

Table 15. Efficacy of fungicides for strawberry disease management.

Fungicide <sup>a</sup>	Gray mold	Leather rot	Leaf spot	Powdery mildew	Anthracnose	Red Stele
<b>Alone</b>						
Aliette <sup>b</sup>	-	+++	-	-	-	++
Cabrio	++	?	+++	+++	++++	?
Captan	+++	+	+++	-	+++	-
Elevate <sup>c</sup>	++++	-	-	-	-	-
Quadris <sup>d</sup>	+	+	+++	+++	++++	-
Ridomil Gold	-	+++	-	-	-	++++
Sulfur	-	-	-	+++	-	-
Switch <sup>e</sup>	++++	-	-	-	++	-
Thiram	+++	+	++	-	+++	-
Topsin-M <sup>c</sup>	+++	-	+++	++	+	-
<b>In Combination</b>						
Topsin-M plus captan	+++	+	+++	+++	+++	-
Topsin- M plus thiram	+++	+	+++	+++	++	-
Elevate plus captan	+++	+	++	-	++	-
Elevate plus thiram	+++	+	++	-	+	-

Efficacy rating system: ++++= excellent; +++=good; +=moderate; +=poor; -=not effective or not labeled for this use; ?+ unknown.

<sup>a</sup> This is not a complete listing of the fungicides used for strawberry disease management.

<sup>b</sup> Limited efficacy data available for Aliette.

<sup>c</sup> \_\_\_\_\_ Fungicide that is prone to develop resistant strains of fungi For resistance management, Topsin-M, and Elevate are recommended only in combination with an unrelated fungicide such as; captan or thiram.

<sup>d</sup> This material is extremely phytotoxic to McIntosh and some other apple varieties and should not be used near apples or in a sprayer also used on apples.

<sup>e</sup> Note restrictive plant back regulations on this product.

of favoring Black Root Rot rather than controlling it. Moving to a planting site which has not grown strawberries recently, and is well-drained is the best method of managing this disease.

even stimulate aphids to feed. Planting virus-free material will decrease overall damage from virus diseases.

## Virus Diseases

Viruses are disease-causing organisms so small they cannot be seen with an ordinary microscope. Several viruses infect strawberries in the Northeast, and it is not uncommon for two or more viruses to be found within the same plant. Viruses in a plant may not show obvious symptoms. However, their presence does weaken the plant.

Loss of vigor and yield caused by viruses are more likely to show up when growing conditions are unfavorable and plants are stressed. Virus symptoms on strawberries, include chlorotic (yellow) spots or irregular patches on leaves. Leaves may crinkle, or otherwise be malformed. Herbicide injury and virus symptoms may be similar.

**Management:** Once strawberry plants are infected with a virus, they cannot be cured. The infection is passed on to all daughter plants via runners. Most viruses are spread from plant to plant via aphids. Chemical insecticides will not kill aphids before they are able to transmit viruses and may

## Insects

### Fruit Damaging Insects

**Tarnished Plant Bug (*Lygus lineolaris*):** The tarnished plant bug (TPB) is a small (1/4") bronze-colored insect with a triangular marking on its back. The immature stage, or nymph, is smaller and bright green, resembling an aphid, but much more active. Both adults and nymphs feed on the developing flowers and fruit, sucking out plant juices with straw-like mouth-parts. This results in deformed fruit: typically “cat-faced” berries, also called nubbins or button berries. Such fruit are generally unmarketable.

**Management:** Controlling weeds in and around the planting may reduce populations of this insect, but insecticide sprays may be necessary. If mowing around fields, do so after insecticides have been applied (to control migrating insects). Avoid planting strawberries near alfalfa which attracts high populations of TPB. White sticky traps are available for

**Table 16.** Monitoring for tarnished plant bug in strawberry.

NUMBER OF CLUSTERS EXAMINED	NUMBER OF FLOWER CLUSTERS INFESTED			
	CONTROL NOT REQUIRED	KEEP SAMPLING	CONTROL REQUIRED	
			Low threshold 0.15 nymphs/cluster =2% damage	High threshold* 0.25 nymphs/cluster =4% damage
15	0	0 to 3; check 5 more	3 or more	5 or more
20	0	0 to 4; check 5 more	4 or more	5 or more
25	1 or less	1 to 4; check 5 more	4 or more	6 or more
30	2 or less	2 to 4; check 5 more	4 or more	7 or more
35	3 or less	3 to 5; check 5 more	5 or more	7 or more
40	3 or less	3 to 5; check 5 more	5 or more	8 or more
45	4 or less	4 to 6; check 5 more	6 or more	9 or more
50	5 or less	5 to 6; check 5 more	6 or more	9 or more

\*Primarily for processing fruit.

Source: N. J. Bostanian, Agriculture and Agri-Food Canada, St. Jean-sur-Richelieu, P. Q. Courtesy Pam Fisher, Ontario Ministry of Food and Agriculture.

monitoring tarnished plant bug adults. These traps are used as a indication of when plant bugs begin their activity in the spring and a relative indication of their abundance, not as an indication of when to control this insect. Immature TPB (nymphs) are sampled by shaking flower trusses over a flat white surface. Thirty flower clusters should be sampled evenly from across the field (typically 6 clusters at 5 locations or 5 clusters at 6 locations). If 4 or more flower clusters are infested with nymphs (regardless of how many) a spray is recommended. A follow-up spray application may be made after bloom if TPB are still present in high numbers (check harvest interval before selecting material).

See *Integrated Pest Management for Strawberries in the Northeastern United States* for more detail on tarnished plant bug life cycle and sampling (ordering information at the end of this guide). See pest management schedule for recommended materials and timing. Do not apply insecticides during bloom.

**Sequential Sampling: a time-saver.** To save time, a sequential sampling plan may used to deter-

mine how many clusters should be sampled. By using Table 16 above, you can make a spray/no spray/keep looking decision by first examining a minimum of 15 clusters. If you find 0 TPB nymphs, you can stop and make a “no spray” decision. If you find more than 0 but less than 3, (or, between 1 and 5 if you are using a high threshold) you must continue sampling. If you find 3 or more TPB nymphs, control is required in order to avoid economic damage to your crop. If the maximum of 50 flower clusters are sampled and no decision is indicated, the grower should sample again in 1 or 2 days. This method allows scouts to spend less time monitoring in fields where populations are very low, or very high. More time is spent sampling fields where TPB populations are close to the threshold.

**Strawberry Bud Weevil, “Clipper”**

(*Anthonomus signatus*): The strawberry bud weevil or “clipper” occurs somewhat less frequently than tarnished plant bug. This insect is a very small beetle (1/8”) with a copper-colored body and a black head

**Table 17.** Revision to monitoring procedure for strawberry bud weevil (clipper).

	Old Method	New Method	New Method
Unit examined	Flower buds	Flower Clusters	Flower buds
Assessment	Clipped buds or Not clipped	Cluster highly damaged* or Cluster with low amounts of damage	Clipped buds or Not clipped
Threshold	2 clipped buds/m	3 highly damaged clusters/m	3 clipped 1½ buds/m or 30 clipped 2½ or 3½ buds/m

\*highly damaged=1 clipped primary (1½) bud, or 2 clipped secondary (2½) bud, or 3 clipped tertiary (3½) buds  
Courtesy Pam Fisher, Ontario Ministry of Food and Agriculture

with a long snout.

The female weevil chews a small hole in unopened flower buds and lays an egg in the hole. She then girdles the stem just below the bud. The flower bud dries up and dangles from the stem, eventually falling to the ground. The immature weevils, or grubs, develop in the girdled buds, emerging as adults in the early summer, and then migrating to wooded areas.

These insects are not always present and may only cause minimal damage some years. Examine the plants before bloom for clipped buds. If the field has had a history of clipper injury, the first appearance of clipper indicates the need to spray.

**Management:** Check for presence of clipper by examining new flower trusses as they first emerge from the crowns in April or May. The weevils will sometimes crawl in among the unopened buds for shelter. They are most likely to be in rows near woods or hedgerows. Later, look for shot-holes in opened flower petals and/or clipped buds of unopened flowers. In the past, the IPM action threshold for this insect is 1 clipped bud per 2 ft. of row or one live adult. Research done in recent years suggests that many more clipped buds can be tolerated without significant yield loss. A comparison of old and new sampling methods done by researchers at Cornell University (Hortscience 34 (1): 109-111, 1999) can be seen in Table 17 below. Sample at least 5 locations in the field. If you determine that the infestation is limited to the edge of a field, you may only need to spray the border rows. If you see evidence of clipper and determine a spray application is necessary, follow recommendations for materials and timing in the strawberry pest management schedule.

**Sap beetles (*Stelidota geminata*):** Sap beetles cause hollowed out cavities on ripe fruit, an injury very similar to slug injury. Adults are small oval beetles about 2mm long and dark brown in color. They are often hard to see because they drop to the ground when disturbed, but they may be found in the cavities they have chewed out. They are found almost exclusively when there is ripe fruit in the field.

**Management:** The best management for this pest is sanitation; keeping the field as free as possible of ripe fruit. Sap beetles may be trapped with bait baskets of over-ripe fruit placed between the edges of the field and wooded areas. Spacing

recommendations are not known. Place traps as soon as bait fruit is available. Brigade™ may be used for control if absolutely necessary; it can be sprayed within 12 hours of harvest, but might devastate mite predators. Read the label carefully. See pest management schedule for recommended materials and timing.

**Thrips (*Thysanoptera*):** Thrips are tiny insects that feed on flower parts. Several species occasionally infest the flowers of strawberries. The adults are slender, winged, about 1/25 inch long, and are orange or yellow. Young thrips are smaller, wingless, yellowish, and active. These insects breed on grasses and weeds in spring, and move to strawberries at bloom. They insert their eggs in plant tissue at the base of flowers, and in tender, new foliage.

Thrips begin feeding on the seeds and the inner surface of the hull soon after the buds open. As the fruit expands and the seeds separate the thrips feed extensively on the fruit between the seeds. Thrips feed by piercing the surface cells with their mouthparts and sucking the contents, causing cells to die. With continued feeding, the entire fruit becomes bronzed.

**Management:** Thrips can build up to damaging levels. Scouting for this insect can be difficult because of their small size. Fruit should be examined when they are very small, 5-10 mm in diameter. Examine under the calyx for presence of thrips, or place in a zip-lock bag in the sun. This will drive the thrips out so that they can be counted. Canadian researchers indicate that more than 25 thrips per 50 sampled fruit will result in unacceptable levels of fruit damage. See Table 18 below. Several insecticides labeled for use on strawberries are effective on thrips. Consult the labels.

Table18. Tentative guidelines for thrips in strawberries.

Characteristic	Definition
Sample Size	50 fruit/acre
Sample Time	Early fruit maturity stage (5-10 mm diameter)
Suggested Limits	25 thrips/50 fruit for PYO 5 thrips/50 fruit for shipping berries 2 thrips/berry = 20% damage

Source: Kevin Lynch, *New Brunswick Agriculture, 1995. Courtesy Pam Fisher, Ontario Ministry of Food and Agriculture*

---

## Leaf Damaging Insects and Mites

---

**Strawberry Leafrollers** (*Ancyliis comptana fragariae*): These insects have an immature stage (larvae) which damages strawberry leaves. They are small green or bronze larvae (caterpillars) up to 1/2" long at maturity. They occur in the field prior to bloom and in mid- to late July. Larvae are first found on the undersides of leaves in silken covers, then on upper sides of leaves that have been folded or rolled and tied with silken threads.

**Management:** Remove and destroy rolled leaves. If infestation is severe, a pre- or post-bloom spray application may be needed. Timing will depend on when larvae are present. In Southern New England they occur in mid-May so a pre-bloom insecticide spray is recommended.

**Twospotted Spider Mite** (*Tetranychus urticae*): Twospotted spider mites (TSSM) are very small (1/50"), 6- or 8-legged creatures that feed on strawberry foliage. Under heavy infestations, mite feeding destroys leaf chlorophyll and causes leaves to have yellowish or whitish speckles, then an overall bronze color. Leaves will be covered in a fine webbing. Yield reductions may occur from repeated heavy infestations. The most serious reductions in yield may result from early season feeding, so scouting for overwintered mites in early May is especially important.

Twospotted spider mites are found on the underside of leaves, are barely visible to the naked eye, and are especially active during hot, dry months. Mites generally form colonies and may be most noticeable by the webbing that they produce around their aggregations, which may occur as localized "hotspots" in the field. Therefore, when looking for mites, the grower must look over the whole field, checking first for bronzing and then looking for mites with a hand lens. Overwintered female TSSM mites are easily seen because they are orange-colored.

**Management.** Mites should be monitored weekly by sampling the field in 5 to 10 locations. Five to ten leaves should be sampled at each location for a total of 60 leaves. Examine the underside of the leaves for the presence or absence of TSSM. Record the information on a field map so that "hot spots" can be identified and treated. A miticide application is recommended if 25% (i.e., 15 leaves) or more of a

60 leaf sample is infested with TSSM. See pest management schedule for recommended materials and timing.

Natural predators exist which feed on two-spotted spider mites. One such predator, also a mite (*Neoseiulus fallacis*), is native to the northeast and often maintains TSSM populations at non-damaging levels. It is equally small but lacks the two spots on its back, is teardrop shaped, shiny, and pale yellow in color. They are also easily distinguished from TSSM by their rapid movement across a leaf in search of prey; (they resemble bumper cars moving forward and backward as they search for food). When sampling a field, presence of predators as well as TSSM should be noted.

Several companies sell predatory mites, including *N. fallacis*, for release in various crops. However, the benefit of releasing commercially reared mites has not been demonstrated in the northeast, where natural populations of *N. fallacis* are pervasive. It is important to encourage natural enemies of spider mites by reducing the use of broad-spectrum pesticides (especially carbamate and pyrethroid insecticides) which harm natural enemies. One strategy that has worked exceptionally well has been the early-season use of 1% oil with a mist blower. This inexpensive treatment is highly selective: it kills TSSM, but not predatory mites. The resulting imbalance between predators and TSSM allows predators to "mop-up" the remaining TSSM. Please note that oil-incompatible pesticides should not be applied prior to the oil spray. See the Table 48 at the end of this guide for toxicity of pesticides to beneficial insects. Contact your local Extension Specialist or call (916) 324-4100 for a copy of Suppliers of Beneficial Organisms in North America, an excellent sourcebook for natural enemies such as predatory mites. This reference is also available via the Internet at <http://www.cdpr.ca.gov/docs/ipminov/bensuppl.htm>. Also, see Integrated Pest Management for Strawberries in the Northeastern United States (listed at the end of this guide) for more details on life cycles and biological control of twospotted spider mites.

**Cyclamen Mite** (*Steneotarsonemus pallidus*): This soft-bodied mite is orange-pink, white, or green and about 1/100" long. These mites feed on the unfolding leaves in the crown of the plant, leading to distorted, purplish leaves, and buds that fail to open. Cyclamen mite is not as common as two-spotted

mite in strawberries and has been known to occasionally come in on nursery stock. It is, therefore, important to buy plants from a reputable source.

**Management:** See pest management schedule for recommended materials and timing.

**Strawberry Aphids** (*Chaetosiphon* spp.): There are several species of aphids that infest strawberries. Adults are small (1/16" long), soft-bodied insects. Aphids occur on new shoots, undersides of leaves, and on buds while they are still in crown. Root aphids have been found on rare occasions. Damage occurs primarily when aphids transmit viruses from infected to non-infected plants. When present in great numbers, feeding can result in stunted, malformed plants.

**Management:** See pest management schedule for recommended materials and timing.

**Leafhoppers** (*Empoasca fabae*): Leafhoppers are small (1/8"), green, bullet-shaped insects which take flight quickly if disturbed. The nymphs are lighter colored and do not fly. They are easily identified by their habit of moving sideways when disturbed. Leafhoppers feed primarily on the underside of strawberry leaves, causing them to yellow between the veins and become curled and distorted. These symptoms are often mistaken for herbicide injury. Feeding activity is most serious during the late spring and early summer. They reduce vigor and runner production. Insecticides should be applied only when large populations of nymphs are noted on the leaves or symptoms become apparent.

**Management:** See pest management schedule for recommended materials and timing.

**Spittlebug** (*Philaenus spumaris*): Hidden beneath masses of white frothy spittle are soft-bodied, tan and green, elongate bugs about 1/8-1/4" long. These insects feed on stems and blossom clusters before and during bloom. Heavy feeding activity results in reduced plant vigor and decreased yield. Early season feeding can result in stunted, off-color plants; damage appears much like that caused by cyclamen mites.

**Management:** Spittlebug seldom does damage to the plants. It is mainly a problem because customers are bothered by the froth in the field when picking. Often heavy rains and/or irrigation will wash froth from plants. This insect tends to be more of a problem in weedy fields. Insecticide applications early in the season (e.g., for tarnished plant

bug) are usually adequate for keeping this insect in check. Recommended action threshold is one spittle mass per foot of row. See pest management schedule for recommended materials and timing.

**Cutworms:** The immature stage (larvae) of these insects causes feeding injury to plants. Larvae may reach 2" long at maturity. Color and arrangement of stripes and spots varies from one kind of cutworm to another, but are often mottled or dingy gray. Cutworms may be observed on plants at night during spring and summer. Larvae consume leaves, buds, flowers, and developing fruits.

**Management:** Consult with your Cooperative Extension Specialist for management options.

---

## Root Damaging Insects

---

Root-feeding insects can cause above-ground symptoms that are similar to root diseases: general loss of vigor and collapse during dry weather. Where damage is suspected, plants can be dug with a spade to examine roots and to check soil for the presence of root-feeding insects.

**Strawberry Rootworm** (*Paria canella*): The adult form of this insect are beetles that are small (1/8"), round, and copper-colored with a dark markings on their backs. The immature root-feeding grubs are also small (1/8"), creamy white in color with 3 pairs of legs, and are actively feeding on roots in the late spring to early summer. The new generation of adults appears after renovation (late July or early August).

This insect can be most easily observed in the field as adult beetles feeding on leaves. Feeding occurs at two times in the growing season in Massachusetts (May and July-August), and results in shot-holes in the leaves. The second feeding period usually is more evident because a greater number of beetles are feeding then. The earlier feeding is done by the overwintering population.

**Management:** As with all the root-feeding insects, control of the root-feeding stage is very difficult. Therefore, control measures for strawberry rootworm should be directed toward the adult stage of the insects. Presence of adults can be detected by feeding injury or direct sightings of the adult beetles in the field. Sticky traps used for monitoring tarnished plant bug may aid in sighting strawberry rootworm adults since they feed primarily at night.

Some of these beetles find their way onto the traps.

If feeding injury is observed in May or June, an insecticide spray at this time will reduce the number of egg laying females and therefore, the number of grubs feeding during the summer. When the next generation of adults emerges in July or August, control measures may be needed again.

No threshold is established for this insect.

Feeding injury, as with all the root-feeding insects, is most damaging if root diseases (i.e. black root rot) infect the plants as a result of wounding. Therefore, it is advisable to keep the root-feeding population low. See pest management schedule for recommended materials and timing.

**Root Weevils** (*Otiorhynchus* spp., *Polydrusus* spp.): There are several rootfeeding weevils that are damaging to strawberries; black vine weevil (*Otiorhynchus sulcatus*) strawberry root weevil (*O. ovatus*), and the rough strawberry root weevil (*O. Rugosostriatus*) are the best known. Additionally, green leaf weevils, (*Polydrusus* spp.) have also been found feeding on strawberries in Massachusetts and Connecticut.

These insects damage strawberries primarily by weakening the root systems which are then more susceptible to winter injury and disease infection. Root feeding is done by the larvae (grubs) of these weevils. The grubs are whitish and crescentshaped, ranging in size from 1/4" to 1/2". They have no legs. Adult weevils feed on leaves from May through August, causing notching of the leaf margins. Adults in heavily infested fields can contaminate harvested berries. Adult feeding generally does not cause serious injury to the plants unless the plants are already weakened from previous feeding of larvae on the crown. It is the root and crown feeding that is most injurious. Under heavy infestation by root weevils, the plants decline, appear stunted and bear poorly. Infestations are generally in patches in the field.

**Management:** The easiest time to detect weevil activity is during harvest. Randomly pick 100 leaves from each field and count the number that have feeding notches along the margin. Greater than 50% leaf notching may indicate the need for control measures. Confirm the presence and species of weevils involved by observing them at night with a flashlight. The easiest time to detect root injury from larval feeding (and from other root disorders) is in

the autumn. The foliage of plants with poor root systems turns orange-red earlier than healthy plants. Plants should also be examined in the spring if patches of poor vigor are noticed. Lift a section of row with a spade and examine the roots within a 6" layer of soil. If grubs are found, insect pathogenic nematodes should be applied in early May or late August. Be sure to keep the field irrigated during periods of active growth to avoid stress on the plants.

Predatory nematodes attack root weevil grubs in the soil. Although populations of these nematodes naturally occur, application of commercially produced nematodes can achieve faster biological control. contact your local Extension Specialist or call (916) 324-4100 for a copy of *Suppliers of Beneficial Organisms in North America*, an excellent sourcebook for natural enemies such as predatory mites. (Also available via the Internet at <http://www.cdpr.ca.gov/docs/ipminov/bensuppl.htm>.) Available species useful against root weevils include *Steinernema carpocapsae*, *S. feltiae*, *Heterorhabditis bacteriophora*, and *H. marelatus*. The *Heterorhabditis* spp. have the ability to penetrate insect cuticle, which facilitates infection of white grubs. The cost and quality of nematodes can vary widely, so talk to your Small Fruit Specialist to find out more about different products. A banded spray may be very cost effective compared with application through overhead irrigation. Nematodes application should be preceded and followed with irrigation. Protect them from sunlight by applying them in the evening. Brigade™ is now registered to control the adults, before they lay eggs. Controlling root weevil adults requires the highest labeled rate, and is best applied at night when adults are active. This material can induce spider mite outbreaks, and may kill beneficial root weevils predators. See pest management schedule for recommended timing and rates.

**White Grubs of Asiatic Garden Beetle, European Chafer, Japanese Beetle, and Oriental Beetle:** (*Maladera castanea*, *Popilla japonica*, *Rhizotrogus majalis*, and *Exomala orientalis*): While not considered major pests of strawberry, it appears that many growers are experiencing leaf and root damage from these scarab beetles, collectively also called white grubs. Root feeding by larvae dramatically weakens the plant and also provides an entry site for root diseases like black root rot.

All of these species overwinter as a grub in the

soil, emerging in late May through July in the Northeast. The adult Japanese beetle is copper-brown and -green in color and approximately 1/2" long. They are often found feeding during the day on leaves in small groups. Asiatic garden beetles (AGB) are small (3/8") and a velvety cinnamon brown color, showing a faint green iridescence in the sunlight. AGB feed at night on the foliage and hide during the day under plants. Feeding by Japanese beetle or AGB is easily distinguished from root weevil feeding because these scarabs principally skeletonize leaves (making holes within the leaves), rather than notching the leaf edge. Leaf feeding typically occurs in June through midAugust. Oriental beetle and European chafer adults are rarely observed because they do not feed much. Oriental beetles are slightly smaller than Japanese beetles, and are usually tan and mottled with darker spots. European chafers are slightly more than 1/2" long and are a uniform tan.

The larvae (or grubs) of these insects look quite similar to one another and are called white grubs. They are c-shaped, have 3 sets of legs, grow up to 1/2" long. They are easily distinguished from the larvae of root weevils, which have no legs. White grubs are very difficult to manage after a strawberry bed has been planted.

It is unknown how much leaf feeding can be tolerated, but if leaf area is greatly reduced it could

affect the following year's flower bud formation, which is initiated in the fall. Large numbers of beetles are of concern, especially if it increases the amount of overwintering grubs. High populations of larvae can be expected the autumn and spring following a dry summer, especially where strawberry fields are surrounded by turf. These conditions favor movement of adults into strawberry fields to lay eggs.

**Management:** Management of grubs in the soil is very difficult, though *Heterorhabditis* spp. nematodes may have some value. (See source reference under root weevils above.) Chemical control of adult beetles can prevent extensive leaf damage, but is not guaranteed to prevent egg laying. Combination pheromone and floral scent lures are commercially available for Japanese beetle, but their placement near strawberries may actually attract more beetles to the area. Therefore, if traps are used, they should be placed at least 20 yards from the strawberry field.

Milky spore disease is a commercially available bacterium that is incorporated into the ground and attacks the grubs (especially Japanese beetles). However, soil temperatures in the northeast are too cool for this disease to easily become established, which makes it impractical for our area.

To avoid the risk of white grub problems, do not plant on newly turned sod land. Rather, plow the field, let it lie fallow or in a rotational cover crop

Table 19. Efficacy of common insecticides and miticides used in strawberries.

Insecticide	Aphid	Clipper	Cyclamen mite	Leafhopper	Leaf-roller	Root weevil	Root-worm	Sap beetle	Spittlebug	Thrips	TSSM	TPB	White grub
Agri-mek (abamectin)	-	-	+	-	-	-	-	-	-	-	+++	-	-
Brigade (bifenthrin)	*	++	-	-	*	+	-	++	+++	-	+	+++	-
Cythion (malathion)	*	-	-	*	*	*	-	+	-	*	*	++	-
Danitol (fenprothrin)	-	-	-	-	-	-	-	-	+++	-	+	+++	-
Dibrom (naled)	*	-	-	-	*	-	-	-	*	*	*	+++	-
Guthion (azinphosmethyl)	*	++	-	-	+++	-	-	-	++	-	-	-	-
Kelthane (dicofol)	-	-	++	-	-	-	-	-	-	-	+++	-	-
Malathion (malathion)	*	-	-	*	*	*	-	-	-	-	-	++	-
Phaser (endosulfan)	*	-	+++	-	-	-	-	-	*	-	-	*	-
Sevin (carbaryl)	-	*	-	-	++	-	-	-	++	-	-	*	*
Sniper (azinphosmethyl)	*	++	-	-	+++	-	-	-	++	-	-	-	-
Thiodan (endosulfan)	+++	-	+++	-	-	-	-	-	+++	-	-	+++	-
Vendex (fenbutatinoxide)	-	-	-	-	-	-	-	-	-	-	+++	-	-

+++ = Highly effective; ++ = moderately effective; + = slightly effective; \* = labeled but insufficient data; - = not labeled.

such as Sudan, buckwheat, or a salable crop such as pumpkins or squash for at least one season prior to planting with strawberries. Also, avoid siting a strawberry field next to large grassy fields which would be a source of these beetles. Control grassy weeds within the planting, which are especially attractive to egg-laying Japanese beetles and European chafers.

---

## Other Pests

---

**Slugs:** Slugs are dark grey, black, yellow-gray or brown worm-like mollusks. They may also be covered with spots and range in size from 1-1/2 to 7" long. Slugs feed mainly at night, eating ragged holes in leaves and/or fruit. They also leave a trail of slime in their paths. Damage occurs primarily on fruit.

**Management:** Slugs thrive in moist places. If mulch is very thick and rows close together, slugs will be favored. Try to open things up a bit by removing excessive mulch and planting at lower densities which also helps manage diseases. Some growers have used diatomaceous earth for slug control. Research results are not available to verify the effectiveness of this material. Baits are also available but are not considered highly effective according to some growers. Consult with your Extension Specialist if you need help with this pest.

**Garden Symphylan, (*Scutigereilla immaculata*):**

The garden symphylan, also known as the garden centipede, is an occasional but very destructive pest of strawberries. Symphylans are not insects but are more closely related to centipedes and millipedes. They have 12 pairs of legs and 14 body segments. Symphylans overwinter in the soil as

adults. In spring they move into the top 6 inches when the soil temperature rises above 45°F.

Eggs are deposited in soil crevices and tunnels in late April, May, and June. The eggs hatch two to three weeks later into tiny, white nymphs that resemble the adults in appearance except they have only six pairs of legs. As the nymphs develop, they grow bigger and add a pair of legs at each molt until they have 12 pairs. About three months are required to complete development from egg to adult. The adults remain in the upper 6 inches of soil until extreme dryness or cold weather drives them deeper into the soil. Mature symphylans are white, slightly less than 1/4 inch in length, with a pair of long beaded antennae. Their entire life (one to two years) is spent in the soil.

Garden symphylans feed on the roots of strawberry plants, weakening or killing them. Infestations seldom encompass an entire field, but rather involve one or more small areas within a field. Usually, the first indication of a symphylan infestation is a small area of stunted, unhealthy plants. Crop losses continue in the same area of the field year after year, with the infected area increasing in size about 10–20 feet each year.

**Management:** It is best to control symphylans before the crop is planted or at the time of planting. To check for symphylans, turn over at least 10 shovelfuls of soil. Sift the soil while looking for active symphylans. An average of one symphylan per shovelful signals that a treatment is necessary before planting. If symphylans are abundant, an insecticide should be broadcast and incorporated into the soil of the infested area before planting takes place.



Table 20. Strawberry pest management schedule<sup>†</sup>.

Early Spring, Pre-bloom (New leaves are expanding and blossom buds are visible)			
Pest	Spray Material, Rate/A (pre-harvest interval)	Cultural Practices and Scouting Notes	Comments
Strawberry bud weevil (clipper)	*Lorsban 4E, 2 pt (21) Sevin 50WP, 2 - 4 lb (7) Sniper 50PVA, 1 lb (5) Brigade WSB, 6.4 to 32.0 oz (0) PyGanic EC 1.4, 16oz (0)	Spot treatments can be made if infestation is localized to field perimeter. See text on bud weevil above for details of scouting methods.	All of these insecticides are toxic to mite predators. <b>Lorsban</b> can only be used pre-bloom and is limited to two applications per season. Follow-up first spray with a second spray 10-14 days later.
Tarnished plant bug <b>only</b>	Dibrom 8EC, 1 pt (1) Sabadilla 0.8WP, 6 lb (0)	See text on tarnished plant bug for details of scouting and sampling methods.	<b>Brigade</b> , with 0 days to harvest (12 hr REI), and <b>Dibrom</b> , with only a 1 day harvest interval may be very useful for day neutral varieties.
Tarnished plant bug <b>and/or</b> Spittlebug	Thiodan 3EC, 1.3 qt (4) Phaser 3EC, 1.3 qt (4) Phaser 50WSB, 2 lb (4) Malathion 57EC, 1.5-3 pt (3) Cythion 8E, 1.5-2 pt (3) *Danitol 2.4 EC, 10 2/3 oz (2) Brigade WSB, 6.4 - 32 oz (0) PyGanic EC 1.4, 16oz (0)		<b>Thiodan</b> may not be applied more than twice in a 35 day period when fruit is present; you must wait 15 days between applications.
Spittlebug <b>only</b>	Guthion Solupak 50WP, 1 lb (5) *Sniper 50 PVA, 1 lb (5)	Suggested action threshold is 1 spittle mass per square foot of row.	Spittlebugs generally do not damage fruit but make them less appealing to pickers. <b>Guthion</b> has 48 hr REI for mowing, irrigating, and scouting; and 4 day REI for all other activities.
Two-spotted spider mite (TSSM)	Vendex 4 L, 1 pt (1) Kelthane 35WP, 1-3 lb (2) *Agri-Mek 0.15EC, 16 oz (3) Sunspray Ultra-Fine Oil, 1% (0) JMS Stylet Oil, 3 qts (0) Trilogy (Neem) 1-2% solution (0) Predatory mite release, rate varies (0)	Scout for presence of TSSM by randomly sampling 60 leaves from whole field.  Treat field with miticide or release mite predators if TSSM are found on more than 25% of leaves sampled.  Consult your Extension Specialist for help identifying mite predators and/or finding a source of predators for release.	Adjust spray volume and nozzle placement to assure maximum coverage of tops and undersides of leaves.  <b>Agri-Mek</b> applied at a lower rate (6 oz.) selectively kills spider mites. The full rate (16 oz.) kills predatory mites.  <b>Sun Spray Ultra-Fine Oil</b> and <b>JMS Stylet Oil</b> require direct contact to kill mites and their eggs. Spray oils at no less than 400 psi.  Oils are phytotoxic in combination with captan or Morestan residues and should not be used in a spray program with Kelthane or within 14 days of a sulfur application.

Table 20 continued. Strawberry pest management schedule<sup>†</sup>.

Early Spring, Pre-bloom (New leaves are expanding and blossom buds are visible)			
Pest	Spray Material, Rate/A (pre-harvest interval)	Cultural Practices and Scouting Notes	Comments
Leaf spot	<b>Combine:</b> Topsin-M 70WP, 8 oz (1)	Improve air circulation by narrowing row width, increasing distance between rows, and raising beds. This will allow faster drying after rain, irrigation, and dew.	Treatment not needed unless infection is severe. Fungicide applications for gray mold will usually manage leaf spots as well.
Leaf scorch			
Leaf blight			
	<i>plus</i> Captan 50WP, 3 lb (0) <i>or</i> Thiram 65WP, 3.5 lb (3)	Remove or thoroughly incorporate leaf debris from field at renovation. This helps disrupt the disease cycle of these fungi.	<b>Captan</b> has a 0 day phi, but the REI of 24 hrs requires that PPE be worn during this period.
	<b>Or, use alone:</b> Syllit 65W, 1.5 - 2 lbs. (14) Cabrio EG 12-14 oz (0)		
		Avoid excess Nitrogen application that promotes dense foliage and poor air circulation.	<b>Syllit</b> (dodine) must be applied with sufficient water (250-300 gal) for thorough plant coverage.
Red Stele	Ridomil Gold EC, 1 pt (0) Aliette WDG, 2.5 - 5 lb (0)		Early spring or fall applications are recommended for control of red stele.  Use sufficient water to move the <b>Ridomil</b> into the root zone. There is no preharvest interval for this application.
Spring, Pre-bloom to Early-bloom (From bud expansion to 10% bloom)			
Tarnished plant bug (TPB)	Same as Early Spring, Pre-bloom treatments shown above	See text on tarnished plant bug for details of scouting and sampling methods.	<b>DO NOT SPRAY INSECTICIDES DURING BLOOM.</b> In case of an emergency, use only those materials listed as having low toxicity to pollinators. See Table 48 at end of guide on toxicity of pesticides to beneficial insects.
Anthracnose	Quadris F, 6.2-15.4 oz (0) Cabrio EG 12-14 oz (0) Captan 50WP, 6 lb (0) Thiram 65WP, 5 lb (3)	This disease is becoming more prevalent in many southern New England locations  <b>Quadris F</b> may be applied no more than 4 times per year and must be alternated with a fungicide with a different mode of action. <b>Quadris F</b> will cause injury to McIntosh and other apple varieties if subject to drift or if the same sprayer is used. <b>Use extreme caution to avoid crop damage to apples.</b> Do not make more than two (2) sequential applications of <b>Cabrio EG</b> before alternating to a non-strobilurin fungicide with another mode of action. <b>Captan</b> has a 0 day phi, but the REI of 24 hrs requires that PPE be worn during this period.	

Pest	Spray Material, Rate/A (pre-harvest interval)	Cultural Practices and Scouting Notes	Comments
Botrytis gray mold	<p><b>combine either:</b> Topsin-M 70WP, 8 oz (1) <i>or</i> Elevate 50WDG, 1.5 lb (0) <b>plus</b> Captan 50WP, 3-4 lb (0) <i>or</i> Thiram 65WP, 2.5 lb (3)</p> <p><b>or, use alone:</b> Elevate 50WDG, 1.5 lb (0) Switch 62.5 WG, 11-14 oz (0) Captan 50WP, 6 lb (0) Stylet Oil, 3 qts. (0) Trilogy, 1-2% solution (0)</p>	<p>Improve air circulation by narrowing row width, increasing distance between rows, and raising beds. This will allow faster drying after rain, irrigation, and dew.</p> <p>Remove or thoroughly incorporate leaf debris from field at renovation. This helps disrupt the disease cycle of the Botrytis fungus.</p> <p>Avoid excess Nitrogen application that promotes dense foliage and poor air circulation.</p>	<p>Blossom protection is the most important component of successful Botrytis control. An early bloom application should be made at 10% bloom and followed up at mid and late bloom if conditions are wet.</p> <p>No more than 4 applications/year of <b>Switch 62.5WG</b> may be made. See label for other restrictions.</p> <p><b>Captan</b> has a 0 day phi, but the REI of 24 hrs requires that PPE be worn during this period.</p> <p>Neither <b>Elevate</b> nor <b>Topsin-M</b> should be used alone for season long control of Botrytis to avoid developing resistance. Do not apply more than 6 lbs of Elevate per acre per season.</p>
Thrips	SpinTor 2SC, 4-6 oz (1)	See text for scouting information.	

#### Full-bloom (From 10% bloom until no blossoms remain)

Tarnished plant bug (TPB)	<b>No spray</b> - may be lethal to pollinators	Do not mow hay or alfalfa in adjacent fields if possible since this will encourage plant bugs to move into strawberry field.	DO NOT SPRAY INSECTICIDES DURING BLOOM
Botrytis gray mold	Same as Spring, Pre-bloom to early-bloom treatments above	See above.	See above.

#### Early Summer (Fruit-set to harvest)

Tarnished plant bug (TPB)	Same as Early Spring, Pre-bloom treatments shown above	See text on tarnished plant bug above for details of scouting and sampling methods.	
Sap beetle	Malathion 57EC, 1.5-2 pt (3) Cythion 8E, 1.5-2 pt (3) *Brigade WSB, 6.4-32 oz (0) PyGanic, 16oz (0)	Bait baskets with overripe fruit or balls of bread dough at intervals around edges of field to catch beetles as they migrate in. Brigade can be applied up to 12 hrs before harvest.	
Spittlebugs	Dibrom 8E, 1 pt (1) Thiodan 3EC, 1.3 qt (4) Guthion Solupak 50WP, 1 lb (5) *Sniper 50 PVA, 1 lb (5) *Danitol 2.4EC, 10 2/3 oz (2) *Brigade WSB, 6.4 - 32.0 oz (0)	Suggested action threshold is 1 spittle mass per square foot of row.	<p>Spittlebugs generally do not damage fruit but make them less appealing to pickers.</p> <p>See note on <b>Thiodan</b> under tarnished plant bug comments.</p> <p><b>Guthion</b> has 48 hr REI for mowing, irrigating, and scouting; and 4 day REI for all other activities.</p>

Table 20 continued. Strawberry pest management schedule†.

<b>Early Summer (Fruit-set to harvest)</b>			
<b>Pest</b>	<b>Spray Material, Rate/A (pre-harvest interval)</b>	<b>Cultural Practices and Scouting Notes</b>	<b>Comments</b>
Botrytis gray mold	Same as Spring, Pre-bloom to early-bloom treatments above	Do not allow fruit to become over-ripe. <b>Harvest regularly.</b>  Spray only if weather is wet or very humid during this period to control secondary infections.	If good coverage was made during bloom, further fungicide applications may not be needed.  Pay strict attention to re-entry periods and harvest intervals for materials used.
Anthracnose	Same as Spring, pre-bloom to early bloom	See Spring, pre-bloom to early bloom.	See Spring, pre-bloom to early bloom.
Leather rot	Ridomil Gold EC, 1 pt (0) Aliette WDG, 2.5 - 5 lb (0)	Make sure to maintain a good mulch layer around plants to reduce puddling and splashing around plants from rain or irrigation.	For control of leather rot apply <b>Ridomil Gold</b> during the growing season at fruit-set.
Leaf spot	No fungicides until after renovation	Fungicides are usually not applied at this time for leaf spot diseases. Materials used for Botrytis management should alleviate leaf spot symptoms until after renovation.  Improve air circulation by narrowing row width, increasing distance between rows, and raising beds. This will allow faster drying after rain, irrigation, and dew.  Remove or thoroughly incorporate leaf debris from field at renovation. This helps disrupt the disease cycle of these fungi.	
Leaf scorch			
Leaf blight			
<b>Harvest (Within 4 days of harvest through harvest)</b>			
Botrytis gray mold	Same as Spring, Pre-bloom to early-bloom treatments above.	Do not allow fruit to become over-ripe. <b>Harvest regularly.</b>	Fungicide applications at this time are for emergency situations. Good coverage at infection periods during bloom should make late season sprays unnecessary.  Be sure to follow label instructions for both REI and PHI restrictions.
Anthracnose	Same as Spring, pre-bloom to early bloom above.	See Spring, pre-bloom to early bloom above.	See Spring, pre-bloom to early bloom above.

## Summer (Post-harvest)

Pest	Spray Material, Rate/A (pre-harvest interval)	Cultural Practices and Scouting Notes	Comments
Strawberry root worm; adult	*Guthion 50WP, 1 lb (5) Sevin 50WP, 2-4 lb (7)	Scout field for 'shot-hole' feeding injury on leaves. If found, look in duff around plants for small copper-colored beetle.	Apply post harvest only when foliar damage is noticed and beetles positively identified.  Larvae feed on roots causing general loss of vigor and possible collapse of plant.
Root weevils (various species)	*Brigade WSB, 8-16 oz (0) <i>Steinernema</i> spp., 3 billion/A (0) <i>Heterorhabditis</i> spp., 1/2 - 1 billion/A (0)	Rotate to non-susceptible crop for 3 years.  Plow under old beds as soon as possible to avoid spread of the insect to new beds.  Adult beetles hide in the soil during the day and feed at night.	The highest rate (16 oz.) of <b>Brigade</b> is needed to obtain control of black vine weevil (best if applied at night).  Apply nematodes in early- to mid-May or mid- to late-August as a band treatment. Application rates are given for the treated area. Irrigate prior to and following the nematode spray.  Contact your local Extension Specialist information about obtaining biologicals.
Two-spotted spider mite (TSSM)	Kelthane 35WP, 1-3 lb (3) *Agri-Mek 0.15EC, 16 oz (3) Savey 50WP, 6 oz (3) Vendex 50WP, 1.5-2 lb (1) Sunspray Ultra-fine Oil 1% (0) Stylet Oil, 3 qts. (0) Trilogy (Neem), 1-2% solution (0)	Scout for presence of predator mite <i>Neoseiulus fallacis</i> ; release 5-10,000 per acre if TSSM population exceeds 2/leaf and no predators are found.  Contact your local Extension Specialist for sources of predatory mites.	Consult your Extension Specialist for help identifying mite predators.  <b>Agri-Mek</b> applied at a lower rate (6 oz.) selectively kills spider mites. The full rate (16 oz.) kills predatory mites.  <b>Savey 50WP</b> may be used for only one application per year.  <b>Sun Spray Ultra-fine oil</b> and <b>Stylet Oil</b> require direct contact to kill mites and their eggs. Oil is phytotoxic in combination with captan residues.
Cyclamen Mites	Thiodan 3EC, 2.6 qt (4) Kelthane 35WP, 4-6 3/4 lb (2)	Predator mites may be effective against cyclamen mites. Check source list in the back for suppliers.	High gallonage (400 gal/A), wetting agent and foliar agitation usually needed for satisfactory control.
Leafhopper	Malathion 57EC, 1.5 - 3 pt (3) Cythion 5E, 1.5 - 2.5 pts (3) Sevin 50W, 2-4 lbs (7)	Plants may be able to tolerate some of this injury without long-lasting damage.	Leafhoppers can infest new or old planting and symptoms show up especially well during runner production.

Table 20 continued. Strawberry pest management schedule<sup>†</sup>.

<b>Summer (Post-harvest)</b>			
<b>Pest</b>	<b>Spray Material, Rate/A (pre-harvest interval)</b>	<b>Cultural Practices and Scouting Notes</b>	<b>Comments</b>
Aphid	Thiodan 50WP, 2 lb (4) Malathion 57EC, 1.5 - 3 pt (3) Cythion 5E, 1.5 - 3pts (3) Diazinon 50WP, 1 lb (5) Pyrenone Crop Spray, 12 oz (0)		Aphids are significant vectors of virus diseases. If virus spread is of concern, aphids should be controlled in the spring and fall when winged forms are building up.  See note on <b>Thiodan</b> under tarnished plant bug comments.
Powdery Mildew	Topsin-M 70WP, 8 oz (1) <b>plus</b> Captan 50WP, 3-4 lb (0)  <b>Or, use alone:</b> Stylect Oil, 3 qts. (0) Kumulus (sulfur), 5-10 lbs (0) Quadris, 6.2-15.4 oz (0)	Plant beds in such a way as to maximize the air circulation and drying of foliage.	Cultivars vary in their susceptibility to powdery mildew. <b>Captan</b> has a 0 day phi, but the REI of 24 hrs requires that PPE be worn during this period. <b>Quadris</b> may be applied no more than 4 times/year and must be alternated with a fungicide with a different mode of action. Do not use near apple tree or in a sprayer that is also used on apple trees or severe injury may occur on <del>some apple varieties.</del>
Leaf spot	Captan 50WP, 3 lb (0)	Improve air circulation by narrowing row width, increasing distance between rows, and raising beds. This will allow faster drying after rain, irrigation, and dew.  Remove or thoroughly incorporate leaf debris from field at renovation. This helps disrupt the disease cycle of these fungi.	Fungicide applications for gray mold will treat leaf spots as well.  <b>Captan</b> requires protective clothing be worn in field for 24 hrs following application.
Leaf scorch	Thiram 65WP, 2.5 lb (3)		
Leaf blight	Kocide 101, 2-3 lb (0) NuCop 3L, 1 1/3 - 4 pts (0)		
Red Stele	Ridomil Gold EC, 1 pt (0) Aliette WDG, 2.5 - 5 lb (0)	Proper site selection and preparation to avoid prolonged periods of "wet feet" should be the primary control strategy for this disease.	Early spring or fall applications are recommended for control of red stele in emergency situations only.  Use sufficient water to move the <b>Ridomil Gold</b> into the root zone. There is no preharvest interval for this application. Routine or preventative application of these materials is not recommended.

<sup>†</sup>Where brand names for chemicals are used, it is for the reader's information. No endorsement is implied, nor is discrimination intended against products with similar ingredients. Please consult pesticide product labels for rates, application instructions and safety precautions. Users of these products assume all associated risks.

\*Restricted use pesticide; pesticide applicators license required.