myzus ascalonicus)

Strawberry aphid (Chaetosiphon fragaefolii)

Pest description: The Shallot aphid is pale greenish-brown and appears in the early spring. The Strawberry aphid is pale green and wingless with small, clubbed hairs on the dorsal surface. Winged adults appear in May and persist into November, with peak population about mid-June. In some years, there is another peak in September and October. They overwinter on plants.

Crop damage: Leaves appear crinkled, curled and, sometimes, yellow due to the virus that is transmitted by the aphid. Damage may spread from small, circular patches to the entire planting.

Chemical control:

Apply chemical treatments when aphids first appear and repeat every two to four weeks, if necessary.

- Endosulfan (Thiodan, Thionex, Phaser) at 1 lb ai/A. Use only when daytime temperatures are expected to exceed 70°F. Apply in late evening to avoid bee poisoning during bloom. Do not reapply within 15 days or more than twice within a 35-day period when fruit is present. Poor aphid control has been reported in some localities where endosulfan has been used for a number of years, indicating possible aphid resistance.
4 day PHI. 24 hour REI.
- Azinphos-methyl (Guthion) at 0.5 lb ai/A. Do not use at bloom; it is highly hazardous to bees. Do not apply more than four applications per crop season, allowing at least 5 days between applications. Aphids have shown resistance in some areas. Restricted Use Pesticide. 5 day PHI. 2 to 4 days REI (depending upon field activity).
- Diazinon at 0.5 lb ai/A. Do not use at bloom; it is highly hazardous to bees. Restricted Use Pesticide. 5 day PHI. 24 hour REI.
- Metasystox-R at 0.5 lb ai/A. One prebloom and two post-final harvest sprays. Do not apply by ground within 100 ft of unprotected people or buildings (150 ft by air). Restricted Use Pesticide. 24c registration. 48 hour REI.
- Methomyl (Lannate) at 0.45 to 0.9 lb ai/A. Do not use at bloom; it is highly hazardous to bees. PHI is 3 days for fresh market, 10 days for processed berries. 48 hour REI.
- Naled (Dibrom) at 1 lb ai/A. Do not apply to bloom. Do not apply when temperature is above 90°F. 1 day PHI. 48 hour REI.

- Chlorpyrifos (Lorsban 4E) at 1 lb ai/A. Use prebloom only. Restricted Use Pesticide. 21 day PHI. 24 hour REI.
- Potassium salts of fatty acids (M-Pede). Apply at a 1 -2% v/v solution. 0 day PHI. 12 hour REI.

Biological control:

- Beauveria bassiana (Mycotrol ES) at 1 to 3 quarts of product/A. Live fungal spores. 0 day PHI. 12 hour REI.

Cultural control: Rogue out plants exhibiting virus symptoms. Isolate new fields from infested fields.

Cyclamen Mite

Steneotarsonemus pallidus

Pest description: The mature mite is flat, lens-shaped, and transparent. The female's hind legs are threadlike. Magnification is needed to see this mite.

Crop damage: Cyclamen mites are found on young, folded leaves along the midvein in early spring. They stunt plants and reduce fruit production. Small bumps felt on leaf midvein and petiole can be indicative of mite feeding. Symptoms are similar to virus symptoms (curled, crinkled leaves). 'Totem' strawberries are very susceptible to cyclamen mite damage.

Chemical Control:

- Endosulfan (Thiodan, Thionex, Phaser) at 2 lb ai/A. Do not reapply within 35 days when fruit is present. Apply in at least 400 gal/A of water. 4 day PHI. 24 hour REI.
- Dicofol (Kelthane 35W, Dicofol 4E) at 2 lb ai/A. Treat infestations shortly after spring regrowth begins. Do not use when temperatures will exceed 90°F. 3 day PHI. 12 hour REI. Two or three applications may be required at 10 to 20-day intervals.
- Diazinon at 1 lb ai/A. Repeat spray if necessary after 7 days. Restricted Use Pesticide. 5 day PHI. 24 hour REI.

Garden symphylan

Scutigereilla immaculata

Pest description: Tiny, centipede-like animals 0.125 to 0.25 inch long. Newly hatched nymphs have six pairs of legs, but at each molt, an additional set of legs is added; adult symphylans have 12 pairs of legs.

Crop Damage: Feeding on roots and root hairs causes stunted plants and reduced yields. Symphylans are exceptionally injurious to young plants.

Chemical control:

- Chlorpyrifos (Lorsban 4E) at 2 lb ai/A. Apply as a preplant broadcast spray and incorporate 2 to 4 inches. Restricted Use Pesticide. 24c registration. 24 hour REI.
- Endosulfan (Thiodan, Thionex, Phaser) at 1 lb ai/A. Mix thoroughly in 100 gal water and dip entire plant before planting.

Leafrollers

Strawberry leafroller (Ancyliis comptana)

Western strawberry leafroller (Compsolechia fragariella)

Pest description: Larvae are brown to greenish and move quickly when disturbed. They overwinter on strawberry plants; moths appear in May. There are several generations a year.

Crop damage: Larvae feed on foliage, which they roll or web together. Leafrollers are seldom a pest that need to be controlled.

Lygus Bugs

Several species, including: Tarnished plant bug (Lygus lineolaris)

Pest description: Adults are 0.25 to 0.5 inches long, winged, and marked with a 'V' on the back. They range in color from light green to shades of grey and brown. Nymphs are smaller and wingless.

Crop damage: Feeding on buds, bloom and immature fruits results in deformed fruits. Lygus bugs are generally not a problem requiring control unless they appear early in the season.

Chemical control:

- Naled (Dibrom) at 1 lb ai/A. Do not apply to bloom. Do not apply when temperature is above 90°F. 1 day PHI. 48 hour REI.
- Azinphos-methyl (Guthion) at 0.5 lb ai/A. Do not use during bloom. Do not apply more than four applications per crop season, allowing at least 5 days between applications. Restricted Use Pesticide. 5 day PHI. 2 to 4 days REI (depending upon field activity).
- Methomyl (Lannate) at 0.9 lb ai/A. Do not use during bloom. Restricted Use Pesticide. PHI is 3 days for fresh market, 10 days for processed berries. 48 hour REI.
- Endosulfan (Thiodan, Thionex, Phaser) at 1 lb ai/A. Do not reapply within 15 days or more than twice

within a 35-day period when fruit is present. 4 day PHI. 24 hour REI.

- Fenpropathrin (Danitol) at 0.2 lb ai/A. Do not apply more than two applications and a total of 0.8 lb ai/a in a 12-month period. 2 day PHI. 24 hour REI.

Meadow spittlebug

Philaenus spumarius

Pest description: Overwinters in the egg stage, which is attached to leaf stems and leaves. Tiny yellow nymphs hatch in April and secrete a white froth over their feeding place on new growth.

Crop damage: Nymphs suck juices from leaves and fruit spurs, causing them to become distorted and stunted. Injury results in reduced yield and inferior fruit quality.

Chemical control: (Treatment before nymphs are half grown are most effective.)

- Endosulfan (Thiodan, Thionex, Phaser) at 1 lb ai/A. Apply late evening or early morning to avoid bee poisoning. Do not reapply within 15 days or more than twice within a 35-day period when fruit is present. 4 day PHI. 24 hour REI.
- Azinphos-methyl (Guthion) at 0.5 lb ai/A. Do not use during bloom. Do not apply more than four applications per crop season, allowing at least 5 days between applications. Restricted Use Pesticide. 5 day PHI. 2 to 4 days REI (depending upon field activity).
- Naled (Dibrom) at 1 lb ai/A. Do not apply to bloom. Do not apply when temperature is above 90°F. 1 day PHI. 48 hour REI.
- Chlorpyrifos (Lorsban 4E) at 1 lb ai/A. Apply prebloom only. Restricted Use Pesticide. 24 hour REI.
- Carbaryl (Sevin) at 1 to 2 lb ai/A. Latex-based formulations of carbaryl are least hazardous to bees. Do not apply to bloom. 7 day PHI. 12 hour REI.
- Fenpropathrin (Danitol) at 0.2 lb ai/A. Do not apply more than two applications and a total of 0.8 lb ai/a in a 12-month period. 2 day PHI. 24 hour REI.

Omnivorous leaftier

Strawberry fruitworm (Cnephasia longana)

Pest description: Adults are tan with brown spots on forewings. At rest, the moths appear bell-shaped. The tiny, orange, first-stage larvae overwinter in crevices of rough-bark trees. Larvae spread by wind into strawberry fields in April and May. Mature larvae are 0.5 to 0.75 inches long with a tan head and

creamy-white body.

Crop damage: Larvae feed on folded leaves before they open and on ripening fruit. Larvae tunnel throughout the fruit, rendering it unmarketable.

Chemical control:

- Naled (Dibrom) at 1 lb ai/A. Do not apply to bloom. Do not apply when temperature is above 90°F. 1 day PHI. 48 hour REI.
- Carbaryl (Sevin) at 1 to 2 lb ai/A. Latex-based formulations of carbaryl are least hazardous to bees. Do not apply to bloom. 7 day PHI. 12 hour REI.
- Azinphos-methyl (Guthion) at 0.5 lb ai/A. Do not use during bloom. Do not apply more than four applications per crop season, allowing at least 5 days between applications. Restricted Use Pesticide. 5 day PHI. 2 to 4 days REI (depending upon field activity).
- Methomyl (Lannate) at 0.9 lb ai/A. Do not use during bloom. Restricted Use Pesticide. PHI is 3 days for fresh market, 10 days for processed berries. 48 hour REI.

Root Weevils

Black vine weevil (Otiiorhynchus sulcatus)

Strawberry root weevil (O. ovatus)

Rough strawberry root weevil (O. rugosostriatus)

Pest description: Adults are beetles and are generally black in color; individual beetles may appear light brown to chocolate-brown. They range in size from 0.25 to 0.5 inches long. The black vine weevil is the largest and has small yellow patches on its back. Larvae (grubs) overwinter 2 to 8 inches deep in the soil. They are white with tan heads, legless and have a characteristic c shape.

Crop damage: Adults appear after bloom, beginning in May and continuing through July. They feed on leaves prior to egg-laying, leaving characteristic notch marks on leaf margins, although this damage is usually insignificant to plant vitality. The larvae feed on small roots and later on the cambium of large roots and crowns, reducing plant vigor and yield, and causing plant death if larvae are numerous.

Cultural control:

- Adult weevils don't fly but can walk long distances; disking field perimeters can minimize ingress from adjacent areas.
- Renovation immediately after harvest removes food supply (leaves) for the adults and exposes them to direct sun and increased temperatures. However, maximum yields from next year's crop are realized when renovation is delayed two to four weeks after final harvest.

- Reduce number of years the strawberries are kept in the ground. Root weevil populations tend to build up over time; instead of keeping fields in for three to four production years, remove the planting after the second cropping year.

Biological control (larvae):

- Parasitic nematodes. Make a single application to the soil in early fall when most larvae are present in the soil. Correct soil moisture is critical for success.

Chemical control (adults):

- Azadirachtin (Neem). See various labels for rate. 12 hour REI.
- Bifenthrin (Brigade) at 0.05 to 0.2 lb ai/a. Do not apply more than 0.5 lb ai/A per season. May cause spidermite flare-ups during current season or next. Restricted Use Pesticide. 0 day PHI. 24 hour REI.
- Azinphos-methyl (Guthion) at 0.5 lb ai/A. Apply at night for maximum effectiveness. Labeled only for obscure root weevil (*Sciopithes obscurus*). Do not apply more than four applications per crop season, allowing at least 5 days between applications. Restricted Use Pesticide. 5 day PHI. 2 to 4 days REI (depending upon field activity).
- Malathion at 2 lb ai/A. Apply at night for maximum effectiveness. 3 day PHI. 12 hour REI.
- Cryolite Bait at 4 to 8 lb ai/A. 24c registration. 3 day PHI. 12 hour REI.

Slugs

Limax spp., Arion spp., Deroceras spp.

Pest description: Slugs are closely related to snails but have no external shell. Color ranges from grey to brown to black; mature slugs are about 0.5 to 0.75 inches in length.

Crop damage: Slugs make deep, even holes in ripening berries. Heaviest feeding is during cloudy days and at night. Damage is accompanied by slime trails, which can also render fruit unmarketable.

Chemical control:

- Metaldehyde baits (various brands) at 0.5 to 2.4 lb ai/A. Apply to the soil surface around plants but do not contaminate edible parts. 6 day PHI. 12 hour REI. For best slug control, bait plants after the first extensive late-summer rains which activate the slugs. Baiting at this time kills egg-laying adults that would produce slugs the following spring.
- Iron phosphate bait (Sluggo) at 2.4 to 4.4 lb ai/A. May be broadcast or applied to the soil surface around plants. PHI unavailable. 0 hour REI.

Strawberry Crown Moth
Synanthedon bibionipennis

Pest description: Adults are clear winged moths which fly in June and July, laying eggs on the undersides of leaves near the crown of the strawberry plant. Larvae are white with a brown head and approximately one inch long. Larvae overwinter in strawberry crowns and roots.

Crop damage: Larvae feed on the inside and outside of strawberry crowns and cause plant stunting and subsequent yield reduction. Severe feeding can cause plant death.

Chemical control:

Because none of the insecticides labeled for use on strawberries displays systemic activity in the plants' crowns and roots, and because most strawberry crown moth larvae are established in these areas by mid-August, applying insecticides to control this pest is not recommended after the first week in August. Use pheromone traps to determine the first consistent emergence of moths in late spring (usually from the last of May to early June depending on location). About 10 to 14 days later, apply either azinphos-methyl or endosulfan in at least 200 gal water/a as a high-pressure spray to saturate crowns. Two weeks later, if plants have not been topped, apply the insecticide not used for the first application. If plants have been topped by this time, use Lorsban as described below.

- Azinphos-methyl (Guthion) at 0.5 lb ai/a. Do not apply more than four applications per crop season, allowing at least 5 days between applications. Restricted Use Pesticide. 5 day PHI. 2 to 4 days REI (depending upon field activity).
- Endosulfan (Thiodan, Thionex, Phaser) at 1 lb ai/A. Apply late evening or early morning to avoid bee poisoning. Do not reapply within 15 days or more than twice within a 35-day period when fruit is present. 4 day PHI. 24 hour REI.
- Lorsban 4 E at 1 lb ai/A. Postharvest use only. Apply in at least 100 gal water/a as a high-pressure spray to saturate crowns. Apply immediately postharvest after topping when no berries are present. Time this application about 14 days after the azinphos-methyl or endosulfan application made during harvest. Do not use more than two applications per season. 24c registration. 24 hour REI.

Thrips
Frankliniella spp.

Pest description: Adults are generally yellowish-brown to straw colored and less than an eighth of an inch long. Winged adults have four wings which are long and narrow with a fringe of long hairs on the margins. Nymphs resemble adults except in size and lack of wings.

Crop damage: Adults and nymphs feed by rasping. Feeding on ripening fruit can cause bronzing and cracking of the fruit.

Chemical control:

- Methomyl (Lannate) at 0.45 to 0.9 lb ai/A. Restricted Use Pesticide. 3 day PHI for fresh market fruit; 10 day PHI for processed fruit. 48 hour REI.
- Malathion at 1 to 2 lb ai/A. 3 day PHI. 12 hour REI.
- Spinosad (Success) at 0.062 to 0.094 lb ai/A. 1 day PHI. 4 hour REI.

Biological control:

- Beauveria bassiana (Mycotrol ES) at 1 to 3 quarts of product/A. Live fungal spores. 0 day PHI. 12 hour REI.

Twospotted Spider Mite

Tetranychus urticae

Pest description: Adult mites are about 0.02 inch long. They have eight legs and are light tan or greenish in color with a dark spot on each side of their back. In fall and again in spring, overwintering forms appear as bright orange globules.

Crop Damage: Mites feed by sucking the contents out of leaf cells, causing a mottling of the leaves. They feed mostly on older leaves, which reduces plant vigor and can negatively affect yield.

Chemical control:

Repeat applications may be necessary to control mite populations. Rotate chemistries to avoid resistance. Apply in sufficient water and at sufficient pressure to coat undersides of leaves.

- Dicofol (Kelthane 35 W, Dicofol 4 E) at 1 lb ai/A. Do not use when temperatures will exceed 90°F. 3 day PHI for Kelthane 35W; 2 day PHI for Dicofol 4E. 12 hour REI.
- Hexakis (Vendex 50 W) at 0.75 to 1 lb ai/A. Apply in 150 to 200 gal/A. Apply when mites appear. Do not apply more than twice per year. Good coverage is essential for good mite control. 1 day PHI. 48 hour REI.
- Fenpropathrin (Danitol) at 0.3 to 0.4 lb ai/A. Do not apply more than two applications and a total of 0.8 lb ai/a in a 12-month period. 2 day PHI. 24 hour REI.
- Potassium salts of fatty acids (M-Pede). Apply as a 1- 2 % v/v solution. 0 day PHI. 12 hour REI.
- Abamectin (Agri-Mek 0.15 EC) at 0.01875 lb ai/A. Make two applications 7 to 10 days apart when

mites first appear. Repeat this sequence of applications, if necessary, to maintain control (wait at least 21 days). Do not exceed 64 fl oz product/A in one growing season. Do not use less than 100 gal water/A. Restricted Use Pesticide. 3 day PHI. 12 hour REI.

- Hexythiozox (Savey 50 WP) at 0.375 lb ai/A. Controls eggs and young motile stages; does not control adult mites. Do not apply more than once per crop season. 3 day PHI. 12 hour REI.
- Bifenazate (Acramite 50WS) at 0.5 lb ai/A. 1 day PHI. 12 hour REI.

Biological Control:

- Predatory mites. Use according to individual insectary's label or advice. 0 day PHI.

Diseases

The mild, moist conditions in Oregon's Willamette Valley are ideal for disease development caused by various fungal organisms. More than 90% of Oregon's strawberry acreage is treated with a fungicide at least once but, more often, two to three times per season (1). Grey mold (fruit rot), caused by *Botrytis cinerea*, is the most wide-spread fungal disease (7). It causes lower quality fruit and/or reduced marketable yields, and requires several (two to five) applications of a fungicide per season for adequate control. Tank mixing or rotation with fungicides that have different modes of action are critical in a grey mold control program to prevent likelihood of disease resistance. Red stele (root rot), caused by *Phytophthora fragariae*, is another serious, wide-spread disease that causes reduced plant vigor and, subsequently, reduced yields. Severely infected plants wilt and die (10).

Black Root Rot

Rhizoctonia sp., Fusarium spp., and Ramularia spp

Black root rot is a complex interaction of fungi, nematodes, weather, and poor soil characteristics. Organisms or factors involved in one area may not be involved in others. Some of these organisms are native soil fungi and survive indefinitely in soil. Root-lesion nematodes are frequently involved in black root rot.

Symptoms: Symptoms include black discolorations on roots; the entire root or all but the core often darken, look unhealthy, and lack new growth. Foliage is reduced in size, has poor color, and wilts in warm weather. Although many roots rot away completely, they lack the red core discoloration typical of

red stele.

Chemical control: Preplant fumigation.

- Telone C-17 at 27 to 41 gal/A broadcast on mineral soils. Allow 2 to 3 weeks between application and planting or until odor leaves the soil. Do not treat extremely heavy soils. Restricted-use pesticide. 72 hour REI.
- Vapam (32.7% metam sodium) at 50 to 100 gal/A. Immediately roll the soil and follow up with tarps or a light watering. May use through an irrigation system. 48 hour REI and/or while tarps are being removed.
- Methyl bromide + chloropicrin. Restricted-use pesticide.

Cultural control:

- Plant certified stock on well-drained fertile soil adapted to strawberry production.
- While planting, keep roots from getting dry, and set plants at the proper depth.
- Use long crop rotation in commercial plantings; include grasses and grains in the rotation.
- Do not plant strawberries on land with a recent history of black root rot.

Common Leaf Spot

Mycosphaerella fragariae(asexual: *Ramularia brunnea*)

This fungus overwinters on old, infected leaves and as sclerotia. Conidia are produced abundantly in lesions on infected leaves. Sclerotia in dead leaf material produce conidia in the spring. Conidia are rain splashed to healthy tissues. Only young leaf tissue is susceptible to infection and then, only after a minimum of 12 hours of leaf wetness. Long wet periods (several days) and warm temperatures (over 50° F) favor disease development in the spring and in summer after renovation. 'Olympus' and 'Shuksan' are very susceptible.

Symptoms: Foliage is at first dark red or purplish, gradually becoming grayish or almost white with age. Fully developed spots are about 0.12 inch in diameter, with a whitish center and reddish margin. They are scattered widely over the leaf surface, reducing leaf function. Infections occur in moist weather and are most severe in spring and fall.

The fungus also can infect fruit in what is called black seed disease. Berries usually have one or two spots but may have as many as 10. Spots are brownish black, hard, and leathery and appear on one to several achenes. Fruit does not rot but discolors under the spot.

Chemical control:

- Benomyl: Benlate at 0.5 to 1 lb/A. To reduce the possibility of tolerance, tank-mix with other fungicides. Do not use more than 5 lb/A/season. Not for use in U-pick operations. 1 day Phi. 24 hour REI.
- Captan 50 WP at 3 to 6 lb/A. 0 day PHI. 24 hour REI.

- Fixed copper. Begin applying when plants establish and continue weekly through the season. Discontinue if signs of phytotoxicity appear.
- Copper Hydroxide:
Champ Formula 2 at 1.3 to 2 pints/A. 24 hour REI.
Kocide DF at 2 to 3 lb/A. 24 hour REI.
Nu-Cop 50 DF at 2 to 3 lb/A. 24 hour REI.
- Myclobutanil: Rally 40 W at 1.25 to 5 oz/A. Do not apply more than 30 oz/A/season. 0 day PHI. 24 hour REI.
- Dodine: Syllit 65 W at 1.5 to 2 lb/A. 14 day PHI. 48 hour REI.
- Thiram Granuflo at 3.4 to 4.4 lb/A. 3 day PHI. 24 hour REI.
- Ziram: Or-Cal Ziram 400 at 2.3 to 3 pints/100 gal water. 7 days PHI. 48 hour REI.

Cultural control: Removing foliage after harvest reduces inoculum in the field. Mow leaves of June-bearing plants 0.5 inch above the crown after harvest. Leaf spot can still be a problem after renovation unless supplemented with chemical protection.

Grey mold *Botrytis cinerea*

This fungus overwinters as sclerotia or dormant mycelia in old leaves, petioles, and mummified fruit. Conidia from within the planting are the principal source of inoculum and are produced readily and for a long time on diseased plant material. Conidia readily infect the petals, stamens and pistals but not sepals. Mycelium then invades the developing fruit. Symptoms are generally delayed until fruit maturity and then progresses rapidly. No cultivar is immune, and even the least susceptible sustain considerable losses when environmental conditions favor disease development. The disease is more severe in high-density, double-row beds.

Symptoms: Blossom blight is characterized by petals and pedicels turning brown. The entire blossom may die. Fruit rot symptoms may occur on any portion of the fruit. They frequently develop at the calyx end and in tissues contiguous with rotting fruit or diseased flowers. Affected tissue turns light to medium brown. Lesions in green or white fruit develop slowly. The fruit may be misshapen as it enlarges. Fruit rot expands rapidly near harvest. In advanced stages, the fungus produces a gray mold over the fruit surface. Rot may not develop until after fruit is harvested.

Chemical control:

Apply during bloom period. Start at first bloom; repeat at regular intervals, especially during wet weather. Applications during fruit ripening are of questionable value. Without floral applications, fruit

ripening applications are worthless.

- Captan 50 WP at 3 to 6 lb/A. Do not use with oil or alkaline materials. 0 day PHI. 24 hour REI.
- Fenhexamid: Elevate 50 WDG at 1.5 lb/A. Do not apply more than twice sequentially or use more than 6 lb/A/season. 0 day PHI. 4 hour REI.
- JMS Stylet Oil at 3 quarts/100 gal water is registered, but its effectiveness in the Pacific Northwest is unknown. Tank-mix with another fungicide. Do not use during freezing temperatures, above 90°F, or when plants are under heat or moisture stress. Do not use when foliage is wet as good coverage is essential. 4 hour REI
- Messenger at 2.3 to 13.4 oz/A. The commercial efficacy of this product (a bacterial protein) is unknown in the Pacific Northwest and is not recommended. Do not use with chlorinated water or at a pH below 5. 0 day PHI. 4 hour REI.
- Cyprodinil + Fludioxonil: Switch 62.5 WG at 11 to 14 oz/A. Do not apply more than twice sequentially or use more than 56 oz/A/season. Do not replant treated areas to anything other than strawberry or onions for 1 year after last application. 0 day PHI. 12 hour REI.
- Thiram Granuflo at 3.4 to 4.4 lb/A. 3 day PHI. 24 hour REI.

Biological control:

- TopShield (*Trichoderma harzianum* strain KRL-AG2) at 6 to 12 oz/100 gal water plus a nonionic spreader sticker. Keep solution agitated. Do not use with low-volume sprayers. No data from the Pacific Northwest on product efficacy. No REI restrictions.

Cultural control:

- Space plants so foliage dries rapidly after rain and irrigation.
- Pick fruit as it ripens and move it quickly to cold storage.
- Shorten picking intervals, if possible, when weather favors Botrytis.
- Use optimal fertilization.
- Time of renovation is important because fall fruit can provide considerable inoculum for the next growing season. It is recommended to renovate 2 to 4 weeks after the last harvest of June bearing types.
- Remove blossoms in the planting year.

Leaf Scorch

Diplocarpon earlianum (asexual: *Marssonina fragariae*)

This fungus overwinters on old infected leaves. Conidia are produced in acervuli and are splashed to healthy tissue. Conidia are sticky and can directly penetrate the leaf cuticle. During spring rains, spores from just a few diseased plants can multiply and spread through the entire planting. This disease is

generally more severe in second- and third-year fields.

Symptoms: Small, dark purple spots develop on upper leaf surfaces and remain dark purple. A white center never forms, as with common leaf spot. Spots have an irregular outline. If numerous, spots run together, and leaves appear scorched. In severe cases, foliage is reduced considerably, and plants may be stunted. Infected fruit has elongated, slightly sunken, reddish areas or streaks, but the marks disappear as the fruit ripens.

Chemical control: Tolerant strains of some fungi have become troublesome when Benlate or Topsin M is used exclusively in a spray schedule. To reduce the possibility of tolerance, tank-mix Benlate with fungicides having a different mode of action. Do not mix Benlate and Topsin M; they have the same mode of action.

- Benlate at 0.5 to 1 lb/A. Do not use more than 5 lb/A/season. See warning above. Not for use in U-pick operations. 1 day PHI. 24 hour REI.
- Dodine: Syllit 65 WP at 1.5 to 2 lb/A. 14 day PHI. 48 hour REI.
- Thiophanate-methyl: Topsin-M 70 W at 0.75 to 1 lb/A. 1 day PHI. 12 hour REI.

Cultural control:

- 'Hood' and 'Rainier' are resistant. 'Northwest', 'Puget Beauty', 'Shuksan', and 'Totem' have intermediate susceptibility. 'Benton', 'Linn', 'RedCrest' and 'Quinault' are susceptible.
- Space plants so foliage dries rapidly after rain and irrigation.
- Use optimal fertilization.
- Summer renovation will help reduce inoculum levels. It is recommended to renovate 2 to 4 weeks after the last harvest of June bearing types.

Powdery Mildew

Sphaerotheca macularis f. sp. Fragariae

This fungus overwinters on infected plant tissue, including living leaves. This fungus is favored by conditions that produce high humidity but dry leaves. It is a highly specialized pathogen that forms a close association with the host. Conditions that favor the host also favor the pathogen. Much of the fungus remains on the outside of infected plant parts but sends in rootlike structures, haustoria, to obtain nutrients. The white growth seen is composed of both mycelium and fungal spores.

Symptoms: Edges of infected leaflets curl up, exposing undersides that often are reddened and coated with a grayish white powdery mildew fungus. Diseased leaves later turn purplish or red. In irrigated fields, the fungus also may attack fruit. Some day-neutral cultivars are susceptible to fruit infection in fall even though leaves may appear healthy.

Cultural control:

- Destroying old leaves by renovating plants after harvest may help reduce inoculum.
- Plant resistant cultivars: Hood, Totem, and Benton are moderately resistant or tolerant; Shuksan, Sumas, and Linn are moderately susceptible; Olympus, Redcrest, Independence, Puget Summer, Firecracker, and Northwest are very susceptible.

Chemical control: The disease needs to be controlled on highly susceptible cultivars after summer renovation so plants remain vigorous until they cease growth and go dormant in late fall.

- Bicarbonate-based products can supplement a normal program when powdery mildew is first observed. Do not mix with other pesticides. Thorough coverage is essential. These products are easily washed off by rain, so reapplication is necessary. 1 day PHI. 4 hour REI.

¢ Armicarb 100 (85% potassium bicarbonate) at 2.5 to 5 lb/A.

¢ FirstStep (85% potassium bicarbonate) at 2.5 to 5 lb/A.

¢ Kaligreen (82% potassium bicarbonate) at 2.5 to 3 lb/A.

- JMS Stylet Oil at 3 quarts/100 gal water. Do not use during freezing temperatures, above 90°F, or when plants are under heat or moisture stress. Do not use when foliage is wet because good coverage is essential. 4 hour REI.

- Sulfur (80%): Kumulus DF or Microthiol Disperss at 5 to 10 lb/A. May burn plants if applied above 85 - 90°F. Do not use a spreader sticker. 24-hr reentry.

- Potassium salts of fatty acids: M-Pede at 1 gal/50 gal water. This product is registered on strawberry for soft-bodied insects and has shown good activity against powdery mildew on several other crops. 0 day PHI. 12 hour REI.

- Myclobutanil: Rally 40 W at 1.25 to 5 oz/A. Do not apply more than 30 oz/A/season. 0 day PHI. 24 hour REI.

- Triflumizole: Procure 50WS at 4 to 8 oz./A. Make application at first sign of disease. Applications to leaves prior to bloom will reduce in-season disease pressure. 1 day PHI. 12 hour REI.

Biological control:

- *Ampelomyces quisqualis* (a fungal hyperparasite): AQ10 at 0.5 to 1 oz/A plus a mineral-oil-based surfactant. Use at least two sequential sprays 7 to 14 days apart. Apply during early evening or morning when humidity and/or leaf wetness are high. Ineffective as a stand-alone treatment or if symptoms of powdery mildew are present. Not compatible with certain fungicides such as sulfur and soaps. 4 hour REI.

Red Stele

Phytophthora fragariae var. *fragariae*

The causal agent of red stele is a soil-infesting fungus-like microorganism that may live many years in the soil. It is active in cool, wet weather. It attacks roots soon after fall rains begin and remains active through winter, spreading most rapidly where drainage is poor or in heavier soils. Well-drained fields are less often attacked, but low areas often show typical red stele infection. Of the seven races of this organism that have been described, five have been reported from Oregon.

Symptoms: The core or stele of diseased roots in winter and spring has a reddish pink tinge gradually turning a cinnamon-brown while the root's outer cortex stays white. Ultimately the diseased core turns black. Most of the plant's main roots show the symptom, but after May it is difficult to see. Lateral roots are quickly destroyed, giving main roots a rat tail appearance. Severely diseased plants are stunted, and under certain conditions the youngest leaves take on a bluish-green tinge and lack normal glossiness. Older leaves generally turn red, orange, or yellow. Such plants eventually wilt and die.

Chemical control: Alternate between chemicals with different modes of action to prevent or delay building up resistant microorganisms. Red stele microorganisms resistant to Ridomil have been detected in the major strawberry-growing areas of the Willamette Valley of Oregon.

- Fosetyl-Al: Aliette WDG at 2.5 to 5 lb/A. Apply when plants resume growth in spring; continue at 30- to 60-day intervals. Apply no more than twice in spring and twice in fall. 0 day PHI. 12 hour REI.
- Mefenoxam: Ridomil Gold EC at 1 pint/A. Do not use more than 1.5 quarts/A/year. Apply once at planting and again in spring as plants begin to grow. Apply again in fall after harvest but before fall rains. 48 hour REI.

Cultural control:

- Use certified plants only.
- Set new plants in well-drained soil (no standing water in winter) where red stele has not been known to occur.
- Plant on beds raised 8 to 10 inches to improve drainage, or use drain furrows.
- Do not plant in draws or swales where surface water flows after heavy rain.
- Chisel or subsoil 18 to 20 inches deep between rows in late fall to increase drainage.
- Clean soil from equipment before using it in other fields.
- Resistant cultivars include: Olympus, Hood, Totem, Rainier, and Shuksan, but even these are infected sometimes if virulent races of the pathogen are in soil.

Verticillium Wilt

Verticillium dahliae and *V. albo-atrum*

This soil-borne fungus can live many years in soil. Isolates that can attack strawberry have a wide host range, so it is not advisable to plant strawberry after solanaceous (potato family) or small fruit crops that have shown evidence of the disease. Many cultivars derived from resistant clones of *Fragaria chiloensis*, *F. virginiana*, and *F. virginiana* subsp. *glauca* are resistant to strains of *Verticillium*.

Symptoms: Individual plants wilt, sometimes in patches in the field. Plants are most severely affected in their first year. Older leaves wilt and tend to curl up along the midvein. Inner (younger) leaves tend to remain green although stunted. Plants often are stunted, dry, and flattened with small yellowish leaves, especially as fruit ripens. Brownish streaks occur in vascular tissue of crown roots or at the base of the petiole.

Chemical control:

Preplant fumigation:

- Chloropicrin (33 to 50%) and methyl bromide under polyethylene film. Restricted-use pesticide.
- Telone C-17 at 27 to 41 gal/A broadcast on mineral soils. Allow 2 to 3 weeks between application and planting or until odor leaves soil. Do not treat extremely heavy soils. Restricted-use pesticide. 72 hour REI.
- Vapam (32.7% metam sodium) at 50 to 100 gal/A. Immediately roll the soil and follow up with tarps or a light watering. May use through an irrigation system. 48 hour REI and/or while tarps are being removed.

Cultural control:

- Plant only healthy, certified berry stock from nurseries or other plantings known to be free of wilt.
- The fungus may persist many years in soil and can attack susceptible plants' roots whenever they are placed in infested ground. Rotating to nonsusceptible grasses and cereals may lower the amount of Verticillium in infested soil but seldom eliminates it. Rotations of 5 to 8 years have been tried, though Verticillium often survives longer in soil.
- Remove infected plants and the plants on either side to stop wilt spread. Do not replant where infection occurred.
- Avoid planting other susceptible crops which may increase Verticillium in the soil. Susceptible crops include potato, tomato, caneberries, stone fruit, eggplant and pepper, maple among other nursery trees, and many common weeds.
- Use resistant cultivars.

Virus Diseases

Strawberry crinkle virus, Strawberry mottle virus, Strawberry mild yellow-edge virus, and Strawberry vein-banding virus commonly infect strawberry plants in Oregon. These viruses are transmitted by aphids (see above section on insect control). Tomato ringspot virus is spread by the dagger nematode (see nematode control section, below). Tobacco streak virus and pallidosis disease also are found in Oregon strawberry fields but they spread naturally by unknown means.

Symptoms: There are few if any diagnostic symptoms of specific viruses in strawberry cultivars commonly planted in Oregon. Some general symptoms are described below:

Tomato ringspot virus: stunting and sometimes death. Susceptible cultivars are Benton, Hood, Olympus,

Puget Beauty, Rainier, Shuksan, and Totem. 'Northwest' appears to be immune.

Aphid-transmitted viruses: vigor and yield decrease, but usually the only distinctive symptoms are dwarfing, leaf cupping, and yellowing. 'Totem', 'Shuswap', and 'Sumas' are the most virus tolerant cultivars; 'Hood' is the most sensitive. The former cultivars become infected as readily as others but usually do not show symptoms unless infected by three of the viruses.

Tobacco streak virus: loss of vigor and yield without distinctive symptoms.

Pallidosis agent: increases the severity of many aphid-transmitted viruses.

Cultural control:

- Use planting stock that is certified as tested and free of all known viruses.
- Do not set out new plants next to old, virus-infected fields.
- Use cultivars that are tolerant to viruses.
- Control known insect vectors.

Nematodes

Several different nematodes are commonly found in strawberry plantings (10). Their feeding on roots can stunt plants and reduce runner production. Of greater concern, however, is the potential for them to vector virus diseases. Sampling for nematodes prior to planting is critical as any chemical controls are pre-plant only. Growers are advised to avoid nematode infested areas, if possible.

Dagger Nematode

Xiphinema americanum and related species

Dagger nematodes are vectors of Tomato ringspot virus. They are migratory found only in soil. As virus vectors, they can be damaging at very low population levels. Dagger nematode populations may be very low in late summer when other nematodes are abundant. The best time for sampling is December to April.

Symptoms: In the absence of the virus, the nematodes may cause sunken reddish brown lesions on roots. Feeding can reduce the root system, which can stunt growth and reduce runner production. If Tomato ringspot virus is vectored, the plants will appear stunted and some areas of the field will have dead plants.

Chemical control:

Preplant soil fumigation is best for controlling this nematode. Apply in fall for planting the next spring.

- Telone II at 24 to 36 gal/A or Telone C-17 at 27 to 41 gal/A broadcast on mineral soils. Allow 2 to 3 weeks between treating and planting or until odor leaves the soil. Do not treat extremely heavy soils. Restricted-use pesticide. 72 hour REI.
- Vapam (32.7% metam sodium) at 50 to 100 gal/A. Immediately roll the soil and follow up with tarps or a light watering. May use through an irrigation system. 48 hour REI and/or while tarps are being removed.
- Methyl bromide plus chloropicrin (33 to 55%) under polyethylene film. See label for rates. Restricted-use pesticide.
- Fenamiphos: NemaCur 15 G at 14.7 to 22 oz or NemaCur 3 at 5.9 to 8.8 fl oz per 1,000 ft of row in a 12- to 18-inch band over the row. Incorporate immediately by cultivation or sprinkler irrigation. Do not apply more than once. Do not apply within 110 days of harvest. Use maximum band width and rate in fields with high populations of nematodes or a history of nematode damage. Restricted-use pesticide. 48 hour REI.

Cultural control:

- Use certified planting stock.
- Plant on soil that has been tested and found free of dagger nematodes.
- In areas with dagger nematodes, consider planting tolerant or resistant cultivars such as 'Northwest'.

Root-knot nematode

Meloidogyne hapla

This nematode lives in soil and attacks many other kinds of plants. Root-knot nematodes are sedentary endoparasites; only second-stage juveniles (the infective stage) and adult males (which may be rare) are in soil.

Symptoms: Plants look unthrifty and off-color. Roots have large or small galls. Sampling should include both soil and roots.

Chemical control:

Preplant soil fumigation. Apply in the fall before planting the next spring.

- Telone II at 24 to 36 gal/A or Telone C-17 at 27 to 41 gal/A broadcast on mineral soils. Allow 2 to 3 weeks between treating and planting or until odor leaves the soil. Do not treat extremely heavy soils. Restricted-use pesticide. 72 hour REI.
- Vapam (32.7% metam sodium) at 50 to 100 gal/A. Immediately roll the soil and follow up with tarps or a light watering. May use through an irrigation system. 48 hour REI and/or while tarps are being removed.

- Methyl bromide plus chloropicrin (33 to 55%) under polyethylene film. See label for rates. Restricted-use pesticide.

Cultural control:

- Rotate using corn or small grains.
- Use certified plants.

Root-Lesion Nematode

Pratylenchus penetrans and *P. crenatus*

This nematode lives in soil. Legumes such as clover, alfalfa, and vetch often harbor large populations of root-lesion nematodes, which may affect future strawberry plantings. The number of nematodes in the soil can be a rough guide to possible plant damage. Factors such as crop age, planting frequency, presence of other diseases and pests, and adverse growing conditions influence the effect on plant growth. In some cases, 300 nematodes/100 g of soil affect plant growth, but much higher populations often have little effect. Root-lesion nematodes are migratory endoparasites; part of the population is in soil and part in the roots at all times.

Symptoms: Infected plants are dwarfed, off-color, and grow poorly. Damage is frequently seen as spots in the field. Roots have brown lesions. Include soil and roots when sampling. Populations are relatively low through winter and spring but increase rapidly through summer. Before planting strawberries, it is best to sample in late summer.

Chemical control:

Preplant soil fumigation:

- Telone II at 24 to 36 gal/A or Telone C-17 at 27 to 41 gal/A broadcast on mineral soils. Allow 2 to 3 weeks between treating and planting or until odor leaves the soil. Do not treat extremely heavy soils. Restricted-use pesticide. 72 hour REI.
- Vapam (32.7% metam sodium) at 50 to 100 gal/A. Immediately roll the soil and follow up with tarps or a light watering. May use through an irrigation system. 48 hour REI and/or while tarps are being removed.
- Methyl bromide plus chloropicrin (33 to 55%) under polyethylene film. See label for rates. Restricted-use pesticide.

Cultural control:

- If possible, rotate plantings to new land.
- Use certified plants.

Stem and Bulb Nematode

Ditylenchus dipsaci

This nematode infects aboveground portions of plants but is rarely found in strawberries. Take soil samples before planting strawberries if the field has a history of stem nematode problems. If this nematode is suspected in an established plant, only the affected crowns need to be submitted for testing.

Symptoms: Plants are stunted from the crown with short, thick petioles. The symptoms are most evident in cool, wet springs.

Cultural control:

- Remove infected plants.
- Rotate to new land or other crops for 3 years.
- Avoid planting in fields where red clover has been affected.

Weeds

Weed competition in strawberry fields can reduce plant vigor and, subsequently, yield. Approximately 80% of all strawberry acreage is treated with an herbicide (1). Hand weeding in the plant row and cultivation between the rows are also common practices, usually in conjunction with herbicide applications (6). Weed control practices in strawberries must be timed to coincide with the crop's non-reproductive phases or when minimal herbicide uptake can be expected. Strawberries can be induced into a non-reproductive summer dormancy by withholding water and fertilizer after harvest. Beds are renovated by mowing old leaves, cultivating row middles, and sometimes applying an herbicide. In mid-August, plants are fertilized and watered to enhance flower bud development.

Although strawberries are rotated with other crops every 3 to 5 years, weed shifts or the incidence of tolerant species often occur with repeated use of the same or similar weed control practices. Often, a combination of mechanical methods, herbicide treatments, and sometimes hand removal or spot treatment with herbicide sprays will provide the most effective year-round control (12). Sulfentrazone (Spartan 4F) has used under Section 18 emergency exemption registration for the past two year for control of many broadleaf weeds, especially those seemingly resistant to napropamide (Devrinol) and simazine, and some grass weeds,. Spartan has been allowed for use during three distinct periods: Pre-plant, after renovation before new growth resumes, and during winter dormancy.

New Plantings

Glyphosate

Formulation: Roundup UltraMax RT

Application Type and Timing: Post emergence. Used for site preparation; apply pre-plant only and at least three days before transplanting.

Application Rate: Rate depends on weed to be controlled. Consult label. (supplemental label allows use in all Oregon counties.)

PHI: NA

REI: 4 hours

Napropamide

Formulation: Devrinol 50 DF

Application Type and Timing: Preemergence. Apply before weeds germinate or after cultivating to remove growing weeds. Do not apply from bloom through **harvest**.

Application Rate: 4 lb ai/A

PHI: Unavailable

REI: 12 hours

Remarks: Requires sprinkler irrigation the same day to wet soil 2 to 4 inches deep. Applications during the growing season may delay or inhibit rooting (pegging) of runners. Application of 2 lb ai/A at planting at planting can minimize root pruning and pegging problems; apply an additional 2 lb ai/A in fall.

Pendimethalin

Formulation: Prowl 3.3 EC

Application Type and Timing: Preemergence. Apply before transplanting strawberries.

Application Rate: 0.75 to 1.65 lb ai/A (1.8 to 4.0 pints/A)

PHI: 365 days

REI: 24 hours

Remarks: Non-bearing strawberries, only. Most effective when incorporated in weed emergence zone by rainfall or irrigation within 7 days. Stunting, reduced growth, or reduction in daughter plants may occur. 24c registration.

DCPA

Formulation: Dacthal W-75

Application Type and Timing: Preemergence. Apply soon after transplanting or preplant incorporate.

Application Rate: 9 lb ai/A

PHI: NA

REI: 12 hours

Remarks: Applications west of the Cascades usually perform erratically.

Lactofen

Formulation: Cobra

Application Type and Timing: Preemergence. Apply immediately before or after transplanting or within 48 hours after transplanting if soil is placed over plants to minimize contact and possible injury.

Application Rate: 0.25 to 0.38 lb ai/A (16 to 24 ounces product/A)

PHI: 365 days

REI: 12 hours

Remarks: Non-bearing strawberries, only. Activate with 0.25 to 0.5-inch water within 48 hours. Grasses are not controlled. 24c registration.

Sethoxydim

Formulation: Poast

Application Type and Timing: Post emergence. Apply at optimum weed growth stage listed on the label.

Application Rate: 0.19 to 0.478 lb ai/A (1 to 2.5 pints product/A)

PHI: 7 days

REI: 12 hours

Remarks: Controls grasses only. Control often is erratic on grasses that are stunted or stressed from drought, high temperatures, or low fertility. Resistant grasses include annual bluegrass and all fine fescues, but quackgrass can be suppressed. Addition of a non-phytotoxic crop oil concentrate (at 2 pints/A) will improve leaf absorption. Do not exceed 2.5 pints of product per acre per season.

Clethodim

Formulation: Prism, Select 2 EC

Application Type and Timing: Post emergence. Apply to actively growing grass weeds.

Application Rate: 0.094 to 0.125 lb ai/A (13 to 17 fl oz/ Prism; 6 to 8 fl oz/A Select)

PHI: 4 days

REI: 24 hours

Remarks: Controls grasses only. Effective on annual bluegrass. Limited observations suggest that April treatments may cause slight cupping and browning of petals or blossoms. Addition of a non-phytotoxic crop oil concentrate (at 1%v/v) will improve leaf absorption.

Established Plantings
(*Early Fall or Winter Applications*)

Simazine

Formulation: Simazine 90 WDG or 90 DF, Princep Caliber 90, Simazine 4L

Application Type and Timing: Preemergence. Apply in October or November and activate with rain. Apply only once per year

Application Rate: 1.0 lb ai/A

PHI: NA

REI: 12 hours

Remarks: Established weed seedlings will not be controlled. Do not use on sandy or coarse soils.

Terbacil

Formulation: Sinbar

Application Type and Timing: Preemergence. Apply to plants that have been established in the field for at least six months. Apply during late fall or winter, when strawberry plants are not actively growing.

Application Rate: 0.1 to 0.3 lb ai/A

PHI: NA

REI: 12 hours

Remarks: Weeds greater than one inch tall or wide will not be controlled. Treatments may reduce plant vigor. Do not use on sandy, loamy sands, gravelly soils or soils containing less than 2% organic matter. Avoid use for 2 years when replanting is anticipated; consult label for recropping information. Do not apply more than 0.5 lb Sinbar (0.4 lb ai) per growing season.

Napropamide

Formulation: Devrinol 50 DF

Application Type and Timing: Preemergence. Apply fall through early spring before weeds emerge, preferably in November or December.

Application Rate: 4 lb ai/A

PHI: Unavailable

REI: 12 hours

Remarks: Due to possible carryover in wheat rotations, use other weed control practices the final year of strawberry production or deep plow to dilute the soil residue.

DCPA

Formulation: Dacthal W-75

Application Type and Timing: Preemergence. Apply in fall or early spring to control late summer weeds.

Application Rate: 6 to 9 lb ai/A

PHI: NA

REI: 12 hours

Remarks: Applications west of the Cascades usually perform erratically.

Sethoxydim

Formulation: Poast

Application Type and Timing: Post emergence. Apply at optimum weed growth stage listed on the label.

Application Rate: 0.38 to 0.48 lb ai/A (2 to 2.5 pints/A Poast)

PHI: 7 days

REI: 12 hours

Remarks: Controls grasses only. Control often is erratic on grasses that are stunted or stressed from drought, high temperatures, or low fertility. Resistant grasses include annual bluegrass and all fine fescues, but quackgrass can be suppressed. Addition of a non-phytotoxic crop oil concentrate (at 2 pints/A) will improve leaf absorption. Do not exceed 2.5 pints of product per acre per season.

Clethodim

Formulation: Prism, Select 2 EC

Application Type and Timing: Post emergence. Apply to actively growing grass weeds.

Application Rate: 0.094 to 0.125 lb ai/A (13 to 17 fl oz/ Prism; 6 to 8 fl oz/A Select)

PHI: 4 days

REI: 24 hours

Remarks: Controls grasses only. Effective on annual bluegrass. Addition of a non-phytotoxic crop oil concentrate (at 1% v/v) will improve leaf absorption.

2,4-D Amine

Formulation: Formula 40

Application Type and Timing: Post emergence. Apply only when strawberries are fully dormant during winter.

Application Rate: 0.95 to 1.425 lb ae/A

PHI: NA

REI: 48 hours

Remarks: Controls broadleaf weeds only. Injury may result from variations in climatic conditions, stage of strawberry growth, or susceptibility of varieties. Use only in fields with extreme infestations of established broadleaf weeds when other weed control alternatives are lacking. The Formula 40 label states, "Do not apply unless injury to the crop is acceptable".

Established Plantings *(During bed renovation in summer)*

Simazine

Formulation: Simazine 90 WDG or 90 DF, Princep Caliber 90, Simazine 4L

Application Type and Timing: Preemergence. Apply after bed renovation and first irrigation, followed with additional 0.5 inch irrigation to activate the herbicide. Apply only once per year.

Application Rate: 1.0 lb ai/A

PHI: NA

REI: 12 hours

Remarks: Established weed seedlings will not be controlled. Do not use on sandy or coarse soils. In summer, simazine is only about half as active as in winter applications.

Terbacil

Formulation: Sinbar

Application Type and Timing: Preemergence. Apply to plants that have been established in the field for at least six months. Apply before new strawberry growth begins and before weeds are more than 1 inch tall or wide.

Application Rate: 0.1 to 0.3 lb ai/A

PHI: NA

REI: 12 hours

Remarks: Make a split application (summer and fall/winter), using a lower rate after bed renovation in summer; do not apply more than 0.5 lb Sinbar (0.4 lb ai) per growing season. Weeds greater than one inch tall or wide will not be controlled. Treatments may reduce plant vigor. Do not use on sandy, loamy sands, gravelly soils or soils containing less than 2% organic matter. Avoid use for 2 years when replanting is anticipated; consult label for recropping information.

Napropamide

Formulation: Devrinol 50 DF

Application Type and Timing: Preemergence. Apply to weed-free soil after bed renovation.

Application Rate: 4 lb ai/A

PHI: Unavailable

REI: 12 hours

Remarks: Applications during the growing season may delay or inhibit rooting (pegging) of runners.

Paraquat

Formulation: Gramoxone Max, Gramoxone Extra

Application Type and Timing: Post emergence. Apply as a directed spray between rows using shields to prevent spray contact with crop.

Application Rate: 0.5 lb ai/A (1.3 pints/A Gramoxone Max; 1.5 pints/A Gramoxone Extra)

PHI: 21

REI: 12 hours

Remarks: Add a nonionic surfactant or crop oil concentrate as label directs; avoid anionic formulations that react to form insoluble precipitates. Do not apply more than three times a year. Restricted use pesticide.

2,4-D Amine

Formulation: Formula 40

Application Type and Timing: Post emergence. Apply after harvest when no new growth is visible but before flower buds begin to form.

Application Rate: 0.95 to 1.425 lb ae/A

PHI: NA

REI: 48 hours

Remarks: Controls broadleaf weeds only. Injury may result from variations in climatic conditions, stage of strawberry growth, or susceptibility of varieties. Use only in fields with extreme infestations of established broadleaf weeds when other weed control alternatives are lacking. The Formula 40 label states, "Do not apply unless injury to the crop is acceptable".

Sethoxydim

Formulation: Poast

Application Type and Timing: Post emergence. Apply at optimum weed growth stage listed on the label.

Application Rate: 0.38 to 0.48 lb ai/A (2 to 2.5 pints/A Poast)

PHI: 7 days

REI: 12 hours

Remarks: Controls grasses only. Control often is erratic on grasses that are stunted or stressed from drought, high temperatures, or low fertility. Resistant grasses include annual bluegrass and all fine fescues, but quackgrass can be suppressed. Addition of a non-phytotoxic crop oil concentrate (at 2 pints/A) will improve leaf absorption. Do not exceed 2.5 pints of product per acre per season.

Clethodim

Formulation: Prism, Select 2 EC

Application Type and Timing: Post emergence. Apply to actively growing grass weeds.

Application Rate: 0.094 to 0.125 lb ai/A (13 to 17 fl oz/ Prism; 6 to 8 fl oz/A Select)

PHI: 4 days

REI: 24 hours

Remarks: Controls grasses only. Effective on annual bluegrass. Addition of a non-phytotoxic crop oil concentrate (at 1% v/v) will improve leaf absorption.

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