

Strawberry Management Schedule

The following is a general guide to strawberry management based upon crop and pest development. The suggested timing will vary according to strawberry variety, weather and location. The actions are for established plantings except where otherwise noted.

Timing	Type of Action	Action
JANUARY/ FEBRUARY	Plant Care	<ul style="list-style-type: none"> No activity usually required.
	Soil Care	<ul style="list-style-type: none"> Check for poor drainage and erosion - plan for fall drainage improvements. New plantings. Take soil samples if not taken the previous fall.
	Other	<ul style="list-style-type: none"> "Finalize marketing plan for this season's crop to processors and/or fresh market. If fresh marketing, order fruit containers. New plantings. Confirm plant order with supplier to make sure plants are available. Also, advise supplier of expected planting date. Obtain required plant import permits. Ensure sprayers are tuned-up and calibrated.

MARCH Early growth starts	Plant Care	<ul style="list-style-type: none"> Start spring cleanup. Remove old leaves before new growth starts. Rotovate to narrow rows to about 30 cm and incorporate leaves into soil.
	Disease Control	<ul style="list-style-type: none"> "Remove and destroy old leaves to control fruit rot, powdery mildew and leaf spot diseases. Inspect weak areas for signs of red stele."
	Insect Control	<ul style="list-style-type: none"> "Start monitoring for two-spotted spider mites (late March). Apply miticide, if necessary. If areas of poor growth appear, check plant roots for root weevil larvae, wireworms or leatherjackets. Control if necessary."
	Weed Control	<ul style="list-style-type: none"> "Begin hand weeding to remove any overwintering weeds. Before weed seeds germinate, apply a herbicide for residual weed control."
	Soil Care	<ul style="list-style-type: none"> "Incorporate cover crop or winter mulch, if used. New plantings. To prepare for a new planting, apply and incorporate lime, compost or manure, if they are to be used."
	Food Safety	<ul style="list-style-type: none"> Ensure a food safety plan is in place including a record keeping system.

<p>APRIL Early growth starts</p>	Plant Care	<ul style="list-style-type: none"> ● Apply complete fertilizer in bands, in early April. Continue spring cleanup, if not finished earlier (see March). ● New plantings. Continue soil preparation and begin planting as weather permits. Apply first fertilizer once new leaves start to appear. Irrigate if soil is dry.
	Disease Control	<ul style="list-style-type: none"> ● Watch for common leaf spot on susceptible varieties (Puget Reliance). Apply fungicides if needed. Remove and destroy old leaves, if not done in March. Check roots for signs of red stele. Apply Aliette after new leaves emerge.
	Insect Control	<ul style="list-style-type: none"> ● Continue to monitor for two-spotted mites and predators, cyclamen mites, root weevil larvae, wireworms and leatherjackets. Inspect emerging leaves for aphids, especially after a few days of warm weather. Control when noticed.
	Weed Control	<ul style="list-style-type: none"> ● Hand weed in the strawberry rows and cultivate or rotovate the aisles, as needed. ● New plantings. Apply herbicide for residual weed control. If rain does not occur within a few days, irrigate to activate the herbicide.
	Other Pests	<ul style="list-style-type: none"> ● Watch for slugs, especially if the weather is rainy. Control high grass around strawberry fields.
	Soil Care	<ul style="list-style-type: none"> ● New plantings. Continue soil preparation, including adding manure or compost, before planting, if not done earlier.

MAY Flower buds appear and open	Plant Care	<ul style="list-style-type: none"> If plant growth is weak, begin applying weekly foliar fertilizer sprays, as needed. Irrigate as necessary, if the soil is dry.
	Disease Control	<ul style="list-style-type: none"> Begin <i>Botrytis</i> fruit rot control spray program when the first flowers open. If the weather is warm and humid, watch for the first signs of powdery mildew. Apply control sprays, if required. Apply a second Aliette spray if required.
	Insects/Mite Control	<ul style="list-style-type: none"> Check for aphids, especially after a few days of warm weather and control when noticed. Immediately at first flowering, monitor for lygus bugs and spray if required. Continue to regularly monitor fields for aphids, lygus bugs, two-spotted mites and predators, strawberry mites, root weevils, and other pests. New plantings. Check for aphids, especially under new, folded leaves emerging from the crowns. Control them, as required, to prevent the spread of viruses. Watch for leaf notching caused by the feeding of adult weevils, especially near the edges of the fields and control if present.
	Weed Control	<ul style="list-style-type: none"> Hand weed to remove any weeds not controlled by herbicides.
	Food Safety	<ul style="list-style-type: none"> Test irrigation and spray water for E. coli and fecal coliforms. Order toilets, hand washing units and other sanitary supplies.

JUNE Flowering continues. Fruit development and ripening.	Plant Care	<ul style="list-style-type: none"> Continue to apply foliar fertilizers, if needed. If weather is warm and dry, continue to irrigate. Harvest and market fruit. New plantings. Set new runners in the rows and, if the plant growth is not strong, remove the flower buds while hand weeding.
	Disease Control	<ul style="list-style-type: none"> Continue Botrytis fruit rot control program. To obtain good spray coverage increase spray pressure and water volume as leaf canopy develops to obtain good spray coverage. Continue to watch for powdery mildew and leaf spot, especially following warm, humid weather. Control as required. Nematodes. Test soil for nematodes in fields that will be planted to strawberries next spring, to see if fumigation is required.
	Insect Control	<ul style="list-style-type: none"> Continue to watch for aphids, root weevil feeding injury, lygus bugs, spittlebugs, two-spotted mites and predators, strawberry mites, etc.
	Weed Control	<ul style="list-style-type: none"> Last chance for hand weeding before harvest.
	Other Pests	<ul style="list-style-type: none"> Slugs. Mow or rotovate any high grass near the strawberry fields to discourage slugs. If the weather is rainy it may be necessary to apply slug bait at field edges and/or between the rows.
	Food Safety	<ul style="list-style-type: none"> Place portable toilets and hand washing units. Ensure workers are trained in good hygiene and harvesting practices.

<p>JULY/ AUGUST Post-har- vest care</p>	<p>Plant Care</p>	<ul style="list-style-type: none"> Take plant leaf samples or soil samples for analysis immediately after harvest, if needed. Begin renovation and post-harvest clean-up. Mow the tops of the plants off about two weeks after harvest ends. Rotovate to narrow the rows and to bury the plant debris. Apply the main fertilizer application in bands along the strawberry rows. Irrigate as necessary to encourage strong regrowth. New plantings. Band remaining nitrogen fertilizer when runnering starts.
	<p>Disease Control</p>	<ul style="list-style-type: none"> Conduct post-harvest renovation (as above) to reduce Botrytis, powdery mildew, and other disease problems. Apply fungicides if required. Check for root and crown diseases and soil problems in areas of poor growth. If fumigation is recommended, fields to be planted next spring should be kept weed-free in preparation for soil fumigation in September.
	<p>Insect Control</p>	<ul style="list-style-type: none"> Continue to monitor two-spotted mites and predators, aphids, root weevils. Control if necessary. Check for wireworms (late-Aug.) in fields to be planted next spring.
	<p>Weed Control</p>	<ul style="list-style-type: none"> Apply Lontrel before mid-August (before mowing) for control of established hard-to-control weeds like white clover, sorrel, vetch, etc. Hand weed if necessary. Apply a residual herbicide for seasonal weed control. If quackgrass is a problem, apply Venture or Poast when the regrowth reaches the 3-5 leaf stage.
	<p>Soil Care</p>	<ul style="list-style-type: none"> New plantings. If necessary, install drainage in fields to be planted next spring. Seed cover crops in fields being prepared for spring planting. Cover crops should be established by Sept. 15. Where wireworm control is needed, leave field bare over winter.

SEPTEMBER	Plant Care	<ul style="list-style-type: none"> ● Order plants for the next spring's planting. If soil is dry, irrigate as necessary.
	Disease Control	<ul style="list-style-type: none"> ● Continue to check for disease problems. Control if necessary. Cultivate between the rows to slightly ridge up the soil in the row area, if needed to improve winter drainage. ● New plantings. If recommended by soil analysis, fumigate for nematode control, in preparation for next season's planting.
	Insect/Mite Control	<ul style="list-style-type: none"> ● Continue to monitor for aphids, two-spotted mites and predators. Control two-spotted mites before they change into the orange, overwintering stage. ● New plantings. Check fields to be planted next spring for wireworms, if not done earlier.
	Weed Control	<ul style="list-style-type: none"> ● Check fields for weeds. Hand weed, if required. Apply a residual herbicide for seedling weed control during the fall and winter.
	Soil Care	<ul style="list-style-type: none"> ● Subsoil between the plant rows before fall rains start, to break soil compaction and to improve winter drainage. ● New plantings. Install drainage in fields to be planted next spring, if not done earlier. If wireworm control is not needed, seed fall cover crops by mid-Sept.

OCTOBER/ NOVEMBER Post-harvest care	Plant Care	<ul style="list-style-type: none"> ● Order plants for next spring, if not done earlier. ● Interior. Apply mulch for crop protection after several frosts have occurred.
	Disease Control	<ul style="list-style-type: none"> ● Apply Aliette before plant growth ceases or Ridomil up to Nov. 30 in the row area for red stele suppression during the winter months.
	Insect Control	<ul style="list-style-type: none"> ● Apply controls for leatherjackets, if present.
	Weed Control	<ul style="list-style-type: none"> ● Apply residual herbicide for winter weed control if not done earlier. It is generally applied to the whole field, not just to the row areas, unless an inter-row cover crop has been sown. Mow any tall grass and weeds around the field that could provide protection for mice during the winter.
	Other Pests	<ul style="list-style-type: none"> ● If mouse activity is noticed, around the field, apply mouse control bait before mice invade the strawberry field.
	Soil Care	<ul style="list-style-type: none"> ● Subsoil fields early in the month, if not completed earlier.
NOVEMBER/ DECEMBER	Other Pests	<ul style="list-style-type: none"> ● Apply Ridomil for red stele control up to Nov. 30 if not done earlier. Continue mouse control activities (see October). Deer can be a problem in some areas. Contact a conservation officer at the BC Ministry of Environment.

June Bearing Varieties

The following varieties are listed in their order of ripening. They are believed to be generally suited to the area specified. Discuss the choice of variety with the intended packer before making a final decision. Note: PARC is the Pacific Agri-Food Research Centre, Agriculture and Agri-Food Canada.

Hood

Recommended for plantings in all areas, but is very susceptible to virus and should be grown in isolation from other strawberry fields. Ripens 4-5 days earlier than Totem. Suited for early fresh market and processing. Fruit borne on strong upright clusters, fruit is large, round conic, glossy, flesh bright red, medium firm and one of the sweetest varieties. Tolerant to powdery mildew, produces moderate number of runners.

Honeoye

A New York variety which has performed well in the Okanagan Valley. Not recommended in the Fraser Valley as it is very susceptible to virus and red stele. Vigorous, high yielding plants which produce early, large attractive fruit suitable for the fresh market. Flavour may be somewhat tart.

Nisgaa (BC 92-20-85)

A new release from the PARC Agassiz breeding program that produces high yields of large fruit that ripen 3 to 5 days earlier than Totem. Fruit is medium-dark red, firm and glossy with a sweet strawberry flavour. It is mainly suited for the fresh market. It caps well and is also suitable for the processing market. Plants are small, dense and moderately vigorous. It shows good tolerance to viruses and soil born diseases. It is recommended for trial in all areas.

Valley Red (ORUS 1790-1)

A new release from the USDA-ARS program in Corvallis that produces high yields of uniform, large, dark red fruit. Its dark external and internal colour makes it suitable for the processing market only. Plant has an open habit and is easy to harvest. Harvest season is similar to that of Puget Reliance and slightly earlier than Totem. It is recommended for trial in all areas.

Puget Reliance

Recommended in all areas. Produces high yields of large, good quality fruit on vigorous, relatively virus-tolerant plants. Well adapted to a wide range of sites and is relatively easy to grow. It is a processing-type variety but has also been successfully fresh marketed. The fruit is softer than Totem but is more resistant to fruit rot. Flavour is not as good as Totem or Rainier. Matures at the same time or slightly earlier than Totem. Plants produce fewer runners than Totem. Highly susceptible to common leaf spot.

Totem

It is the major processing variety grown in BC recommended for planting in all locations. In the last few years it has shown more virus and red stele root rot infection than in the past. This suggests that resistance has

broken due to new viruses and fungal strains. It is relatively winter hardy and partially resistant to powdery mildew. It is primarily suited for the processing market.

Sweet Bliss (Orus 2180-1)

A new release from the USDA-ARS breeding program in Corvallis that produces medium-large fruit with excellent flavor and light red colour. It is suited for both the fresh and processing markets. It tested very favourably in the Fraser Valley and is recommended for trial in all areas.

Shuksan

Recommended for all locations. It is relatively winter hardy and shows resistance to red stele. It is more susceptible to virus diseases and powdery mildew than Totem. It is also susceptible to Verticillium and common leaf spot. Fruit ripens 2 to 5 days later than Totem and shows a similar level of rot resistance. It is suited to both the processing and fresh markets. Primary fruit may be misshapen.

Rainier

Recommended for all locations. The high quality fruit ripens 4 to 5 days later than Totem. It is suited to the fresh or processing markets. Plants grown on silty loams seem to produce larger yields than those on sandy soil. Fruit flavour is excellent, but it is softer and more susceptible to fruit rot than Totem. It is susceptible to the virus complex in the Fraser Valley.

Stolo (BC 96-33-4)

A release from the PARC breeding program recommended for trial planting in all areas. It is a high yielding variety that produces large, firm, excellent quality fruit. Its harvest season starts a few days later than Totem making it mainly suited for the late fresh market. Plants are vigorous, virus resistant and have shown field resistance to root weevils.

Puget Crimson (WSU 2833)

A new release from the WSU program in Puyallup recommended for trial planting. It produces high yields of large firm, excellent flavour fruit. It matures several days later than Totem. It is susceptible to powdery mildew.

Clancy

A release from the New York breeding program recommended for trial planting in all areas. It is a high yielding variety that produces medium to large, firm, excellent quality fruit. Its harvest season starts a few days later than Totem.

Table 1. June Bearing Strawberry Variety Traits (5 = Excellent and 1 = Poor)

Source: PARC Agassiz and field trials

Variety	Yield	Fruit Weight	Firmness	Fruit Rot Resistance	Virus Tolerance	Winter Tolerance

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Hood	4	4	3	3	2	4
Honeoye	5	5	3	3	2	4
Nisgaa	5	4	4	4	4	4
Valley Red	4	4	5	5	4	?
Puget Reliance	5	5	2	5	3	4
Totem	4	4	4	4	3	4
Sweet Bliss	4	5	5	5	4	?
Shuksan	4	4	3	4	3	4
Rainier	3	5	2	1	2	4
Stolo	5	5	5	4	4	?
Puget Crimson	5	5	5	?	?	?
Clancy	5	5	5	4	4	4

Dayneutral Varieties

Dayneutral or true everbearing strawberries produce flowers and fruit from July to the first frost in the planting year and June to frost the next year. They are suitable for local fresh market sales. They are usually grown on raised beds covered in black plastic with drip irrigation. For this reason, dayneutral strawberries require more management than June bearing strawberries.

Albion

A California variety which produces high yields of firm, large, attractive, glossy fruit. Internal colour is pink. Flavour is excellent. It produces higher yields than Selva or Diamante and produces more evenly through the harvest season in both the first and second years.

Diamante

A California variety which produces large crops of large, firm fruit. Medium flavour when ripe. Fair internal red colour and excellent shelf life. Similar to Selva in that it produces throughout the growing season with distinct production flushes particularly in the second year.

Monterey

A new California variety which produces high yields of firm, large, attractive, glossy fruit. Internal colour is pink. Flavour is medium. It produces higher yields than Albion and produces evenly through the harvest season in both the first and second years. Recommended for limited trial.

San Andreas

A new California variety which produces high yields of firm, large, attractive, glossy fruit. Internal colour is pink. Flavour is medium. It produces higher yields than Albion and produces evenly through the harvest season in both the first and second years. Recommended for limited trial.

Seascape

A California variety. Similar to Selva, it produces high yields of large fruit but is not as firm as Selva. Fruit is bright red, attractive and glossy. Fruit flavour and internal red colour are better than Selva. The fruit also withstands rain better than Selva. It seems to perform best on Vancouver Island. In the Fraser Valley some seediness may occur.

Selva

A California variety. Produces high yields of large, very firm fruit. The internal fruit colour is pale but the skin is bright red and glossy. The flavour is fair in the early summer but improves later in the season. It has good shelflife and shipping qualities. Flowers are produced in flushes giving alternating light and heavy picks, particularly in the second year.

New Plantings

Site Selection

The selection of a suitable site is essential for good strawberry production. Consider the following:

Soil

The best soil for growing strawberries is a deep, well-drained sandy-loam soil to loamy-silt soil with a good supply of humus (over 4% organic matter). These soils hold moisture well which is important for good yields. Avoid heavy clay soils as they are usually slow to drain even if there is a subsurface drainage system.

Strawberries grown in poorly drained soil are more prone to root rot problems. Coarse, sandy soils require careful attention to fertilization and irrigation for successful yields. Strawberries grow best in a slightly acidic soil with pH 5.5 to 6.5.

Drainage

Strawberry roots are injured if soils are waterlogged or flooded for more than one or two days – especially when the plants are actively growing. The roots will rot and, if damage is severe, the plants may die. A subsurface drainage system is necessary for fields that are not naturally well drained. Surface drainage provided by the slope of fields or raised beds may reduce the risk of root rot. Avoid planting on steep slopes. To prevent soil erosion, install a subsurface drainage system, plant across moderate slopes, seed fall cereal cover crops and plant grassed waterways in areas where water runs in the field.

Irrigation

Strawberries are shallow rooted. Most of the roots are in the top 15 cm of soil. Irrigation is essential for consistent high yields.

Strawberries have a low tolerance to salts. Laboratory tests of irrigation water should show a Sodium Adsorption Ratio (SAR) of less than 30 and chloride levels below 110-180 mg/L. If irrigation water has more than 500 ppm total dissolved salts (TDS) or an electrical conductivity of more than 0.7 mS/cm, its use can result in the accumulation of toxic levels of salt. Avoid fields with salt levels above 1.0 mS/cm.

Rotation

Crop rotation is a sound agricultural principle that should be followed whenever practical. Do not grow strawberries repeatedly in the same field for many years. Insects, diseases and herbicide-resistant weeds tend to increase when strawberries are grown frequently on the same site. When this occurs, strawberry yields decline.

Verticillium wilt may be a problem in fields where strawberries, raspberries, potatoes, peppers or tomatoes were grown in the previous four or five years. When planning crops for rotating with strawberries, consider the herbicides used on a crop. For example, the herbicide Sinbar is long-lasting in the soil. Cole crops and other vegetable crops, are a good rotation crop with strawberries. However, cole crops should not be planted within two years of a Sinbar application.

Site Preparation

Site preparation is a critical first step to successful long-term yields. Begin preparation the year before planting.

Weeds

Weed control is especially critical. Poor weed control can result in crop failure and financial disaster. Before planting, control established weeds such as quackgrass, clover, sheep sorrel, horsetail, curled dock and Canada thistle. It is also essential to reduce the number of weed seeds in the soil. For more information see "Preplow Clean Up of Weeds" in this guide and the weed control chart in this section.

Nematodes

Fields should be tested for nematodes in the spring or summer the year before planting. If required, the best time to fumigate soils is from late summer to early fall. Refer to "Nematodes" in this guide for details on soil fumigation.

Cover Cropping

Plant cereal cover crops the fall before planting to help control winter weeds and add organic matter. Plow down the cover crop in the early spring so the cover crop is decomposed before setting out the strawberry plants. Refer also to "Cover Crops" in the [soil management](#) section of this guide. For wireworm control, use treated wheat seed (see "Wireworms" in this section).

Manure

Broadcast and incorporate composted or aged manure in early spring at least two weeks before planting. This helps to increase the soil organic matter, improve soil health, and provide crop nutrients. Fresh manure can injure young plants. To reduce the risk of leaching, plant a fall seeded cover crop to trap some of the nitrogen released by the manure or fertilizer.

Apply manure at a rate that does not exceed 50 kg/ha (20 kg/acre) of available nitrogen. Strawberries require low amounts of nitrogen and this rate is nearly the maximum required. Most poultry manure contains up to 12 kg/yd³ of total nitrogen. Some ammonia nitrogen is lost during application and losses are greater when manure is left on the soil surface for more than 12 hours. Applying and immediately incorporating about 5 yd³/ha (2 yd³/acre) poultry manure provides most of the nitrogen required by the strawberry crop. A soil test three weeks after applying manure will show if more nitrogen is required.

Soil pH

If lime is required to increase the soil pH, broadcast after plowing, and incorporate it into the soil at least 2 months before planting. In coastal areas, apply any time during the fall or early spring and incorporate it as soon as the soil conditions are suitable. However, in drier regions, lime should be incorporated in the fall. To lower the pH, refer to [General Nutrient Management](#) section in this guide.

Nutrients

Take soil samples in the fall before planting to plan for spring applications of fertilizer or manure. If the soil is low in potassium, broadcast and incorporate half the amount required in the spring before planting. Refer to “Nutrition” below.

Planting

Consider these points:

- Purchase plants that are certified free of viruses and other diseases. Order a year in advance to ensure availability.
- Plant early in the spring when soil can be worked—usually mid April to mid-May. Avoid planting too early in wet soil as this can result in compaction, lumpy soil, poorly set plants and more weed problems.
- If plants must be stored before planting and growth has not started, keep at 1°C to 3.5°C for up to two weeks. If growth has started, keep at 4°C to 10°C, for a short time. If no cold storage is available, put plants in a shaded, cool location and cover with wet burlap bags. Set plants as soon as possible once they are removed from the cooler. In all situations, check the plants frequently and remove plants with mould.
- On the day of planting, it is important that the plants do not dry out. Keep the plants in the shade and covered with a tarp until planting. If needed, sprinkle the top layer lightly with water to keep the roots moist.
- Set plants so the middle of the crown is at the soil level. If the crown is buried, runnering will be delayed and reduced or the crown can rot. If the roots are exposed, plants will dry out and could die. Have someone follow the planting machine to reset plants that are not at the correct depth. Also be sure the machine is set so the roots are in a vertical position after planting.

Spacing

The matted-row system is normally used for growing strawberries in BC. Plants are set out in single rows. Runners produced from these plants are trained to form a solid row of fruiting plants.

The distance between the rows and the spacing between plants varies depending upon soil productivity, plant vigour and equipment used. The outside plants in the matted row produce the most fruit so avoid wide row widths. Row and plant spacings are usually within the range given on Table 2. Generally, the best spacing is about 30 cm (12 in) between plants as this usually ensures the rows are runnered-in or matted by the end of the first season. For vigorous varieties, spacings of up to 40 cm (16 in) may be more appropriate.

With dayneutral varieties runners are generally removed to promote branched crowns. They are usually planted on raised beds with plastic mulch in double rows 20 cm (8 in) apart 150 cm (5 ft) between rows (57,000 plants/ha; 24,000 plants/acre).

Table 2. Strawberry plants per hectare and acre at various spacings

Distance between plants	Distance between rows			
	105 cm (42 inches)	110 cm (44 inches)	115 cm (46 inches)	120 cm (48 inches)
30 cm (12 inches)	31,746/ha 12,446/ac	30,303/ha 11,880/ac	28,986/ha 11,363/ac	27,778/ha 10,890/ac
38 cm (15 inches)	25,397/ha 9,957/ac	24,242/ha 9,504/ac	23,188/ha 9,091/ac	22,222/ha 8,712/ac
45 cm (18 inches)	21,164/ha 8,297/ac	20,202/ha 7,920/ac	19,324/ha 7,576/ac	18,519/ha 7,260/ac
50 cm (20 inches)	19,048/ha 7,467/ac	18,182/ha 7,128/ac	17,391/ha 6,818/ac	16,667/ha 6,534/ac
60 cm (24 inches)	15,873/ha 6,223/ac	15,152/ha 5,940/ac	14,493/ha 5,682/ac	13,889/ha 5,445/ac

Care in the First Year

Care in the first year should encourage quick establishment, early runner growth and strong runner plants (“daughter plants”). The number of early runners largely determines the crop size in the second year.

Plant Care

In new plantings, the traditional practise is to remove flower trusses starting when blooming begins. This may result in earlier and increased runnering, a more developed root system, more crowns, and thus a larger first-season crop. However, if plants are set at 30 cm (12in) or closer and established well, blossom removal is not necessary.

Vigorous varieties that runner well, like Rainier, can be left to flower and harvested in the first year without seriously affecting establishment.

Weed Control

Apply herbicides as recommended to avoid plant injury. Misapplication of herbicides can severely set back new plants. Refer to the weed control chart in this section for suitable herbicides. Cultivation and hand weeding are usually necessary until the plants are fully established. Shallow cultivation (2.5 to 5 cm) is best to avoid damaging strawberry roots. Always cultivate in the same direction in each row so the roots of the trained runner plants are not disturbed.

Nutrition

Consider the nutrient contribution of any manure or compost added to the soil before planting, when applying commercial fertilizers. Reduce the amount of commercial fertilizer to compensate for the nutrients available

from the manure. Refer to the Table, "Nutrient Content of Various Manure" in the [Nutrient Management](#) section to determine manure contribution.

Under normal conditions apply about 20 to 50 kg/ha (8 to 20 kg/acre) or 2/3 of total amount of nitrogen plus all the phosphorus and potassium requirements 5 to 7 days after planting. Apply 15 cm away from the plants on each side of the row and 7 cm below the soil surface. An additional 25 kg/ha (10 kg/acre) or remaining 1/3 of the nitrogen can then be applied in mid-summer when the plants are starting to produce runners.

High rates of potassium (over 90 kg/ha or 36 kg/acre) should be split and applied separately about 4 weeks apart. The first application should be broadcast and incorporated prior to planting and the remainder should be banded along the rows in the normal manner with the other fertilizers.

Magnesium and calcium are frequently at low levels on light, coarse, sandy soils. Soil analysis will indicate these levels.

Soil Care

Cultivate soon after planting while applying fertilizers. Then cultivate only to control weeds, to keep the soil loose for rooting runner plants, and to train unrooted runners. Avoid frequent rotovation as it damages the soil structure.

Runner Management - Matted Row System

From any mother plant, the first runner is the most productive. Potential yields decline with each runner. The fourth runner is usually not rooted by the end of the season.

Runners can be placed to fill large gaps between plants using a hoe during hand weeding or as a separate operation. Also, cultivate to position the runners in the row. Always cultivate in the same direction in the row. After the desired row width is established, by about mid-August, use a rotovator to cut off runners that extend into the alleys. Irrigate as needed during runnering for good root development.

Runner Management - Plasticulture, Day Neutral Varieties

To encourage maximum fruit production, runners should be removed from the mother plants of day neutral strawberries. This can be done by cutting or pinching by hand several times through the growing season. Alternatively, they can be suppressed using the plant growth regulator, Apogee, as follows:

Apogee (27.5 % prohexadione calcium) at 135 g/ha (54 g/acre) in 300 L/ha (120 L/acre) of water. The addition of a non-ionic surfactant such as Agral 90 at 0.5 mL/L spray volume is recommended where uptake may be reduced such as under drought conditions, low humidity, hot temperatures or when lush growth is present. Spray grade ammonium sulfate should be added to the spray mix at a 1/1 ratio with Apogee if the water source contains high levels of calcium. Apply prior to the beginning of runner initiation and make subsequent applications at 14 to 21 day intervals up to a maximum of 3 applications per season. Do not apply within 21 days of harvest.

Note: **Apogee** has been evaluated for phytotoxicity under a wide range of conditions; however, it has not been possible to evaluate all commercially important varieties under every possible condition. Apply Apogee

Plant Growth Regulator to a small area and evaluate crop safety for 3–5 days before attempting a large-scale spray to make certain that no phytotoxicity occurs.

Established Plantings

Mulching

Fall mulching with straw or wood chips is recommended for Interior strawberry plantings, especially where snow protection is not reliable. In these areas, mulching has many benefits. Freezing and thawing soil can lift plants and damage the roots. Mulching keeps soil temperatures more uniform and reduces the risk of frost heave. Mulching also reduces low temperature injury to roots and crowns. By delaying removal of the mulch, blooming can be delayed to reduce frost injury.

Apply the mulch after the plants have been hardened by several frosts but before the temperatures drop below -7°C . Cover the plants with a 5 to 8 cm (2 to 3 in) layer of straw or wood waste (wood chips) using about 4.5 to 6.5 t/ha (2 to 3 tons/acre). To ease spreading, the mulch should be dry and not frozen.

Remove the mulch when new plant growth starts in the spring. If delayed too long, the new growth will be yellow and spindly, and crowns may be damaged when the mulch is taken off the plants. The mulch can be incorporated into the soil but additional nitrogen should be applied. Additional mulch can be applied to improve the conditions in the rows for U-pick operations.

Mulching is not recommended in coastal areas as it can increase disease and insect problems.

Nutrition

Soil Analysis

Soil analysis is the most accurate guide to nutrient requirements with the exception of nitrogen and a few micro-nutrients. The best time to take soil samples is immediately following harvest. Soil test results can then be used to plan fertilizer requirements for late summer application. Soil testing may also be done in the fall and used to plan spring fertilizer or manure applications.

Take soil samples from within the matted crop row for June bearing varieties and between plants in the row for Dayneutral varieties. Sample from 0 to 15 cm (0 to 6 in) depth. Up to 90% of strawberry roots are within this depth. When sampling prior to planting, take samples to a depth of 30 cm (12 in). Refer to the BCAGRI factsheet, "Soil Sampling", or contact the private laboratory that will test the soil, (see factsheet, "Resources for Berry Growers") for more information on sampling procedures.

Leaf Analysis

Leaf analysis is a tool to monitor the uptake of nutrients by the plant. It is an alternative to soil testing or can be used if a nutrient deficiency is suspected. Sample only the youngest mature leaves. Details on sampling for tissue testing are available from private tissue testing laboratories.

Table 3 gives an indication of the range of plant tissue nutrient levels that should be present in healthy plants.

Table 3. Strawberry tissue analysis values

Nutrient	Normal Range	Nutrient	Normal Range
Nitrogen	2.0 - 3.0%	Sulphur	0.15 - 3.0%
Phosphorus	0.25 - 0.4%	Zinc	20 - 250 ppm
Potassium	1.3 - 2.5%	Manganese	50 - 250 ppm
Calcium	0.8 - 1.8%	Iron	60 - 250 ppm
Magnesium	0.25 - 0.5%	Boron	25 - 50 ppm

Table 4. Macro-nutrient requirements for established strawberry plantings

Nutrient	Time of Application	Rate (kg/ha)	Rate (kg/ac)
Nitrogen (N)	Split application: • Pre-bloom • Renovation	0-25	0-10
		30-50	12-20
Phosphorus (P ₂ O ₄)	Early spring, when rows narrowed	60-90	24-36
Potassium (K ₂ O)	Early spring, when rows narrowed	53-80	21-32

Fertilizers

This section gives general fertilizer recommendations only. Nutrient requirements may vary with varieties and soil type. A standard blend of fertilizer may be available to meet the crop needs. However, soil test analysis is the best way to determine the nutrient requirements. Also monitor fertilizer applications, soil nutrient levels and crop yield over time. A custom blend of fertilizer may be necessary to provide the required nutrients for a particular field.

Table 4 is the approximate macro-nutrient requirements for established plantings in coastal areas.

Consider the following when applying nitrogen:

Total application of nitrogen should not exceed 75 kg/ha (30 kg/acre) per year.

Apply fertilizer in bands as close as possible to the sides of the matted row and 7 cm below the soil surface. Fertilizer may also be broadcast over the top of the rows. To avoid plant injury, broadcast when the plants are dry.

Research has shown that spring applied nitrogen has little benefit in increasing yield. In addition, excessive nitrogen before flowering can cause vigorous leaf growth. The leaves may cover flowers and interfere with pollination. Heavy growth can also increase fruit rot.

Nitrogen at renovation is key to revitalizing the plant, obtaining good flower bud initiation, and providing nutrient reserves in the plant for the next year's crop. Apply the second application of nitrogen as soon as possible after mowing.

Late applications of nitrogen can make plants more susceptible to winter injury.

In coastal areas, late nitrogen applications can leach and will not be available to the crop in the spring. In the Interior, late nitrogen applications will be available in the spring and should be accounted for in the fertilizer program.

Foliar Feeding

Fertilizers can be applied as sprays to the leaves but this method of application is supplemental to soil applications. Plants respond much more quickly to foliar fertilizer applications. However, the effects do not last as long as with soil-applied fertilizers because the rates are lower. The two main uses for foliar feeding are:

To give a boost to frost-damaged or weakly growing plants; and

To apply additional nitrogen, boron, magnesium or other elements during the growing season.

Nutrient sprays should not be applied during very hot weather as leaf-burning may occur. The plants generally respond better to foliar feeding during the earlier portion of the growing season when the leaves are younger and less waxy.

Nutrient Deficiencies

Leaf and soil testing can determine deficiencies of some micro-nutrients. Use Table 3 to help interpret leaf analysis results. Also refer to the Table 5 below and the Table, "Foliar Symptoms of Nutrient Deficiencies and Corrective Treatments" in the [Nutrient Management](#) Section.

Boron, magnesium and calcium are frequently at low levels on light, coarse, sandy soils. Soil analysis can be used to determine the amount available to the plant. Foliar sprays of these micro-nutrients can be applied during the growing season if nutrient deficiency symptoms appear.

Table 5. Foliar corrective treatments for strawberry nutrient deficiencies

Nutrient	Deficiency Symptom	Materials	Application Rate	Comments
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Boron (B)	Leaf tip burn on new leaves, monkey-faced fruit, hollow fruit with green tips, crowns may be dark brown inside.	Solubor	1.0 kg/ha (0.4 kg/ac) in 1000 L/ha (400 L/acre) water	Apply at full leaf. Also avoid high amounts of lime, manure or irrigation water.
Magnesium (Mg)	Yellowing between the veins starting with older leaves, and in the centre of the leaf.	Epsom salts (magnesium sulfate)	22 kg/ha (9 kg/ac) in 1000 L/ha (400 L/acre) water	Apply at full leaf and under cool, slow drying conditions. Add 0.5 kg urea (46-0-0) in 1000 L/ha (400 L/acre) water to improve uptake.

Renovation

Renovation – or after-harvest care – allows plantings to be kept for two, three, or more harvests. The yield, fruit size, and quality of the third crop is typically less than the first and second crops. It is often not profitable to take a third harvest.

Renovation is most successful on vigorous plantings with reasonable control of perennial weeds. Growth in strawberry plants slows down considerably towards the end of harvest. Renovation begun shortly after harvest, stimulates new growth.

Successful renovation includes the following activities. The order may differ between plantings:

If perennial weeds such as clover or thistle are present, apply Lontrel before mowing.

Mow plant tops to 2 to 5 cm (1 – 2 in) above the crowns – take care not to damage crowns. Do not mow dayneutral varieties.

Thin plants. This may be needed to keep plants about 15 cm (6 in) apart. Rake unrooted or poorly rooted runners into the alleys. They will then be removed when the rows are narrowed. Hand thinning is not usually economical.

Narrow rows to desired width. This removes excess runners and incorporates the leaf trash. Do not throw soil up on the plants in the row.

Apply the remaining fertilizer – band or broadcast over row (see Table 4).

Apply recommended herbicides (see “Weed Control” below).

Irrigate if rainfall does not occur within a few days.

Remove weeds by hand, if necessary.

Watch for aphids on the new leaves, and control as necessary to reduce the spread of viruses.

Weeds

Cultural Weed Control

Weed control in strawberries is difficult as the crop is not a good competitor and is particularly sensitive to herbicides. The following practices will help reduce weed pressure and lessen hand-weeding costs:

Rotate crops and herbicides to discourage build-up of specific problem weeds. A good rotation program will also minimize disease problems making the crop more vigorous and a better weed competitor.

Control difficult perennial weeds such as quackgrass, thistle and horsetail before planting. See "Preplow Clean Up of Weeds" in the section, [Pest Management](#).

Encourage rapid crop growth and runner development to fill the rows and limit weed germination:

- Delay planting until soils are warm enough to encourage good early growth.
- Fertilize appropriately to encourage good establishment and growth.
- Practice timely post-harvest renovation to encourage rapid regrowth.

Cultivate on a timely basis to control weeds between the rows.

Chemical Weed Control

Herbicide application rates are listed on pesticide labels and in the production guide for broadcast or total field coverage. If spraying a band over the row area only, then the treated area is only a portion of the whole field. For example, when spraying 60 cm bands on rows 120 cm apart, only half of the field is treated.

Always use lower rates of herbicides on sandy or stony soils and the higher rates on heavier or high organic matter soils.

Numerous chemicals are available for weed control. Select a combination of herbicide treatments from the following pages with a knowledge of the major problem weeds in the field. Most treatments are applied to the row area only by sprayers using low pressure (200 to 275 kPa) and a spray volume of 300 to 500 L/ha (120 to 200 L/acre).

Preplant		
Treflan EC or Bon- anza 480 (480 g/L tri- fluralin)	1.7 L/ha (0.68 L/acre) on light soils	<ul style="list-style-type: none"> ● Apply to well-prepared soils shortly before planting. ● Incorporate immediately by rototilling or double discing to a depth of 8 to 10 cm (3 to 4 in). A second pass at right angles to the first provides best incorporation. ● Do not use on soils with greater than 15% organic matter (peat, muck or heavily manured fields). Provides residual control of germinating
	2.3 L/ha (0.92 L/acre) on medium to heavy soils	

<p>Rival 500 EC (500 g/L trifluralin)</p>	<p>1.2 L/ha (0.5 L/acre) on light soils</p> <p>1.6 L/ha (0.65 L/acre) on medium, silty or sandy clay loam soils</p> <p>2.2 L/ha (0.9 L/ac) on heavy soils</p>	<p>weeds such as annual bluegrass, barnyard grass, crabgrass, pigweed, lamb's quarters, chickweed, knotweed and purslane</p> <ul style="list-style-type: none"> Nightshades, shepherd's-purse, mustards, groundsel, lady's thumb and cudweed are resistant.
<p>Dual Magnum or Dual II Magnum (915 g/L S-metolachlor and R-enantiomer)</p>	<p>1.25 to 1.75 L/ha (0.5 to 0.7 L/acre)</p>	<ul style="list-style-type: none"> Apply to well prepared soil and thoroughly incorporate before planting. Controls annual grasses, nightshade, suppresses redroot pigweed and yellow nutsedge. Some initial injury may occur, some varieties may be particularly sensitive. Do not apply to fields to be harvested in the year of planting. Apply only once per year.

Year of Planting		
Annual Grasses and Broadleaf Weed		
<p>Princep Nine-T (simazine)</p> <p>Simadex 500F</p>	<p>1.1 kg/ha (0.4 kg/acre)</p> <p>2.2 L/ha (0.9 L/acre)</p>	<ul style="list-style-type: none"> Apply after mid-September when runners are well rooted. Apply in a minimum of 300 L/ha (120 L/acre) of water. Controls many annual grassy and broad leaf weeds including barnyard grass, millets, lady's thumb and wild buckwheat. For use in coastal BC only. Do not use in BC Interior. Apply to firm weed-free soil and follow with light irrigation if rain does not occur shortly after application. Triazine-tolerant weeds such as groundsel and pigweed are not controlled.

Devrinol 50 DF or Devrinol DF-XT (napropamide)	9 kg/ha (3.6 kg/acre)	<ul style="list-style-type: none"> ● Delay application until desired number of daughter plants have established. ● Apply only to mineral soils with less than 10% organic matter. ● If rain fall does not occur within 7 days (spring or fall application) or 2 days (summer application) irrigate to wet soil to a depth of 5 to 10cm. ● Controls many annual grassy and broadleaf weeds including barnyard grass, millets, lamb's quarters, redroot pigweed, chickweed and mustards. ● Do not apply more than once per season.
Devrinol 50 DF (napropamide) plus Princep Nine-T (simazine)	3.0 to 4.0 kg/ha (1.2 to 1.6 kg/acre) 0.6 to 0.83 kg/ha (250 to 340 g/acre)	<ul style="list-style-type: none"> ● Apply 1 to 2 weeks after transplanting but prior to weed emergence. ● Ensure that plants are properly set and covered with soil. ● Make only one application per year. ● Controls barnyard grass, redroot pigweed, chickweed and mustards. ● Rain or irrigation is required shortly after application.
Sinbar 80 WP (terbacil)	275 to 550 g/ha (110 to 220 g/acre)	<ul style="list-style-type: none"> ● Apply after mother plants are well established but before new runners start to root. ● Use the lower rate on sandy soil to prevent injury. ● Use the lower rate on varieties which have not been tested for Sinbar sensitivity. ● Moisture is required to activate Sinbar. ● Do not replant to any crop within two years after last application. ● Controls many annual grassy and broadleaf weeds including barnyard grass, millets, lamb's quarters, redroot pigweed, chickweed and mustards.
Dual Magnum or Dual II Magnum (S-metolachlor)	1.25 to 1.75 L/ha (0.5 to 0.7 L/acre)	<ul style="list-style-type: none"> ● Apply after planting before weeds emerge. ● Will control annual grasses, nutsedge, nightshade and provide suppression of redroot pigweed.

and R-enantiomer)		<ul style="list-style-type: none"> Some initial injury may occur, some varieties may be particularly sensitive. Do not apply to fields to be harvested in the year of planting. Apply only once per year.
Betamix EC (153 g/L phen-medipham, 153 g/L desmedipham)	1.15 to 1.75 L/ha (0.46 to 0.7 L/ha)	<ul style="list-style-type: none"> Apply as a broadcast spray in 100 to 200 L/ha water (40 to 80 L/acre) after transplanting when weeds have reached the cotyledon stage. Repeat applications at 5 to 7 day intervals or when another flush of weeds germinates. Do not apply more than 3 times per season. Use on June-bearing strawberries in the year of planting only. Do not harvest berries in the year of planting. Strawberry varieties may vary in tolerance to Betamix. Limit initial application to a small area to confirm tolerance. Betamix may cause temporary chlorosis or tip burn, but normal growth should return in 7 to 21 days.
Annual Grasses and Quackgrass		
Venture (fluazifop-p-butyl)	0.8 to 2.0 L/ha (0.32 to 0.8 L/acre)	<ul style="list-style-type: none"> Apply in spring before bloom. Apply only once per year. Use the low rates for seedling grasses in the 2 to 5 leaf stage and the highest rate for quackgrass in the 3 to 5 leaf stage. Apply in 50 to 200 L/ha of water. Use the higher volume when weed density is high. Do not apply within 30 days of harvest. Warning: Women capable of bearing children should avoid exposure to Fusilade II. Read label for more information.
Poast Ultra (sethoxydim)	0.47 to 1.1 L/ha (200 to 440 mL/acre)	<ul style="list-style-type: none"> Apply at the 1-6 leaf stage of annual grasses and to actively growing quackgrass that has 1-6 leaves. Use the high rate for quackgrass control. Apply with the adjuvant, Merge, at a rate of 1% of water volume used.

- Do not apply within 25 days of harvest.

Note: Herbicide application rates are listed on pesticide labels and in the production guide for broadcast or total field coverage. If spraying a band over the row area only, then the treated area is only a portion of the whole field and rates must be reduced accordingly.

Mature Plantings

Annual Grasses and Broadleaf Weeds

Princep Nine-T (90% simazine) Simadex 500 500 g/L simazine)	1.1 kg/ha (400 g/acre) 3.6 L/ha (1.45 L/acre)	<ul style="list-style-type: none"> • Apply post harvest at renovation. Alternatively, a spray may be applied in mid September to provide overwinter weed control. • Do not apply before harvest. • Do not apply more than once per season. • See comments under “New Plantings” on previous pages.
Devrinol 50 DF (50% napropamide)	9.0 kg/ha (3.6 kg/acre)	<ul style="list-style-type: none"> • Apply in fall or early spring before weeds emerge. Do not apply from bloom to harvest. • See comments under “New Plantings” on previous pages.
Sinbar 80 WP (80% terbacil)	700 to 850 g/ha (280 to 340 g/acre)	<ul style="list-style-type: none"> • Apply after harvest for residual control of seedling weeds. Reduce rate to 550 to 700 g/ha (220 to 280 g/acre) in areas subject to periodic winter injury. • See comments under “New Plantings” on previous pages.
Chateau WDG (51.1% flumioxazin)	210 g/ha (84 g/acre)	<ul style="list-style-type: none"> • Apply in enough water to ensure good coverage of the soil surface. • Over the row applications must be made to dormant strawberries. For non-dormant strawberries, applications must be made to row middles only, using a hooded or shielded sprayer. • At least 0.5 cm of rainfall or irrigation is necessary to activate the herbicide. • Apply only to coarse and medium textured soils with less than 5% organic matter. Do not apply to fine-textured soils or to soils with more than 5% organic matter.

		<ul style="list-style-type: none"> ● Apply to well-drained soil as crop injury may occur from applications made to poorly drained soils and/or under cool, wet conditions. ● Do not allow spray drift to come in contact with fruit or foliage. ● Do not apply more than once per growing season. ● Do not apply after fruit set.
Kerb 50 WSP (50% propyzamide)	2.25 kg/ha (0.9 kg/acre)	<ul style="list-style-type: none"> ● Apply from late September to early November when soil temperatures are low and soil moisture is high. ● Chickweed and seedling grasses will be controlled. Dandelion, dock and many other broadleaved weeds will not be controlled. ● Apply in 300 to 500 L/ha (120 to 200 L/acre) of water to obtain even soil coverage.
Goal 2XL (240 g/L oxyfluorfen)	1.0 L/ha (400 mL/acre)	<ul style="list-style-type: none"> ● Apply a single spray in 500 L/ha (200 L/acre) of water to dormant plants in late fall or early winter. ● Will control or suppress a range of broadleaf winter annuals. ● Do not apply within 150 days of harvest.
Authority (480 g/L sulfentrazone)	0.29 L/ha (0.12 L/acre)	<ul style="list-style-type: none"> ● Apply as a broadcast spray or as a banded treatment. ● Apply a single spray in 200 to 400 L/ha (80 to 160 L/acre) of water to dormant plants in late fall. Spring applications may be made during dormancy to established plantings only. ● Do not apply within 70 days of harvest. ● Do not use flood irrigation to activate this product. ● Do not apply to saturated soils. When soils are wet, do not apply if heavy rainfall is expected within 24 hours. ● Do not apply to frozen soils ● Applications to strawberry plants with emerged growth are not recommended due to leaf burning and possible stand loss
Dual Magnum or Dual II Magnum (S-	1.25 to 1.75 L/ha (0.5 to 0.7 L/acre)	<ul style="list-style-type: none"> ● Apply in early spring before weeds emerge.

metolachlor and R-enantiomer)		<ul style="list-style-type: none"> ● Will control annual grasses, nutsedge, nightshade and provide suppression of redroot pigweed. ● some varieties may be particularly sensitive to Dual ● Apply only once per year. ● Do not apply within 30 days of harvest
Annual Grasses and Quackgrass		
Venture (125 g/L fluazifop-p-butyl)	0.8 to 2.0 L/ha (0.32 to 0.8 L/acre)	<ul style="list-style-type: none"> ● See comments under “New Plantings” on previous pages. ● Do not apply within 30 days of harvest.
Poast Ultra (450 g/L sethoxydim)	0.47 to 1.1 L/ha (200 to 440 mL/acre)	<ul style="list-style-type: none"> ● See comments under “New Plantings” on previous pages ● Do not apply within 25 days of harvest.
Perennial Broadleaf Weeds		
Lontrel 360 (clopyralid)	560 to 830 ml/ha (225 to 330 ml/acre)	<ul style="list-style-type: none"> ● Apply immediately after harvest but before mowing. Do not apply after mid-August as crop damage to the following years’ crop could result. ● Apply in 150 to 200 L/ha of water. Use the higher volume when weed density is high. ● Use the low rate for tufted vetch and season long control of Canada thistle. Use the high rate for sheep sorrel, oxeye daisy and longer term control of Canada thistle. Other weeds controlled include scentless chamomile, alsike, red and white clover, wild buckwheat, groundsel and sow thistle. It is not effective against chickweed and shepherd’s purse. ● Wait 7-10 days after application before mowing. ● Apply only once per year.
Annual Weeds (Between the row only)		
Aim EC (240 g/L carfentrazone-ethyl)	37 to 117 mL/ha (15 to 47 mL/acre)	<ul style="list-style-type: none"> ● Apply between the rows with a hooded sprayer to emerged weeds. Crop injury will occur if drift is allowed to come in contact with green stem tissue, leaves, blooms or fruit.

		<ul style="list-style-type: none"> ● To improve control, apply with surfactants such as Agral 90 or Ag-Surf at 0.25% (0.25 L/100 L of water) or Merge at 1% (1 L/100 L of water). ● Do not apply within 1 day of harvest
Gramoxone (200 g/L paraquat)	5.5 L/ha (2.2 L/acre)	<ul style="list-style-type: none"> ● Apply with wetting agent in 550 to 1100 L of water/ha (220 to 440 L/acre). ● Apply only between the rows and use shields to keep spray off desired strawberry plants. ● In renovated plantings, 2 applications may be required – one just after harvest and one in the fall.

Note: Herbicide application rates are listed on pesticide labels and in the production guide for broadcast or total field coverage. If spraying a band over the row area only, then the treated area is only a portion of the whole field and rates must be reduced accordingly.

Insects and Mites

Avoid applying insecticides when bees are active. Refer to "Bee Poisoning" in the [Pollination](#) section of this guide.

Aphids

Hosts

Strawberry, many weeds especially chickweed, and wild rose.

Damage

Aphids spread plant viruses, even from a short feeding period.

Shallot aphid. Flower stalks become short and thick. This is followed by misshapen blossoms and failure to fruit. Generally the entire plant is stunted with twisted yellowish leaves. Damage is caused by small populations and occurs in spotty areas.

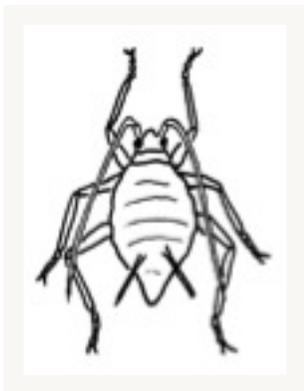
Strawberry aphid. Rarely causes direct damage but spreads viruses.

Identification

The shallot aphid is very small and is found only on the youngest leaves. The strawberry aphid is found mainly on the under surface of youngest, emerging leaves.

Nymph. Resemble wingless adults but smaller.

Adult. Small and pale green. Winged and wingless forms are present.



Life History

Shallot aphid. Overwinters as nymphs and adults in strawberry crowns or weeds. Aphids move from weeds to strawberries in the very early spring when the weeds are removed. Winged aphids leave the plantings in June and reappear starting mid-August.

Strawberry aphid. Overwinters as nymphs or adults in strawberry crowns or as black eggs on older leaves. Under coastal conditions, the eggs hatch in February. Aphids are most abundant in the spring when the plants are growing quickly. Many generations occur each season.

Monitoring

Inspect field weekly starting in early April. Be sure to check the underside of new, folded leaves emerging from the crown.

Management

Several strawberry viruses are spread by aphids. They must be controlled to lengthen the useful life of a planting. The best way to reduce virus spread within a field or from farm to farm is for everyone in an area to control aphids in their strawberries.

Cultural control

Control weeds, especially chickweed.

Biological control

A number of beneficials help to control aphids. Lady beetles, lacewings, syrphid flies and parasitic wasps can reduce aphids to non-damaging levels. However, where viruses are a concern, it is usually necessary to apply an insecticide.

Chemical control

Apply:

Beleaf 50SG (50% flonicamid) at 0.12 to 0.16 kg/ha (48 to 64 g/acre) as a foliar spray in enough water to obtain good coverage. Use the higher rate when insect pressure is heavy or when foliage is dense. Repeat as necessary. Allow a minimum of 7 days between applications. Do not apply more than 3 times per season. Beleaf may be applied up to the day of harvest; or

Admire 240F or Alias 240SC (240g/L imidacloprid) at 0.85 to 1.3 L/ha (340 to 520 mL/acre) as an over the row drench in 2000 L/ha (800 L/acre) of water. Apply in early spring when growth begins and aphids are first detected. Apply to established plantings only. The highest rate will provide the longest-term residual control. Do not apply during bloom. Do not apply more than once per season. Do not apply within 30 days of harvest; or

Assail 70WP (70% acetamiprid) at 56 to 86 g/ha (22 to 34 g/acre) in a minimum of 187 L/ha (75 L/acre) of water by ground application. Use the higher rates under heavy insect pressure. Use enough water to obtain good coverage. Do not apply more than twice per season. Do not apply more than once every 7 days. Do not apply during bloom as Assail is toxic to bees directly exposed to treatment. Do not apply within 1 day of harvest; or

Sivanto Prime (200g/L flupyradifurone) at 500-750 ml/ha (196-295 ml/acre) in a minimum of 100 L/ha (40 L/acre) of water as a foliar spray. Do not apply more than once every 10 days. Do not exceed 2000 ml/ha (787 ml/acre) per season. Can be applied up to the day of harvest.

Exirel (100 g/L cyantraniliprole) at 500 to 1500 mL/ha (200 to 600 mL/acre) in enough water to obtain good coverage. Do not apply during bloom as Exirel is toxic to bees. Do not apply more than 4 times per season or a maximum of 4.5 L/ha (1.8 L/acre). Do not apply 1 days of harvest, or

Note: It is recommended that a small area be tested to demonstrate safety to fruit and leaves before using in large areas.

Cygon 480 or Lagon 480E (480 g/L dimethoate) at 2.25 L/ha (0.9 L/acre). Apply when aphids are first detected and repeat as needed. Do not apply more than 3 times per year. Do not apply within 7 days of harvest; or

Note: Do not use Lagon or Cygon on crops to be exported to the U.S.

Caterpillars

(Strawberry Fruitworm, Omnivorous Leaf Tier and other Leafrollers including Clepsid sp.)

Hosts

Strawberry, thistle, vetch, clover and a wide range of other plants.

Damage

Young larvae feed on young, unopened leaves and tie or web these together. They also damage green berries immediately after the blossom period. Older larvae enter ripening berries beneath the calyx caps. One larva may injure many berries.

Identification

The larva is light cream to greyish, with a tan head and a stripe down each side of the body. Mature larvae are about 19 mm long. The moths are whitish, slender and weak fliers. They are seldom seen. Larvae of other species can be brown, black, or green.

Life History

The moths lay eggs in rough fence posts, power poles and rough-barked trees. In early spring, young larvae are blown by the wind to many host plants. There is only one generation per year. The larvae move from leaf buds to blossoms and then fruit. The moths begin to fly towards the end of strawberry harvest.

Other leafroller species have two generations per year.

Monitoring

Watch for early signs of attack by looking at the unfolding leaves in late April to early May.

Management

Caterpillars are periodic pests, often not needing control. Larval feeding in early spring can affect yield and should be controlled if more than 10% of plants checked have caterpillars.

Chemical control

Spray when young leaves are tied together by webbing, at the first sign of blooms, will usually prevent fruit injury. Use one of the following:

Malathion 85E (85% malathion) at 975 mL/ha (390 L/acre) of water and spray thoroughly. Repeat if necessary. Do not apply within 3 days of harvest; or

Malathion 25W (25% malathion) at 2.75 to 4.25 kg/ha (1.1 to 1.7 kg/acre). Spray for thorough coverage. Do not apply within 3 days of harvest; or

Note: Do not apply Malathion sprays unless the temperatures are above 20°C;

Sevin XLR Plus (466 g/L carbaryl) at 2.5 to 5.8 L/ha (1.0 to 2.3 L/acre). Use in 1000 to 2000 L/ha (400 to 800 L/acre) spray volume. Repeat at intervals of 7 to 10 days or as necessary. Do not apply within 2 days of harvest; or

DiPel 2XDF (*Bacillus thuringiensis*) at 0.525 to 1.125 kg/ha (210 to 450 g/acre) in 600 L water/ha; or

Success 480SC (480 g/L spinosad) at 145 to 182 mL/ha (58 to 73 mL/acre) in 300 to 500 L/ha of water. Use the upper rate under high insect pressure and/or on large larvae. Apply a maximum of 3 times per year and do not apply within 3 days of harvest; or

Entrust 80W (80% spinosad) at 80 to 109 g/ha (32 to 44 g/acre) or **Entrust SC** (240 g/L spinosad) at 267 to 364 mL/ha (107 to 146 mL/acre) in 300 to 500 L/ha of water. Use the upper rate under high insect pressure and/or on large larvae. Apply a maximum of 3 times per year and do not apply within 3 days of harvest. Entrust is OMRI approved for organic production.

Leatherjackets (Coastal Area)

Hosts

Strawberry, grasses.

Damage

Larvae feed on the roots, crowns and leaves of plants. In new plantings, transplants can be cut at soil level as occurs with cutworms. Damage is most severe in March, April and May. Populations are highest in damp or heavy soils. Normally only a problem in new fields which were in grass the previous September.

Identification

Larvae. Leatherjackets are the larvae of crane flies. The larvae have a tough, grey skin. They are about 3 cm long when mature.

Pupae. Elongate and brown with rows of spines along the top and bottom surfaces. The back end is pointed. Empty pupal cases can be seen at the surface of the soil after crane fly emergence.

Adult. A large, slender, long-legged, brown fly (crane fly) about 2 cm long.

Life History

The European marsh crane fly, the main species, lays eggs during September. Larvae (about 3 mm long) hatch from these eggs within two weeks. The leatherjackets are present until the next year in June, growing to 2.5 to 3 cm long.

Monitoring

If a weedy piece of land or grassland is to be used for planting, test for leatherjackets in the spring before cultivation. Apply a 0.1% Diazinon 500 EC solution as a drench to the soil. If leather jackets are present they will come to the surface. Watch for damage in planted fields shortly after planting.

Management

Cultural control

Control weeds especially in fall, winter and early spring.

Chemical control

None.

Lygus Bugs (Tarnished Plant Bug)

Hosts

Strawberry, raspberry, weeds, clover and vegetable crops.

Damage

Adults and nymphs feed by sucking sap from all parts of the plant. Lygus bugs feeding on the flowers or developing green berries are the main cause of misshapen berries or “monkeyfaces”. This occurs because the nymphs or adults destroy the developing embryos in the seeds, preventing the growth of the fruit tissue beneath the seed.

There are other causes for misshapen fruit (see “Misshapen Fruit” below). Be sure to correctly identify the cause of the misshapen fruit before deciding to spray. The seeds on fruit damaged by lygus are hollow inside but are the same size in both the undamaged and monkeyfaced areas. The damage is probably not lygus if the seeds are smaller in the monkeyfaced area.

Identification

Nymphs. Look like large, green aphids. But unlike aphids, they are very fast moving.

Adults. Shield-shaped, flattened bugs about 6 mm in length. They are a mottled brownish colour with a characteristic white V-shaped pattern on their back. They quickly run or fly when disturbed.



Life History

Adult bugs overwinter under plant debris. They lay eggs in the spring in the plant stems. Nymphs appear at blossom time. Bugs from one or two generations will feed on blossoms and fruit until September.

Monitoring

Start monitoring for the appearance of nymphs once blossoming starts.

To monitor fields, walk slowly through the field and randomly select plants to inspect for lygus. At each plant, look for adults on the leaves. To find the nymphs, shake the flower clusters over a tray or white paper. Nymphs are usually found feeding and hiding in the flower clusters where they cannot be seen by visual inspection. Sample about 13 evenly-distributed plants per acre. Make weekly field inspections throughout the blossoming and fruit development period.

Be especially alert monitoring strawberry fields located beside hay fields. Lygus bugs often move into the strawberry field when the hay is cut and begins to wilt. The lygus bugs are forced to find new feeding areas. They can suddenly appear in the strawberries causing extensive crop injury.

Research has shown that properly installed yellow sticky traps can be used to detect adult lygus activity.

Control sprays should be applied if one 1 lygus nymph is found per 20 plants.

Management

Cultural control

Good weed control within and beside strawberry plantings helps keep lygus bugs at low levels. Be sure to destroy weeds when lygus are still in the nymph stage and cannot fly. When weeds are destroyed after this, lygus adults will move into the strawberries. If the weeds are not destroyed, lygus adults will move into the crop when the weeds dry up.

Biological control

Natural predators of lygus are bigeyed bugs, damsel bugs, and lacewings. Lygus bugs are parasitized by a number of braconid wasps and several tachinid flies. However, none of these insects will prevent lygus from causing economic damage when lygus numbers are high.

Chemical control

For the best results, time sprays to kill the earliest stages of nymphs. Apply controls as soon as nymphs become active in the strawberries. Try to limit the number of treatments and carefully select sprays. All the listed pesticides should kill lygus. Ripcord will also kill natural predators of two-spotted mites and could lead to a build-up of this problem. Do not apply these pesticides when bees are in the field.

When chemical control is needed, use:

Group 3

Matador 120EC, Silencer 120EC (120 g/L lambda-cyhalothrin) or **Warrior** (122 g/L lambda cyhalothrin) at 104 mL/ha (42 mL/acre). Apply 7 to 10 days after first bloom and repeat 7 to 10 days later if required. Do not use more than 3 applications per year. Do not apply within 7 days of harvest; or

Mako or Ripcord 400EC (407 g/L cypermethrin) at 250 mL/ha (100 mL/acre). Use 300 to 500 L (120 to 200 L/acre) of water per hectare. Apply at early bloom (about 10%) and repeat in 10 to 12 days at the end of full bloom. Do not apply within 7 days of harvest; or

Decis 5.0EC or Decis (50g/L deltamethrin) at 200 mL/ha (80 mL/acre). Apply when insects are present or insect feeding signs are evident and repeat if needed. Very toxic to fish. Do not apply near ditches and water courses. Do not use more than 2 applications per year. Do not apply within 14 days of harvest; or

Note: Decis is not acceptable for some markets. Check with your packer before using

Group 2A

 **Thionex EC** (400 g/L endosulfan) at 2.5 L/ha in up to 2000 L of water (1 L/acre in up to 800 L water). Apply at first bloom and repeat 10 days later. Do not apply more than 2 times per season. Do not apply within 7 days of harvest; or

Restricted re-entry: Do not re-enter fields within 4 days for scouting, hand-weeding, mulching or irrigation, 7 days for other activities.

 **Thionex 50W** (50% endosulfan) at 2.0 kg/ha in up to 2000 L of water (0.8 kg/acre in up to 800 L water). Apply at first bloom and repeat 10 days later. Do not apply more than 2 times per season. Do not apply within 12 days of harvest; or

Restricted re-entry: Do not re-enter fields within 7 days for scouting, hand-weeding, mulching or irrigation, 12 days for other activities.

Group 15

Rimon 10EC (10% novaluron) at 835 mL/ha (334 mL/acre) in enough water to ensure good coverage. Apply when lygus bugs are first detected. Additional applications at 10-14 day intervals may be required. Do not apply more than 3 times per season. Do not apply within 1 day of harvest; or

Note: Rimon is not acceptable for some markets. Check with your packer before using.

Group 4

Assail 70WP (70% acetamiprid) at 84 to 210 g/ha (34 to 84 g/acre) in a minimum of 187 L/ha (75 L/acre) of water by ground application. Use the higher rates under heavy insect pressure. Use enough water to obtain good coverage. Do not apply more than twice per season. Do not apply more than once every 7 days. Do not apply during bloom as Assail is highly toxic to bees directly exposed to treatment. Do not apply within 1 day of harvest; or

Group 4A

Clutch 50WDG or Clothianidin (50% clothianidin) at 448 g/ha (180 g/acre) in at least 500 L/ha (200 L/acre) of water. Apply prior to the start of bloom when lygus bugs are detected. Do not apply more than once per season. Do not apply within 1 day of harvest. Clutch is highly toxic to bees exposed to direct treatment or residues on blooming crops. Do not apply during bloom or when bees are present; or

Note: Clutch 50 WDG, Clothianidin and Assail 70 WP are highly toxic to bees and their use is prohibited when strawberries are in bloom.

Group 1B

Cygon 480AG or **Lagon 480E** (480 g/L dimethoate) at 2.75 L/ha (1.1 L/acre). Apply at first bloom and repeat 10 to 12 days later if needed. Do not apply within 7 days of harvest.

Note: Do not use Lagon or Cygon on crops to be exported to the U.S.

Group 9C

Beleaf 50SG (50% flonicamid) at 0.20 kg/ha (80 g/acre) as a foliar spray in enough water to obtain good coverage. Apply when lygus bugs are first detected. Will provide suppression only. Repeat as necessary. Allow a minimum of 7 days between applications. Do not apply more than 3 times per season. Beleaf may be applied up to the day of harvest.

Spittlebugs

Hosts

Strawberry, clovers, grasses, many weeds and ornamental plants.

Damage

Leaves and stems become twisted and thickened, and fruit stems shortened, from nymphs sucking and removing plant sap. Yield can be reduced with large populations. Also, pickers object to the frothy spittle.

Identification

Nymphs. Young nymphs are white to lemon-yellow and look like fat aphids. They feed inside the frothy spittle.

Adults. Wedge shaped, greyish-brown insects about 6 mm long which jump and fly readily.



Life History

There is one generation per year. Adults lay orange eggs on the plants during and after the harvest. These eggs overwinter on the plant or in debris. They hatch in early spring and the first spittle masses, containing the nymphs, occur usually in late April to May. Adults appear about late May and are present until late fall.

Monitoring

Watch for spittle masses from just before bloom through the harvest. During harvest the nymphs change to adults.

Management

Chemical control

If spittlebugs were a problem the previous year or when they are seen apply one of the following sprays. Sprays applied for lygus bugs or aphids usually also control spittlebugs. Do not apply if bees are in the field.

Matador 120EC or Silencer 120EC (120 g/L lambda-cyhalothrin) at 104 mL/ha (42 mL/acre). Apply when spittlebugs are first noticed. Do not use more than 3 applications per year. Allow a 7 day interval between treatments. Do not apply within 7 days of harvest; or

Mako or Ripcord 400EC (407 g/L cypermethrin) at 175 mL/ha (70 mL/acre). Use 300 to 500 L/ha (120 to 200 L/acre) of water. Do not apply within 7 days of harvest; or

 **Thionex EC** (400 g/L endosulfan) at 2.5 L/ha in up to 2000 L of water (1 L/acre in up to 800 L water). Apply at first bloom and repeat 10 days later. Do not apply more than 2 times per season. Do not apply within 7 days of harvest; or

Restricted re-entry: Do not re-enter fields within 4 days for scouting, hand-weeding, mulching or irrigation, 7 days for other activities.

 **Thionex 50W** (50% endosulfan) at 2.0 kg/ha in up to 2000 L of water (0.8 kg/acre in up to 800 L water). Apply at first bloom and repeat 10 days later. Do not apply more than 2 times per season. Do not apply within 12 days of harvest; or

Restricted re-entry: Do not re-enter fields within 7 days for scouting, hand-weeding, mulching or irrigation, 12 days for other activities.

Dibrom (864 g/L naled) at 1.1 L/ha (450 mL/acre). Use 100 to 300 L of water/ha (40 to 120 L/acre). Do not apply when the temperature is over 32°C. Do not re-enter treated fields within 48 hours of application. Do not apply within 4 days of harvest; or

Sevin XLR Plus (466 g/L carbaryl) at 2.5 to 5.8 L/ha (1 to 2.3 L/acre). Use in 1000 to 2000 L/ha of water. Do not apply within 2 days of harvest; or

Sevin 50W (50% carbaryl) at 2.25 to 4.5 kg/500 L. Use 1100 to 2,250 L/ha (440 to 900 L/acre) of water. Do not apply within 1 day of harvest.

Spotted Wing Drosophila

Hosts

Berries, stone fruits and numerous wild hosts

Damage

Female flies lay eggs under the skin of ripe fruit shortly before harvest. Larvae hatch and begin to feed within the fruit, causing softening in the area of feeding. There can be several larvae in a fruit, which hastens softening and fruit collapse.

Identification

Adults: 2-3 mm (1/8 inch) long, brownish with red eyes and clear fly-like wings. . Males have a black/grey spot on the end of each wing, as well as two black 'combs' or bands on each front leg. The females do not have spots or leg bands. Females have saw-like egg-laying organs (ovipositors) that are used to cut into fruit skin. Ovipositors are easier to see when extended. A hand-lens or dissecting microscope is needed to identify ovipositor.

Eggs: 0.6 mm long, oval, white, 2 filaments at one end.

Larvae: Legless, headless, up to 6 mm long at maturity, milky-white.

Pupa: 3 mm long, brown, football-shaped, two stalks with small finger-like projections on ends.

Life History

SWD overwinter as adult flies. In spring flies become active and lay eggs in ripening fruit. Based on climate model predictions, there could be up to 5 generations per year in BC. Generations overlap as flies are relatively long-lived particularly at temperatures of 20°C and cooler. Based on Japanese literature, a female can lay eggs for 10-59 days, with 7-16 eggs laid per day, and average 384 eggs per female. Eggs hatch in 2-72 hours, larvae mature in 3-13 days, and pupae reside in fruit or outside of fruit for 3-15 days. In the lab at constant temperature, one generation takes 50 days at 12°C, 21-25 days at 15°C, 19 days at 18°C, 8.5 days at 25°C, and 7 days at 28°C. Adults are attracted to and feed on ripe and decaying fruit.

Monitoring

Flies can be monitored with cup-like traps baited with apple cider vinegar. Place traps when the temperature is consistently over 10°C and/or before fruit starts to ripen. Hang traps in the plant canopy in a shady location. Check traps once per week and look for the SWD adults in the bait solution. Use a hand lens or other magnifier to see the female ovipositor. Replace the bait solution each week. Suspect fruit can also be collected and inspected for larvae.

Management

Cultural control

Where practical, remove or bury cull fruit to eliminate additional feeding and breeding sites. Keep equipment and processing areas free of old fruit. Think beyond the borders of your farm and be aware of host plants in adjacent fields. Encourage neighbours to also manage for SWD. Shorten picking interval where possible: pick early, clean and often.

Biological control

To date, there are no commercially available biological controls for SWD. Research is underway to identify potential predators and/or parasites that may be useful in managing SWD.

Chemical control

Chemical control will be required if trapping shows that adult SWD flies are present in the field when berries begin to ripen. Adults are the target and are killed by direct spray contact and/or when they are exposed to residues of insecticide on the treated fruit and leaves.

Consider the following when planning a spray program:

1. All of the recommended products are toxic to bees. Avoid application when crops are blooming and bees are in the field. If sprays are necessary during this time, they should be applied at night.
2. Use enough water and pressure to ensure adequate coverage (up to 500 L/ha of water). Flies prefer to feed in the lower, shaded part of the canopy.
3. Use spray equipment that will allow effective coverage. Currently, no products are registered for aerial application.
4. To limit development of resistance, rotate between the recommended products.
5. A 7 – 14 day spray interval may be necessary to protect fruit through the ripening period depending on temperature and pest pressure.
6. A post-harvest spray may be necessary to prevent flies from building up on residual fruit and spreading to adjacent later ripening crops.

The following products are registered for control of SWD:

Delegate WG (25% spinetoram) at 280 g/ha (112 g/acre). Do not apply more than 3 times per year. Allow a re-treatment interval of at least 7 days. Do not apply within 1 day of harvest.

Entrust SC (240 g/L spinosad) at 333 to 444 mL/ha (133 to 178 mL/acre). Minimum re-treatment interval is 3 days. It is OMRI approved for organic production. Do not apply more than 3 times per year and do not apply within 1 day of harvest.

The following products received emergency registration for SWD in 2017:

Mako (407 g/L cypermethrin) at 150 mL/ha (60 mL/acre). Apply only once per crop per year. Apply between June 1 and November 30, 2017. Do not apply within 2 days of harvest; or

Malathion 85E (85% malathion) at 1 L/ha (400 mL/acre) in up to 1000 L of water. Apply when the temperature is 20°C or more. Apply between June 1 and November 30, 2017. Do not apply more than 2 times per year. Do not apply within 3 days of harvest; or

For more information see supporting document: [Spotted Wing Drosophila Brochure](#)

Strawberry (Cyclamen) Mite

Host

Strawberry.

Damage

Young, folded leaflets in the centre of the plant are attacked first. Affected leaves are “crinkled” or “puckered” when unfolded. Older leaves are darker green, twisted or distorted and feel brittle. If the leaf stems and runners are attacked, they are shortened and become rough or bumpy. Severely infested plants are stunted and yields reduced.

Identification

This mite is very hard to see without magnification. Large numbers are found on the midrib of very young leaflets. The eggs look like a small pile of salt.

Life History

The mites overwinter as adults deep in the crown of the plant. They lay eggs in spring and throughout the summer. Serious damage is not seen until harvest or after harvest. New plantings can be infested by contaminated runner plants.

Monitoring

Start to watch for deformed leaves, and shortened and rough leaf stems in early spring when growth starts. Damage is most noticeable during the spring and early summer. Strawberry mites attack all varieties of strawberries.

Management

Biological control

Usually these mites are kept in control by predatory mites. If the predatory mites are killed by insecticides, the strawberry mites can become a problem.

Chemical control

If Thiodan is applied for lygus or spittlebug control, separate sprays may not be necessary. However, when sprays are necessary, apply as soon as possible after growth starts in the spring. Use a high pressure and high volume spray to reach the well-hidden mites (2400 kPa and 4500 L/ha (1800 L/acre) of water).

If the mite damage is noticed before or during harvest, apply a spray after renovation when plants start re-growth. Another spray two weeks later may be needed to obtain good control.

Spray with:

Agri-mek 1.9%EC (19 g/L abamectin) at 1.0 L/ha (0.4 L/acre) in at least 375 L/ha (150 L/acre) of water. Do not apply more than twice per growing season. Apply when strawberry (cyclamen) mites first appear and reapply if monitoring indicates mites are still present. Allow 7-10 days between applications. Do not apply more than 2 L/ha (787 L/acre) per season. Do not apply within 3 days of harvest; or

Agri-mek SC (84 g/L abamectin) at 225 ml/ha (88 ml/acre) with 0.1-0.5% v/v non ionic surfactant in at least 375 L/ha (150 L/acre) of water. Apply when strawberry (cyclamen) mites first appear and reapply if monitoring indicates mites are still present. Allow 7-10 days between applications. Do not apply within 3 days of harvest; or

 **Thionex EC** (400 g/L endosulfan) at 5 L/ha in 4000 to 8000 L of water (2.0 L/acre in 1600 to 3200 L water). Apply before flower bud formation in the spring. Do not apply within 7 days of harvest; or

Restricted re-entry: Do not re-enter fields within 4 days for scouting, hand-weeding, mulching or irrigation, 7 days for other activities.

 **Thionex 50W** (50% endosulfan) at 2.0 to 4.0 kg/ha in 4000 to 8000 L of water (0.8 to 1.6 kg/acre in 1600 to 3200 L water). Apply before flower bud formation in the spring. Do not apply within 12 days of harvest; or

Restricted re-entry: Do not re-enter fields within 7 days for scouting, hand-weeding, mulching or irrigation, 12 days for other activities.

Two-spotted Spider Mite

Host

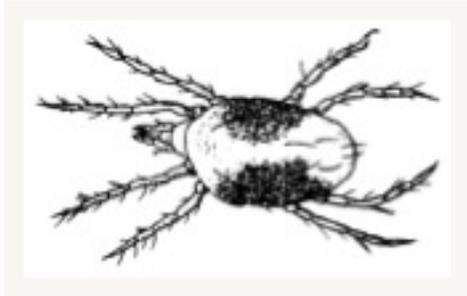
Strawberry, raspberry, tree fruits, and a wide variety of shrubs and vegetables.

Damage

These mites feed on the lower side of strawberry leaves causing a whitish flecking on the upper surface. Large populations cause the leaves to dry up and turn brown. Yields are reduced, especially if populations are large early in the season. Local research shows a 10 to 15% yield reduction when populations reach 30 to 60 mites per leaflet during harvest.

Identification

Two-spotted spider mites are very tiny. From April to October they are pale yellow to green, with two large black spots on the back and sides of the body. Orange overwintering females appear in October. Fine silk webbing is typically present on the underside of the leaves.



Life History

Orange adult female mites overwinter from October to February on the host plant and in the leaf litter. Mites can often be found on the underside of a mature leaf, near the petiole. In February the over-wintering mites become active and change appearance to yellow-green with two black spots. After feeding a few days, they start laying eggs on the old and newly emerging leaves. Eggs hatch in 1 to 2 weeks and the young mites become reproductive adults in another 1 to 3 weeks. Mite numbers increase rapidly in the spring and summer by a succession of generations. Mites develop and reproduce faster at higher temperatures, so more generations occur and numbers may increase rapidly in hot dry weather – particularly if the native predators have been eliminated by pesticides.

Monitoring

Monitor mite levels throughout the growing season to minimize crop losses and maximize spray effectiveness. Start monitoring in late March when the first new leaves are fully opened (mature). Use this fast and easy method to monitor mites in strawberries:

Walk in at least 2 diagonals through the field, picking and examining 200 leaflets for two-spotted mites. Examine only 1 of these leaflets for each sample and space the samples so that the entire field is covered. Use a magnifying glass (10x minimum) to examine the leaflets. Count the number of leaflets with mites and proceed as in Table 6.

Management

Biological control

As an alternative to spraying, release predator mites (*Amblyseius fallacis*) in newly planted fields at the rate of 7,000 per acre about ten days after the first aphid spray. This should establish the predator mites in the field. These mites feed on the two-spotted mites but require time to reduce pest numbers.

If sprays are applied for other pests, try to use chemicals that do not affect the predator mites. Some predators usually survive dimethoate and diazinon sprays. Assume no predators will survive after Matador, Decis

and Ripcord sprays. Re-apply Amblyseius at the rate of at least 7,000 per acre. Predator mites and additional information may be obtained from a pest management consultant.

Table 6. Thresholds for two-spotted spider mite control

Number of leaflets out of 200 leaflets with at least one mite	Action recommended
0 to 20	sample again in 3 weeks
21 to 40	sample again in 2 weeks
41 to 90	sample again in 1 week
91 to 120	a spray is advisable if the number of leaflets with mites increased by more than 25 leaflets in 1 week; otherwise sample again in 1 week.
above 120	a spray is advisable if the number of leaflets with mites increased during the previous week, otherwise sample again in 1 week.

Chemical control

Begin applications when mite numbers are above the thresholds in Table 6 above. To slow the development of resistance, rotate sprays from the following list of miticides:

Apollo SC (500 g/L clofentezine) at 500 mL/ha in 500-1000 L of water/ha (200 mL/acre in 200-400 L of water/acre). Apply at first sign of mite activity. Apollo acts only against eggs and very young larval stages (motiles). The older immatures and adults are not killed. Most predatory mites will survive. Do not apply more than one application per season. Do not apply within 15 days of harvest; or

Note: Apollo is not acceptable for some markets. Check with your packer before using.

Oberon (240 g/L spiromesifen) at 0.88 to 1.16 L/ha (350 to 460 mL/acre) with adequate pressure and in enough water to obtain good coverage on both sides of the leaves. Apply when mite populations begin to build. Oberon is most effective against the egg and nymph stages of mites. Do not apply more than 3 times per season. Do not re-enter fields within 3 days of application. Do not apply within 3 days of harvest; or

Nexter (75% pyridaben) at 300 to 600 g/ha (120 to 240 g/acre) in at least 1000 L/ha (400 L/acre) of water when mites first appear. Do not apply more than twice per season. Do not apply within 10 days of harvest; or

Agri-mek 1.9%EC (19 g/L abamectin) at 1.0 L/ha (0.4 L/acre) in at least 375 L/ha (150 L/acre) of water. Do not apply more than twice per growing season. Do not apply within 3 days of harvest; or

Agri-mek SC (84 g/L abamectin) at 225 ml/ha (88 ml/acre) with 0.1-0.5% v/v non ionic surfactant in at least 375 L/ha (150 L/acre) of water. Allow 7-10 days between applications. Do not apply within 3 days of harvest; or

Nealta (200 g/L cyflumetofen) at 1.0 L/ha (400 mL/acre) in at least 500 L/ha (200 L/acre) of water. Do not apply more than 2 times per season. Allow a minimum of 14 days between applications. Do not apply within 1 day of harvest.

Thrips

Western flower thrips (*Frankliniella occidentalis*)

European flower thrips (*Frankliniella intonsa*)

Hosts

Strawberry, and numerous ornamentals, food crops and weeds.

Damage

Damage is primarily limited to strawberry fruit and appears as russetting, bronzing, splitting or development of a leathery texture particularly around the calyx end of the fruit. Adults and larvae feed by removing sap from punctures they make in the plant tissue. Thrips do not cause monkeyfaced fruit.

Identification

Thrips are small, slender insects, 0.5 - 1 mm in length. Adults have two pairs of narrow wings fringed with long, fine hairs. Their colour varies from yellow to brown or blackish-brown. Young thrips are shiny yellow and lack wings. Insects are seen most readily in flowers, under bracts and petals and under the calyx of fruit.

Life Cycle

Adults move from field margins and grass fields when these spring feeding sites are mowed or dry out. Thrips lay eggs into the plant leaf tissue along the main vein. The eggs hatch in 5 to 7 days. Young thrips hatch and feed on plant parts. They pass through nymph and pupal stages before becoming adults. Flower thrips pupate in the soil. Timing of the complete life cycle is temperature dependent. The adults can live and feed for up to 45 days. Thrips can be present throughout the growing season, but are more abundant in warm summer weather.

Monitoring

There has been no action threshold developed for thrips in strawberries in BC; however, information from California suggests that controls should be applied when 10 thrips per flower are detected. Using a hand lens, inspect flowers and fruit by gently prying apart flower parts and looking under the calyx. Alternatively, shake flowers onto a flat surface and count the number of thrips that fall out. Use yellow or blue sticky traps to monitor for adults; Western flower thrips are more attracted to blue than yellow. Be especially vigilant when nearby hay fields are harvested.

Management

Dayneutral (everbearing) strawberries are at greater risk of thrips damage than June-bearing crops.

Cultural control

Naturally occurring beneficial insects help manage thrips, including pirate bugs (*Orius* spp.) and predatory mites (*Amblyseius* spp.). Other biological control agents are used in greenhouses for thrips management, including foliar application of beneficial nematodes and other predatory mites; however, these products have not been tested on strawberries.

Chemical control

If numerous thrips are found in flowers and on developing fruit, insecticides should be applied. Good coverage is critical as thrips are hidden within flowers and developing fruit. Rotate products to prevent development of resistance. Apply:

Delegate WG (25% spinetoram) at 200 to 280 g/ha (80 to 112 g/acre) when high levels of thrips are detected. A repeat application within 3 or 4 days may be necessary if pest pressure is heavy. Do not apply more than 3 times per season. Do not apply within 1 day of harvest; or

Note: Delegate is toxic to bees and should not be applied when bees are actively foraging. It may be toxic to aphid parasites if they are directly contacted.

Exirel (100g/L cyantraniliprole) at 1000 to 1500 mL/ha (400 to 600 mL/acre) in enough water to obtain good coverage. Do not apply during bloom as Exirel is toxic to bees. Do not apply more than 4 times per season or a maximum of 4.5 L/ha (1.8 L/acre). Do not apply 1 days of harvest.

Note: It is recommended that a small area be tested to demonstrate safety to fruit and leaves before using in large areas.

Malathion, Ripcord, Matador when applied for other pests will aid in controlling thrips.

Weevils

Host

Strawberry, raspberry and some ornamentals.

Damage

Most of the damage is done by the larvae (grubs) which eat the roots. Some can tunnel into the crown causing plants to wilt and die in localized areas of the field. The adults feed on strawberry foliage resulting in characteristic notching. Foliage can become seriously damaged when a large number of weevils are present.

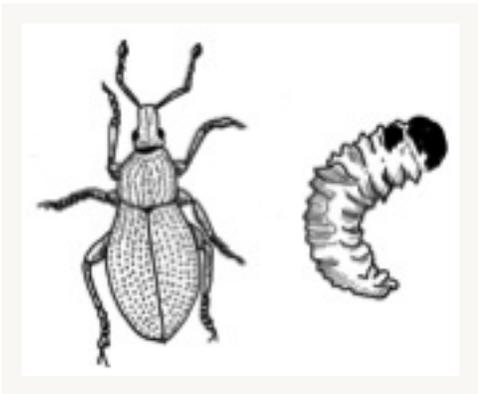


Identification

Several species are present in BC including black vine weevil, strawberry root weevil, woods weevil, clay coloured weevil and obscure root weevil. The most problematic species in BC is the black vine weevil.

Larvae. Creamy-white, legless grubs which, except for woods weevil, are C-shaped. The head is often brown and they do not have legs.

Adults. Small, shiny black to brown beetles, 3 to 9 mm long, with narrow curved snouts and elbow-shaped antennae. The adults do not fly.



Life History

Larvae overwinter in the soil. Some adults also survive the winter in protected areas or old buildings. These adults become active within plantings or begin to invade new areas by mid-April. The invasion can continue throughout the summer until about mid-October. Eggs are often laid in a fold made by the adult on the edge of a leaf, or in the soil, from early-May onward. All the adults are female and can lay eggs. On hatching, the young larvae move into the soil to feed on fine rootlets and overwinter. There is only one generation each year.

Monitoring

Look for fresh leaf notches especially before blossoming and during harvest. Plants close to old berry plantings, pastures or wooded areas are usually the first attacked. The adults feed on the foliage at night. Sweep plants with an insect net at night to determine if adults are present or use a flashlight to inspect leaves and crowns. Be sure to correctly identify the weevil species so control sprays can be accurately timed, if required. The main emergence of black vine weevils occurs in June

Management

Chemical control

Control is directed against the adult beetles which must be killed before they lay eggs. Sprays should be applied only to areas where fresh leaf notches are seen.

Use one of the following:

Matador 120EC, Silencer 120EC (120 g/L lambda-cyhalothrin) or **Warrior** (122 g/L lambda cyhalothrin) at 104 ml/ha (42 mL/acre). Apply when feeding damage is first detected. Do not use more than 3 applications per year. Do not apply within 7 days of harvest; or

Actara 25WG (25% thiamethoxam) at 210 to 280 g/ha (84 to 112 g/acre) in sufficient water to obtain coverage of foliage. Apply when adult weevils or weevil damage is detected. Repeat application if insect populations rebuild. Use the higher rate for heavy infestations. Do not apply more than twice per season. Do not apply within 3 days of harvest; or

Note: Actara is highly toxic to bees exposed to direct treatment or to residues on blooming crops and weeds. Do not apply Actara or allow it to drift onto blooming crops or weeds if bees are foraging in/or adjacent to the treatment area. After an Actara application, wait at least 5 days before placing the beehives near the treated field.

Admire applied to control aphids should also reduce adult weevils numbers.

Caution: Matador, Warrior, Silencer and Ripcord kill mite predators potentially leading to a buildup of two-spotted mites.

For strawberry root weevil adults:

Malathion 85E (85% malathion) at 1.35 L/ha (540 L/acre) of water or Malathion 500 E (500 g/L malathion) at 2.75 L/ha (1.1 L/acre) of water or Malathion 50EC (50% malathion) at 2.5 to 3.75 L/ha (1 to 1.5 L/acre). Spray for thorough coverage. Repeat if necessary. Do not apply within 3 days of harvest.

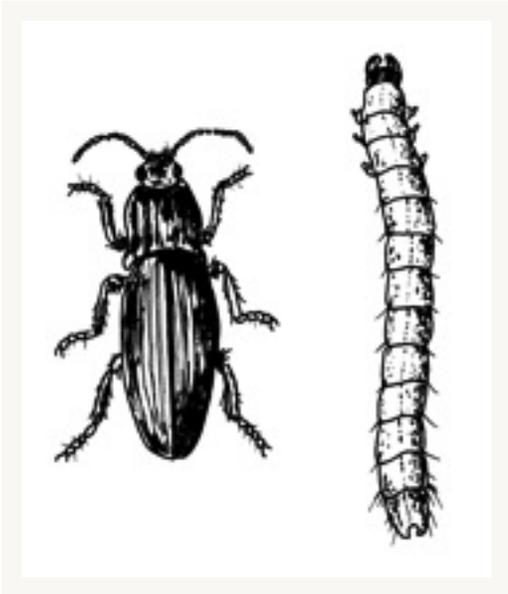
Wireworms

Damage

Wireworms bore into strawberry crowns and destroy them. In heavy infestations, they feed on established plants and greatly reduce the yield, and weaken or kill the plants. Wireworms may enter fruit that is in contact with the ground and become a serious contaminant.

Identification

Yellowish-brown, shiny, slender, hard-bodied worms 5 to 25 mm long.



Management

Plan for control in field preparation for new plantings. For information on controlling wireworms, refer to “General Berry Pests” in this [guide](#).

Other Pests

Slugs

Refer to “Slugs and Snails” in “General Berry Pests”, for more information.

Damage



Slugs eat holes in the ripening strawberries making them unmarketable. Damage to leaves is usually insignificant. They are normally only a problem in wet seasons or when strawberry plantings are adjacent to high grass, bush or other damp areas, and weedy fields.

Management

Cultural Control

Control weeds and keep cover crops mowed as tall grasses and weeds provide protection and may attract these pests.

Chemical control

Deadline M-Ps (4% metaldehyde pellets) at 11.2 to 27.5 kg/ha (4.5 to 11 kg/acre). Apply as a surface broadcast treatment to strawberry rows and headlands in early spring when slugs are first detected. During the flowering and fruiting period apply between the rows only. Do not allow the slug bait to come in contact with fruit. Do not apply more than 6 times per season. Do not apply within 6 days of harvest.

Note: metaldehyde is toxic to dogs, birds and other wildlife. Clean-up or bury any spilled product.

Sluggo or Ferramol (0.76 % ferric phosphate) slug and snail bait at 25 to 50 kg/ha (10 to 20 kg/acre) scattered by hand or granular applicator between the rows and near the base of the plants when slugs are detected. Apply the highest rate if infestation is severe. Reapply at least every two weeks if slugs and snails continue to be a problem. Do not place in piles.

Note: ferric phosphate is not harmful to pets, birds or wildlife.

Diseases

Black Root Rot

Damage

Black root rot mainly affects bearing plants but may occur on the main roots of young runner plants. It causes poor yields and serious plant losses.

Symptoms

Roots. The outer layers of main roots are usually black while the core remains a normal whitish colour. The root system fails to produce new roots. If new roots occur, they have black areas. The roots of seriously affected plants will be completely black, including the core, and eventually rot away.

Leaves. The foliage is a poor colour and reduced in size. Seriously affected plants may wilt and die when berries are ripening.

Disease Cycle

This condition is caused by a combination of factors including *Rhizoctonia*, *Pythium*, other root rot fungi, pathogenic nematodes, water-logged or compacted soil, and cold injury.

Monitoring

Look for the black discolouration on the outside of the main roots. Carefully scrape the outer layer of the root away to check the colour of its core. Except with dying plants, the core should be a creamy-white colour. Any new roots that are present will have black areas. Do not confuse black root rot with the natural darkening of older roots of healthy plants. These plants will produce new, creamy-coloured, healthy roots without the blackened areas.

Management

Cultural control

Plant only certified stock on well-drained fertile soils.

Use a long rotation (at least 2-3 years) between strawberry crops.

Improve the winter drainage by subsoiling between the rows, or planting on raised beds.

Chemical control

Soil fumigation before planting may reduce the problem.

In fields with a history of black root rot, apply:

Quadris (250 g/L azoxystrobin) at 6 mL/100 m of row as an in-furrow application at planting or at 1.1 L/ha (0.44 L/acre) as a banded drench within 8 days of planting. Post-plant drench should be in a 20 cm band

over the row. Do not apply to day-neutral (ever-bearing) strawberries. A plant back interval of 30 days for broadleaf and root crops, and of 45 days for cereals is required. Do not apply within 365 days of harvest; or

Scholar 230 SC (230 g/L fludioxonil) at 1.2 L/ha (0.48 L/acre) or 6.5 mL/100 m of row as a drench application in a 15 to 20 cm band over the row. Use sufficient water to ensure even and thorough coverage. For new plantings apply within one week of transplanting and repeat in late July/early August. For established plantings apply in the spring when leaves emerge and repeat after renovation. Do not apply more than two times per year over two years. Do not apply more than 552 g/ha (220 g/acre) per season. Do not apply within 1 day of harvest.

Scholar may also be applied through a drip irrigation system. Refer to the product label for more information.

Fruit Rots

Several different fungal organisms cause fruit rot. The main cause is *Botrytis* (grey mould). *Rhizopus* (leak) usually occurs after harvest but may develop on ripe fruit in the field in warm weather. Fruit infected with *Rhizopus* softens rapidly and collapses. Anthracnose infected fruit can be a problem in summer-harvested dayneutral varieties. *Botrytis* fruit rot is described below. A fungicide program for *Botrytis* will also control other fruit rot organisms such as *Rhizopus* and *Cladosporium*.

Anthracnose (*Colletotrichum* spp.)

Damage

Anthracnose can affect leaves, petioles, runners, crowns, buds, blossoms and fruits. It is caused by several species of the fungus *Colletotrichum*; *C. fragariae*, *C. gloeosporioides* and *C. acutatum*. Although, anthracnose has generally been considered to be a “warm weather” or “southern” disease of strawberry, over the past few years, incidence of fruit anthracnose, associated with *C. acutatum*, has been reported from the northern US and BC. Fully opened flowers and ripening fruit are most susceptible to infection. In BC, this disease has not been severe to date, causing only limited fruit rot in late harvested June-bearing varieties and on day neutral varieties harvested through the summer. However, anthracnose should be monitored carefully to determine if incidence is increasing so appropriate preventative action can be taken.

Symptoms

On petioles and runners, symptoms first appear as dark spots, and then develop into elongated, dry, sunken lesions which girdle the plant tissue resulting in wilting and death of leaves or entire daughter plants. On leaves, anthracnose appears as small black spots and, in some cases, dark-brown to black lesions appear on leaf margins and tips. The fungus sporulates on these lesions and becomes an inoculum source for flower, fruit, and crown infections. Infected flowers become blighted and dry quickly. On fruit, symptoms appear as whitish, water soaked lesions, and later turn into dark-brown to black, sunken lesions with pale-orange to salmon-colored spore masses. When crown tissue becomes infected, crown rot may develop and the entire plant may wilt and die. The internal crown tissue will show reddish-brown to dark-brown discoloration.

Disease Cycle

Infected transplants and soil associated with transplants appear to be the primary source of inoculum. Once the disease is established in the field, the fungus can overwinter on infected plants and plant debris, such as dead leaves and mummified fruits. In spring and early summer, spores are produced in abundance on previously infected plant materials. Spores are spread by splashing or wind-driven rain or irrigation, by people or equipment moving through the field. Spore germination, infection and spore production of the fungus are favoured by warm, humid weather and rainfall.

Monitoring

Watch the crop during the early growing season for foliar symptoms that may lead to heavy infections later in the season, especially on ripening fruit.

Management

Cultural control

Use disease-free planting stock.

The fungus is spread by splashing water. If using overhead irrigation, sprinkle in the early morning so plants dry during the day, thus minimizing new infections.

Remove old, infected plant debris including infected berries during harvest.

Narrow rows to leave enough space for air movement to encourage rapid drying.

Spores can spread on containers and flats; therefore avoid moving such items from farm to farm. Practice good disinfection and sanitation measures.

Cool fruit as soon as possible after harvest to minimize post-harvest rot.

Chemical control

In fields with a history of anthracnose, apply one of the following fungicides beginning at early bloom:

Group 7/11

Pristine WG (25.2 % boscalid, 12.8 % pyraclostrobin) at 1.3 to 1.6 kg/ha (0.52 to 0.64 kg/acre) in enough water to obtain good coverage. Apply beginning at early bloom. Spray in rotation with other fungicides on a 7 to 14 day schedule. Use the shorter interval when disease pressure is high. Do not apply more than 5 times per crop per season. Do not apply Pristine or other products containing Group 7 or 11 fungicides more than twice in succession. Do not apply within 1 day of harvest; or

Group 11

Cabrio EG (20% pyraclostrobin) 0.56 to 1.0 kg/ha (225 to 450 g/acre) in at least 1000 L/ha (400 L/acre). Begin applications no later than bloom and repeat applications as required at 7 to 14 day intervals. Do not apply more than 5 times per season. Do not apply within 1 day of harvest.

Note: Cabrio and Pristine applied for anthracnose control will also provide suppression of powdery mildew.

Botrytis Fruit Rot (Grey Mould) (*Botrytis cinerea*)

Damage

Botrytis can cause very serious crop losses, especially in wet seasons. The disease affects all stages of fruit development from blossoming through post-harvest marketing. Rot can occur on blossoms, blossom stems, and green and ripe berries. After harvest, the disease can spread rapidly from rotted to healthy berries, causing whole loads to be unmarketable. If not controlled by a spray program, losses of fruit can be expected every year.

Symptoms

Blossoms. Affected flowers turn brown and may be killed. Infection of the flower stem causes it to collapse. A fuzzy, grey growth sometimes develops on the brown petals and stems.

Berries. The infection starts as a light-brown spot, usually near the stem, which spreads over the entire berry. Rotted berries have the characteristic fuzzy, grey growth of the fungus. This growth contains spores which spread easily to other berries and blossoms.

Disease Cycle

Botrytis over-winters in old leaves and fall fruit. In the spring, the fungus produces spores which infect the blossoms. The fungus grows down through the flower parts into the young green berries as they develop. Infected green fruit may not show symptoms until they ripen. The grey mould produces abundant spores which cause more infections.

Monitoring

Cool, wet weather and high humidity favour the disease. Start applying protectant sprays when the first flowers open. Bravo 500 or Echo 720 should be applied earlier (see below).

Management

Cultural control

Renovate and rotovate in early spring to remove and destroy old leaves and fruit.

Fertilize for optimum leaf growth.

Over-fertilization with nitrogen before harvest can cause excessive growth and increase fruit rot.

Manage row spacing and row widths to allow adequate air movement and rapid drying of leaves.

Time irrigation so flowers and leaves dry off quickly.

Control weeds to reduce humidity around the plants and carry-over of disease.

Ensure that fields are picked clean and discard any rotten berries away from the field.

Keep harvested berries in the shade until they are removed from the field. Covering flats with a reflective tarp will help reduce heating.

Cool fruit destined for the fresh market (best to 1°C) as soon as possible after harvest to slow down disease development.

Chemical control

Refer to Fungicide Chart in this section.

Fungicide sprays must be applied regularly to prevent the disease from becoming established in the blossoms and developing fruit. Apply the first spray when the first blossoms open, and repeat every 7-14 days depending on weather. Observe days to harvest and re-entry times listed on product labels.

To obtain adequate coverage, use at least 1000 L/ha (400 L/acre) of water. To delay development of resistance, rotate sprays from the different groups listed below. Never apply fungicides from the same group more than twice in succession.

Strawberry Botrytis Fruit Rot (Gray Mould) Fungicides				
PRODUCT	ACTIVE	RATE	PHI*	COMMENTS
Group 2 Fungicides				
Rovral WP or Rovral WDG	500 g/L iprodione	2 kg/ha (0.8kg/acre)	1	<ul style="list-style-type: none"> ● Use with a non-ionic surfactant. ● Does not control <i>Rhizopus</i> fruit rot or common leaf spot.
Group 7 Fungicides				
Cantus WDG	70% boscalid	560 g/ha (224 g/acre)	0	<ul style="list-style-type: none"> ● Do not use more than 5 times per season. ● Do not use more than 2 consecutive applications of Lance or other group 7 fungicide.
Fontellis	200 g/L penthiopyrad	1.0 to 1.75 L/ha (0.4 to 0.7 L/acre)	0	<ul style="list-style-type: none"> ● Do not use more than 5.25 L/ha (2.1 L/acre) per season. ● Do not use more than 2 consecutive applications of

				Fontellis or other group 7 fungicide
Kenja 400SC	400 g/L isofetamid	1.0 to 1.24 L/ha (0.4 to 0.5 L/acre)	0	<ul style="list-style-type: none"> Do not use more than 5 times per season. Do not use more than 2 consecutive applications of Isofetamid or other group 7 fungicide
Sercadis				
Group 7/Group 9 Fungicides				
Luna Tranquility	125 g/L fluopyram 375 g/L pyrimethanil	1200 ml/ha (486 ml/acre)	1	<ul style="list-style-type: none"> Do not use more than 2 times per season for Botrytis
Group 7 / Group 11 Fungicides				
Pristine WG	25.2% boscalid 12.8% pyraclostrobin	1.3 to 1.6 kg/ha (0.52 to 0.64 kg/acre)	1	<ul style="list-style-type: none"> Do not apply more than 5 times per crop per season.
Group 17 Fungicides				
Elevate 50 WDG	50% fenhexamid	1.7 kg/ha (0.7 kg/acre)	1	<ul style="list-style-type: none"> Do not apply more than 4 times per season. Do not use more than 2 consecutive applications of Elevate
Elevate 50 WDG Plus	50% fenhexamid 80% captan	1.2 to 1.7 kg/ha (0.5 to 0.7 kg/acre)	2	<ul style="list-style-type: none"> Do not apply more than 4 times per season. Do not apply more often than every 7 days Do not re-enter treated fields within 48 hours
Maestro 80 DF		2.75 kg/ha (1.1 kg/acre)		
Group 9 Fungicides				

Scala SC	(400 g/L pyrimethanil)	2.0 L/ha (0.8 L/acre)	1	<ul style="list-style-type: none"> ● Make first application at the white bud stage (prebloom) and repeat as required at 7 to 10 day intervals. ● Do not use more than 2 consecutive applications of Scala. ● Do not apply more than 3 times per season.
Group 9/12 Group Fungicides				
Switch 62.5	(37.5% cyprodinil and 25% fludioxinil)	975 g/ha (390 g/acre)	1	<ul style="list-style-type: none"> ● Begin applications at or before bloom and continue on 7 to 10 day intervals. ● Do not use more than 2 consecutive applications of Switch. ● Do not apply more than 3 times per year.
Group M Fungicides				
Captan 80 WDG	80% captan	2.8 to 4.2 kg/ha (1.1 to 1.7 kg/acre)	2	<ul style="list-style-type: none"> ● Do not apply more often than every 7 days. ● Do not re-enter treated areas within 48 hours.
Captan 50 WP	50% captan	4.5 to 6.75 kg/ha (1.8 to 2.7 kg/acre)		
Maestro 80 DF	80% captan	2.75 to 4.25 kg/ha (1.1 to 1.7 kg/acre)		
Folpan 50 WP	50% folpet	2.0 kg in 1000 L water	1	
Thiram 75 W	75% thiram	2.25 to 2.5 kg in 1000 L of water	3	

Bravo 500	500 g/L chlorothalonil	3.5 L/ha (1.4 L/acre)	30	<ul style="list-style-type: none"> Do not make more than 3 applications per year. Do not re-enter treated areas within 48 hours. Apply once in the fall and twice 10-12 days apart the following spring when new growth appears. This program is not generally effective in the Fraser Valley, but it may reduce disease in drier areas such as the southern Interior
Echo 720	720 g/L chlorothalonil	2.4 L/ha (1.0 L/acre)		
Biological Fungicides				
Serenade Opti	<i>Bacillus subtilis</i>	1.7 to 3.3 kg/ha (0.68 to 1.32 kg/acre)	0	<ul style="list-style-type: none"> Approved for organic production Repeat on 7-10 days intervals
Regalia Maxx	20 % <i>Reynoutria sachalinensis</i>	0.125 to 0.25 % v/v in 500 to 1,000 L/ha water (200 to 400 L/acre).	0	Approved for organic production
Actinovate SP	0.037% <i>Streptomyces lydicus</i>	425 g/1100 L water	0	<ul style="list-style-type: none"> Approved for organic production
Double Nickel 55	<i>Bacillus amyloliquefaciens</i>	0.6-2.5 kg/ha (0.23-1 kg/acre)	0	<ul style="list-style-type: none"> Approved for organic production
Timorex Gold	23.8% tea tree oil	1.5-2.0 L/ha (0.6 -0,8 L/acre) in 400-800 L/ha (160-320 L/ac)	2	<ul style="list-style-type: none"> Avoid spraying in the heat of the day or when temperatures are above 35°C

*PHI - Pre Harvest Interval

Note: Serenade Max no longer produced.

Common Leaf Spot (Ramularia Spot or Bird's-eye Spot) (*Mycosphaerella fragariae*)

Damage

When the spots are numerous, common leaf spot can reduce plant vigour, yield and fruit quality. Minor infections do not cause significant damage.

Symptoms

The disease first appears as small, red or purplish spots. As the spots get larger, they turn grey or light brown in the centre with purplish edges. The disease is most often seen on leaves and petioles but similar symptoms may occur on runners, flower stems, and fruit. Flower stem infection can cause blossom drop on very susceptible varieties. Fruit infection results in "black seed" disease –hard, brown spots on the fruit.

Disease Cycle

The common leaf spot fungus can survive on infected transplants in cold storage, and on plant debris in the soil. The disease develops and spreads during wet weather when temperatures are from 7 to 25°C. It is most severe in the spring and fall. The spores are moved by splashing rain or irrigation. Infection occurs on leaves or stems that are wet for at least 12 hours.

Monitoring

Start to watch for leaf spots when the first new leaves are fully open in the spring. The disease can spread rapidly during periods of prolonged wet weather and may reach damaging levels on susceptible varieties.

Management

Cultural control

Most varieties show some resistance but may develop the disease during long wet periods. Puget Reliance and Shuksan are very susceptible.

Use certified disease-free planting stock.

Mow and rotovate old leaf debris in the spring and renovate after harvest, to reduce disease.

Chemical control

If leaf spotting is severe in the spring a fungicide application may be necessary. Puget Reliance and other susceptible varieties should be sprayed 7-14 days before blossoms start to open. Fall infections generally do not need to be controlled with fungicides.

Apply:

Topas or Jade or Tilt (250 g/L propiconazole) at 500 mL/ha (200 mL/acre) or Mission 418 EC (418 g/L propiconazole) at 300 mL/ha (120 mL/acre) in enough water to obtain good coverage when leaf spots are detected in the spring. Do not apply more than two consecutive applications of Topas. Do not apply more than 4 times per season. Do not apply within 1 day of harvest; or

Captan 80 WDG (80% captan) at 2.8 to 4.2 kg/ha (1.1 to 1.7 kg/acre). Do not re-enter treated fields within 48 hours of application. Do not apply within 2 days of harvest; or

Captan 50 WP (50% captan) at 4.5 to 6.75 kg/ha (1.8 to 2.7 kg/acre). Do not re-enter treated fields within 48 hours of application. Do not apply within 2 days of harvest; or

Senator 70 WP (70% thiophanate-methyl) at 1.1 kg/ha (440 g/acre) commencing when buds are visible in the crown. Repeat every 7-10 days as needed and reduce spray interval to 3-5 days during rainy periods. Do not apply within 1 day of harvest; or

Folpan 50 WP (50% Folpet) at 2 kg/ha (0.8 kg/acre) in 1000 to 2000 L of water/ha (400 to 800 L/acre). Apply before first infection and repeat at 7 day intervals to protect crop until harvest. Do not apply within 1 day of harvest.

Other products recommended for Botrytis fruit rot control will also suppress leaf spot.

Occasionally, other fungi, such as Phomopsis, may cause leaf spots but these are usually controlled by sprays used for fruit rot.

Nematodes

For detailed information on this pest refer to “General Berry Pests – Nematodes”.

Damage

Nematodes are microscopic worms that live in the soil. When plant parasitic nematodes are present in large numbers, they cause stunting and reduced vigour of plants by feeding on the roots. Damage is usually patchy in fields.



Management

New fields should be sampled for nematodes in the year before planting so fumigation can be done in late summer or early fall, if necessary. Compost or manure should always be applied the following spring after fumigation treatment.

See “General Berry Pests—Nematodes” in this guide for details on soil sampling, field preparation and application of fumigants.

Powdery Mildew (*Podosphaera aphanis* (syn *Sphaerotheca macularis*)

Damage

This fungal disease attacks flowers, leaves and fruit and can cause heavy crop losses during warm, humid conditions. There are no completely resistant varieties, but Hood and Totem have shown some tolerance. Shuksan is moderately susceptible. Damage can be severe on dayneutral varieties.

Symptoms

Leaves. Infected leaves curl upward exposing the white powdery fungus on the underside. Diseased leaves later turn reddish purple or have small purple flecks or spots.

Flowers. Flowers are covered with white mycelium and may be deformed or killed. Poor pollination leads to poor fruit set.

Fruit. Infections on green fruit can stop ripening, leaving hard, russetted and cracked fruit. On ripening fruit, the fungus first grows under individual seeds, raising them from the fruit surface. The white, powdery fungus then spreads over the surface of the fruit. Infected ripe berries may be firm, or soft and pulpy, and usually have a somewhat flat, or bitter taste.

Disease Cycle

The disease overwinters in infected leaves. Spores produced on infected plants or debris, are carried by wind to infect new spring growth. The disease develops in moderate to high humidity and warm temperatures (15 to 27°C).

Monitoring

Watch for the first signs of the disease—leaf distortion (curling) and a general purple discoloration—especially in the spring and fall. Closely monitor dayneutral varieties for mildew on the leaves and fruit during the late summer and early fall when days are warm with heavy evening dews.

Management

Cultural control

Renovate plantings soon after harvest to destroy old, infected foliage.

Chemical control

Apply fungicides when the disease is first seen, especially during warm, humid conditions. If the disease was a problem the previous year, apply sprays before symptoms appear. It is usually not necessary to spray after harvest in August or September except for very susceptible and dayneutral varieties.

Use:

Lime Sulphur at 15 L/ha applied in 1000 L/ha of water (6.0 L/acre in 400 L/acre water). Apply when foliage is dry. Apply well before fruit ripening or after harvest.

Cueva (Copper octoanate 1.8%) Use a 0.5% to 2% solution, applied at 470-940 L/ha (188-377 L/acre). Apply 1 month after planting or before flowering on established plants, and twice more at 7 day intervals. Do not apply within 1 day of harvest, or

Group 3

Nova 40W (40% myclobutanil) at 340 g/ha (145 g/acre) in enough water to ensure thorough spray coverage (500 to 1000 L/ha). Begin applications when disease first appears or when conditions favour disease development. Repeat applications as required at 14 to 21 day intervals. Do not apply more than two consecutive applications of Nova or other Group 3 fungicides. Do not apply more than 6 times per season. Do not apply within 3 days of harvest; or

Mettle 125 ME (125 g/L tetraconazole) at 219 to 365 mL/ha (88 to 146 mL/acre) in enough water to ensure thorough spray coverage. Begin applications when disease first appears or when conditions favour disease development. Repeat applications as required at 14 to 21 day intervals. Do not apply more than two consecutive applications of Mettle or other Group 3 fungicides. Do not apply more than 4 times per season. May be used up until the day of harvest; or

Fullback 125SC (125 g/L flutriafol) at 510 to 1024 mL/ha (200 to 400 mL/acre) in enough water to ensure thorough spray coverage. A nonionic surfactant at 0.25 v/v may be added to the spray mix. Do not apply more than 2048 mL/ha (800 mL/acre) per season. Do not apply within 8 days of harvest.

Group 7

Luna Privilege (500 g/L fluopyram) at 500 mL/ha (200 mL/acre) applied through the drip irrigation system preventatively. Apply as needed on a 5 to 7 day interval. Do not exceed 1.0 L/ha (400 mL/acre) per season. Do not apply Luna Privilege or other products containing Group 7 fungicides more than twice in succession. May be used up until the day of harvest; or

Sercadis (300 g/L fluxapyroxad) at 250-333 mL/ha (100-135 mL/acre) in enough water to obtain good coverage. Apply beginning no later than 10% bloom, prior to onset of disease development. Spray in rotation with fungicides from other groups on a 7 to 14 day schedule. Use the shorter spray interval when

disease pressure is high. Do not apply more than 3 times per crop season. Can be applied up until the day of harvest; or

Velum Prime (500 g/L fluopyram) at 500 mL/ha (200 mL/acre) through the drip irrigation system only. Apply preventatively and continue on a 5 to 7 day interval as needed. Do not apply more than two sequential applications of any group 7 fungicide before rotating with a fungicide from another group. Do not apply more than 500g of fluopyram/ha per year. Can be applied up until the day of harvest; or

Group 7/9

Luna Tranquility (125 g/L fluopyram, 375 g/L pyrimethanil) at 1200 ml/ha (486 ml/acre) in a minimum of 500 L/ha (202 L/acre) of water. Begin applications preventatively and repeat as required at 7 to 14 day intervals. Do not apply within 1 day of harvest; or

Group 7/11

Pristine WG (25.2 % boscalid, 12.8 % pyraclostrobin) at 1.6 kg/ha (0.64 kg/acre) in enough water to obtain good coverage. Apply beginning at early bloom. Spray in rotation with other fungicides on a 7 to 14 day schedule. Use the shorter interval when disease pressure is high. Do not apply more than 5 times per crop per season. Do not apply Pristine or other products containing Group 7 or 11 fungicides more than twice in succession. Do not apply within 1 day of harvest; or

Group 11

Flint (50 % trifloxystrobin) at 140 g/ha (56 g/acre) in enough water to obtain good coverage. Apply beginning at early bloom. Spray in rotation with other fungicides on a 7 to 14 day schedule. Use the shorter interval when disease pressure is high. Do not apply more than 3 times per crop per season. Do not apply Flint or other products containing Group 11 fungicides more than twice in succession. May be applied up to the day of harvest; or

Group 13

Quintec (250 g/L quinoxifen) at 300 to 440 mL/ha (120 to 176 mL/acre) as a preventive treatment before visible powdery mildew symptoms appear. Use enough water to ensure thorough coverage of foliage. Use the high rate when disease pressure is severe. Repeat as required at 10 to 14 day intervals. Do not make more than 2 consecutive applications of Quintec. Alternate with fungicides from other groups to delay development of resistance. Do not apply more than 4 times per season. Do not apply within 1 day of harvest.

Biological Fungicides

Actinovate SP (0.037% *Streptomyces lydicus*) at 425 g/1100 L of water. Apply as a foliar spray ensuring coverage of leaves and blossoms. Make the first application when conditions are conducive to disease development and repeat applications every 7 to 14 days. Use the shorter application interval under high disease pressure. Approved for organic production. May be used up until the day of harvest; or

Regalia Maxx (20 % *Reynoutria sachalinensis*) at 0.125 to 0.25 % v/v in 500 to 1,000 L/ha water (200 to 400 L/acre). Apply as a preventive foliar spray when disease symptoms first appear ensuring coverage of

leaves and blossoms. Repeat applications every 7 to 10 days depending on disease pressure. May be used up until the day of harvest; or

Double Nickel 55 (*Bacillus amyloliquifaciens* strain D747 at 5×10^{10} spores/g) at 0.5 to 2.5 kg/ha (0.20 to 1 kg/acre) as a foliar spray in enough water to ensure coverage. Apply at or just before flowering until fruit maturity if conditions favour disease development. Use the low rate (0.2 to 0.4 kg/acre) when plants are small or disease pressure is low, and the high rate (0.4 to 1 kg/acre) when disease pressure is high. Repeat applications every 3 to 10 days depending on disease pressure. May be used up until the day of harvest; or

Timorex Gold (Tea tree oil 23.8%) at 2-8 L/ha (0.8-3.2 L/acre) in 400 to 800 L/ha (160-320 L/acre). Apply at 7-14 days intervals for preventive treatments depending on disease level. Do not apply within 2 days of harvest.

Note: Avoid spraying in the heat of the day or when temperatures are above 35 C. Do not spray this product through irrigation system.

Red Stele Root Rot (*Phytophthora fragariae*)

Damage

This is a common disease, especially in the Fraser Valley. It can cause serious plant losses and poor yields.

Identification

Roots

In early spring, the central core (or stele) of infected roots is a pinkish-red colour, turning to black-red. Feeder roots may rot away completely, giving the main root a “rat-tail” look.



Left – Healthy Strawberry Root

Centre – Early stage red stele root rot

Right – Advanced stage of red stele root rot

Far Right – Black root rot

Leaves

The leaves turn a red, yellow or pale green colour early in the season from lack of nutrient uptake. Severely infected plants are undernourished and stunted. The plants eventually wilt and die.

Disease Cycle

The disease is caused by a fungus-like organism called *Phytophthora fragariae* var. *fragariae*. It lives in the soil and attacks the roots. It attacks only strawberries, but can remain in the soil for many years without strawberries being present.

Infection occurs in cool, wet soil at temperatures from 1 to 10°C. The most damaging periods for infection are during the formation of new adventitious roots in the fall and new feeder roots in early spring. The disease is much more severe under conditions of poor drainage and will often appear in low spots in the field.

In water-logged soils, *Pythium* and other *Phytophthora* species may also cause root and crown rots (see Black Root Rot).

Monitoring

In early spring, carefully scrape the infected tips of the main roots, or slip off the outside layer of the root, to see the pinkish-red to black-red colour of the stele. This symptom usually disappears when soil temperatures rise in June.

Management

Cultural control

Use certified disease-free planting stock. This prevents soil contamination and is the best method of controlling red stele.

Plant only on well-drained sites.

Do not grow strawberries repeatedly in the same field.

Avoid fields where the disease has been severe in the past.

If the disease is present, improve the winter drainage and subsoil between the rows.

Choose varieties showing some resistance to red stele (Puget Reliance and Rainier). These may become infected if certain races of the fungus are present.

Chemical control

If necessary, apply:

Ridomil Gold 480SL or 480EC (480 g/L metalaxyl-M) at 20 ml per 200 meters of row in a 0.5 m wide band (30 ml per 1000 ft. row per 20 inch band) centered over the row. At a 110 cm (44in) row spacing, this works out to 0.9 L/ha (0.4 L/acre).

Apply in late October or November when the soils are cool and damp. Ridomil moves readily into the soil root zone with rain. Do not apply after November 30.

Aliette WDG or Aliette WP (89% fosetyl-AI) at 5.6 kg/ha (2.2 kg/acre. Apply as a directed spray to young growing leaves in spring and/or in fall before leaves die. This fungicide is taken up by the leaves and moves down into the plant roots. Apply not more than 4 times/year (twice in spring and twice in the fall), with applications 30 to 60 days apart. Where Ridomil resistance is not a problem, Ridomil may be applied in the fall and Aliette in the spring. Do not apply within 30 days of harvest.

Verticillium Wilt (*Verticillium dahliae*)

Damage

This disease is not common in the Fraser Valley but can appear in strawberry plantings that follow potatoes or raspberries. It is more common in the southern Interior.

Symptoms

Young, infected leaves in the centre of the plant are small, bluish and dull. Older leaves curl up along the mid-vein, turn brown along the edges and between veins. They may also turn a yellow or reddish colour and wilt. The leaves dry up as the disease progresses. Browning of the older leaves while the younger leaves remain green is typical of Verticillium wilt. Individual plants or small patches of plants in the field may wilt and die during the summer following planting. The plants are often stunted. Brownish streaks occur in the vascular tissue of crown, roots or base of the leaf stem.

Disease Cycle

The disease is caused by a soil-borne fungus called Verticillium. It enters the roots and moves up through the vascular system of the plant. It inhibits the movement of water and nutrients to the leaves. The disease is more severe on light, sandy soils where root lesion nematodes are also present.

Monitoring

To check plants suspected of Verticillium wilt, slice open the crown to look for the brownish streaks often seen in the vascular tissue. This disease can be mistaken for other crown or root rots. A laboratory diagnosis may be necessary to confirm this disease.

Management

Cultural control

Avoid planting susceptible varieties (especially Shuksan) where the disease is likely to cause losses.

Avoid planting strawberries in fields planted to potatoes, raspberries or alfalfa the previous year.

Chemical control

Soil fumigation reduces the disease temporarily but will not eliminate it.

Viruses

Damage

Several virus and virus-like diseases affect strawberries causing varied and complex problems. Infected mother plants pass the virus to their runner plants and, thus, virus related damage is more severe as the planting ages. The damage can seriously reduce vigour and yield. Infected fruit is often small, deformed and poor in flavour.

Symptoms

There are number of viruses and virus-like diseases that have been found in BC. The most common viruses on strawberry are strawberry mottle virus, strawberry mild yellow edge virus, strawberry vein banding virus and strawberry crinkle virus. The symptoms are variable depending on the type of virus or combination of viruses and the strawberry variety. Susceptible varieties like Hood may show stunting, crinkling, yellowing, mottling, and/or leaf curling. More tolerant varieties like Puget Reliance may show few or less symptoms except for stunting and reduced fruit size and yield.

Recently, a new virus complex has occurred in the Fraser Valley. In affected fields symptoms are first seen in the year of planting and progress to cause severe damage in the fruiting years. Beginning with the youngest leaves, the whole plant becomes twisted and severely stunted. Leaves show a distinctive reddening of the veins. Strawberry crinkle virus in combination with other viruses is believed to be involved. Totem and Rainier appear to be particularly susceptible to this condition.

Disease Cycle

Viruses are spread from infected plants to healthy ones mainly by aphids. Strawberry aphids develop wings and are flying before new strawberry fields are planted. They can infect new plants with viruses as soon as the first leaves emerge from the crown. The viruses are then passed to other plants by either winged or wingless aphids as the aphids move about in search of young leaves.

Monitoring

Scout for early symptoms and monitor aphid populations in both established and first year fields and apply sprays as necessary.

Management

Cultural control

Select tolerant varieties. Avoid planting susceptible varieties, such as Hood, close to established plantings of tolerant varieties.

Isolate new plantings from established fields to reduce aphid movement and virus transmission.

Start new plantings from certified stock that was grown to minimize virus infection.

Keep fields free of weeds as they harbour several kinds of aphids that can spread virus diseases.

Chemical control

Control aphids in established fields close to new plantings.

Apply a residual, systemic aphicide when aphids are first detected in a new planting. Apply further aphid control sprays whenever aphids reappear (see also “Aphids” above).

Other Problems

Blossom Frost Injury

Frost-damaged blossoms have black centres and dry-up or drop before forming fruit, or form misshapen fruit. Frost injury is more common in low areas of the field. Damage can be reduced by sprinkler irrigation during the low temperature periods, use of row covers or wind machines. Late blooming varieties such as Rainier are less prone to blossom frost injury.

Misshapen Berries

Berry size and shape is largely due to the number of seeds that develop on the surface of the berry. If a seed, or a group of seeds, does not develop, the portion of the berry under the seed will not enlarge or ripen. This results in a misshapen berry. Misshapen berries are usually pinched-in (called “monkeyfaced” or “catfaced”), multiple-tipped or fan-shaped (fasciated).

Anything that prevents seed development can result in misshapen berries. Causes include:

Poor pollination: cold, wet conditions or lack of bees during bloom,

Frost injury to blossoms,

High temperatures and drying winds during bloom,

Botrytis (grey mould) disease: can cause misshapen fruit when flowers are attacked,

Frost or hail during early fruit development,

Other environmental conditions: short day length in fall can result in fasciation. Cold, dry fall weather can cause multiple-tipped berries,

Insect feeding on flower parts or developing fruit: many insects (strawberry mites, aphids, spittlebugs) when present in high populations can lead to misshapen fruit. Lygus bugs are the most serious pest. Lygus injury can look slightly different than weather-related injuries. Seeds damaged by lygus are hollow inside and about the same size as those in the undamaged areas of the fruit. Seeds damaged by weather-related injuries tend to be smaller than undamaged seeds. Also, lygus injury is usually seen later in the season after the risk of cold-weather injury is reduced. For further information on this problem, see “Lygus Bugs”.

Nutrient imbalances: boron or calcium deficiencies, or excessive nitrogen,

Herbicides: Some herbicides can cause fasciated fruit.

Genetic factors: Some varieties tend to produce fasciated fruit.

Soil Problems

In the western end of the Fraser Valley (especially Richmond and Delta), poor soil conditions are a common cause of poor growth and plant death during the establishment year. Typically, a newly planted field can look good to the end of July. Plants then begin to wilt and die. Further losses occur over the winter leading to a

poor stand in the first cropping year. This type of injury is often caused by a combination of very acid soil (low soil pH), inadequate winter drainage and high levels of soil salts.

Management

Check the acidity of the soil before planting a new field. Add lime, if needed, to raise the pH to a suitable level (pH 5.5 to 6.5).

Improve winter drainage to help leach the salts from the soil.

Avoid fields known to have a high salt level at least until the winter drainage is improved.

Apply sprinkler irrigation during the dry summer months to keep the salts below the root zone.