Crop Profile for Strawberries in New England 2005

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Note:This profile is a comprehensive list of pests that may be encountered by New England strawberry effective options are listed. If treatment is needed, only one of those options would be used per application. Some pests require multiple applications for control; others only require a single application.

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Group C - identified by survey as infrequent problems
Bacterial Angular Leaf spot (*Xanthomonas fragariae*)
Verticillium Wilt (*Verticillium albo-atrum*)
Anthracnose (*Colletotrichum* spp.)

Introduction

Information in this crop profile was collected by a survey of New England strawberry growers conducted in 2004. Number of survey respondents, response rate etc.

I. Basic Commodity Information

Production Statistics

Region Rank:.....8 (6 states considered as a single unit)
% U.S. Production:..... 18%
Acres Planted:..... 1,191
Tons Harvested:..... 5,215
Cash Value:.....$18.8 million
Crop Destination:…….. 100% Fresh Market
Production Regions – Acres or other production units as appropriate**:** Connecticut (206), Massachusetts (267), New Hampshire (133), Maine (354), Rhode Island (43), Vermont (188).
Values were determined from New England Strawberry Pest Management Tactic Survey conducted by New England Pest Management Network in 2004, 2002 Census of Agriculture Volume 1, State Level Data (www.nass.usda.gov/census/census02/volume1/), New England Fruits and Vegetables 2004 crop report (www.nass.usda.gov/nh/05frtveg.pdf) and from New England Agricultural Statistics Service State Rankings from 2002 Census (http://www.nass.usda.gov/nh/2002cenrk.pdf)

Cultural Practices:

Most strawberries in New England are grown in matted-row culture. In this system mother plants are established in the planting year and allowed to produce daughter plants via runners within a certain row width thereby producing solid mats of plants. Field dug dormant mother plants are set out in mid-spring (18" in row spacing, 36" to 60" between row spacing), and are not allowed to set fruit until the following year. Strawberries ripen within 28-30 days after the first bloom and are harvested normally every other day for about 6 to 7 pickings. Bearing plantings are renovated each year in July, after harvest. This consists of an herbicide application, mowing foliage, narrowing the rows to 18", turning in the mulch between rows, fertilizing, irrigating and then allowing runner plants to regrow. The most commonly grown cultivars in New England are 'Darselect', 'Jewel', 'Honeoye', and 'Earliglow'. Plantings are generally fruited for 3-5 years.

Strawberries can grow successfully in a wide variety of New England's soils (e.g., deep river bottom soil of the Connecticut River valley to stony glacial soils of the uplands to the sandy coastal soils). However, to avoid root stress strawberry land should be well drained year-round (no standing water) though not droughty. Where there is a tendency for droughtiness, irrigation is a must. Strawberries prefer a soil pH between 5.5-6.5 with a high organic matter content (≥5%). Best production is often on new land not previously planted to strawberries. Productivity tends to decline on 'old' strawberry land although good rotation programs can delay this decline.

June bearing cultivars are the most common in New England. The harvest season for these cultivars range from late May to mid July. Bloom on these cultivars is early to mid May and spring frosts are an annual concern. Overhead irrigation and row covers are used to protect the blossoms from frost damage.

Some growers are experimenting with a new production system sometimes referred to as plasticulture because of its use of plastic mulch in the planting rows. In this system tissue cultured plug plants or dormant crowns are planted in mid to late July through early September. Row covers are then applied to the field to extend the growing season and delay the onset of dormancy. Production in this system is dependent on branch crown formation on the mother plant during the fall under the row covers. Runners are removed and plants set fruit in the spring, usually 10 – 14 days earlier than strawberries grown in a matted row. The main reasons for employing this system are reduced weed competition, less time between planting to harvest, and an earlier harvest season (leading to higher market prices). Some growers treat the system annual while others may carry the beds over for 2-3 years. In the latter case, runner control and plastic mulch degradation are concerns to be addressed. 'Chandler' is the most commonly grown cultivar for this system.

Weed control is a major concern in strawberry production. New strawberry fields are planted between April 15 and May 30. Immediately after planting, residual herbicides are often applied to cultivated soil as pre-emergent weed control. Additional residual and systemic herbicides are used to reduce emerging weeds in late summer and early fall. After planting, flowers are removed to increase plant growth and runner formation. If the soil contains adequate minor and major elements, applications of 25 to 40 lb./A of actual nitrogen are applied 10 to 14 days after planting and the same amount in August to promote flower bud formation. Irrigation may be used several times during the low rainfall period of July and August. In addition to herbicide applications for weed control, insecticides and fungicides are used in conventional commercial production to control key insect pests and diseases described in detail below. Most strawberry growers in New England have adopted some or all recommended IPM practices for pest management in their fields to increase efficacy of pesticides while minimizing pesticide use.

In established fruiting fields, heavy nitrogen applications are not recommended until after harvest to avoid excessive foliage growth and soft fruit although many growers apply 10 to 30 lbs of Nitrogen to stimulate spring growth. After harvest, fertilizer is typically applied as part of the renovation process and again in late summer to help stimulate flower bud initiation. After renovation, as the foliage is regrowing, it is important to irrigate strawberry fields during hot dry periods to promote rapid regrowth of the plants.

As winter approaches a preemergence herbicide is often applied and then mulch is applied to strawberry plants (2 to 4 tons of straw per acre) to minimize damage from freezing temperatures. Mulch is applied once the ground is frozen, usually late November to mid-December. The mulch is then removed in early spring followed by an

herbicide application if no herbicide was applied in the fall. Some growers then apply spun bonded row covers over a portion of their fields to accelerate growth and ripening and advance the harvest season by 1-2 weeks.

Harvested fruit is sold as fresh market retail (27%), U-Pick (58%), fresh market wholesale (14%), processing and CSA (<1%). Growers describe their production systems as conventional (45.2%), IPM (53%), Organic (12.9%), and other (4.3%).

WORKER ACTIVITIES

Soil Fumigation

- Fewer than 5% of growers use this practice, but those who do are trying to overcome a serious disease, insect, and/or weed infestations on a particular planting site.
- This practice is performed in the fall prior to the planting year.
- This is a tractor operation so, if performed properly, the only point of potential worker exposure is at the mixing and loading site. PPE should be used for mixing and loading.
- This practice is usually carried out by a contracted applicator, not the farmer, since the application equipment is specialized.

Land preparation and cultivation

- These activities include clearing, plowing, rock removal, adding required soil amendments, harrowing, and sometimes bed forming (46% of New England strawberry growers) and laying plastic mulch (24% of New England strawberry growers), and are needed to fit the land suitably for planting and production.
- These activities are performed in the fall prior to the planting year and in the spring of the planting year.
- These are tractor operations to prepare soil for planting and to manage weeds. Little contact by workers with pesticide treated surfaces.

Planting

- Dormant bare-root plants are the most common type of planting material (69% of New England strawberry growers). Some growers use tissue cultured plug plants (14% New England strawberry growers). Plants are set w/ mechanical transplanters on most commercial farms. Very small operations may use hand transplanting.
- This activity is performed in mid-April to mid-May on most New England strawberry farms.
- Transplants are not typically pesticide treated, so worker exposure to pesticides is minimal.

Blossom Removal (Establishment Year Only)

- During the establishment year, plants are not allowed to fruit, so that plants can partition energy to growing a strong root system, large crown, and runners w/ daughter plants to fill in the row. This is accomplished by removing blossoms as they appear.
- Blossom removal is done 4-6 weeks after planting which is generally the middle of June.
- This is a hand labor activity, but few, if any, pesticides are applied to plants prior to bloom in the establishment year. If pre-emergent herbicides have been applied, it is generally before much foliage has grown on the plants, so the likelihood of residue on plant parts is low.

Fertilization

- Strawberry fields are fertilized periodically in the establishment and production years. To determine fertilizer needs, some growers collect soil samples (72% of New England strawberry growers) and/or leaf tissue samples (31% of New England strawberry growers) for analysis.
- Timing of fertilizer applications is generally mid summer and early fall. Timing of soil sampling can be any time of the year, while tissue samples are collected for analysis in August.
- Fertilizer application is a tractor operation so worker exposure to pesticide treated surfaces is negligible. Worker exposure to pesticide residues during soil sampling depends on when samples are collected. It is possible to collect samples in a manner and at a time of year when pesticide exposure is minimal. Collection of leaf tissue samples is done after renovation when new foliage has grown which is unlikely to be treated with pesticides. Never-the-less, it is recommended that samples are collected by workers wearing gloves.

Harvest

- Fruit is harvested for sale.
- Harvest is carried out by hired pickers and Pick-Your-Own customers.
- The harvest period for most varieties grown in New England ranges from the end of May to the middle of July.
- Pesticides are used prior to harvest on conventional farms. If all required pre-harvest intervals and restricted entry intervals are observed, worker and customer exposure to pesticide residues should be minimal. However, harvesting required significant contact with the plants and plant surfaces my have been treated with pesticides.

Mulch Application/Removal

- Strawberry plants need protection from severe winter temperatures and from fluctuating periods of freezing and thawing. This is accomplished by the use of mulch (usually straw) applied over the top of the rows. Mulch is removed from the rows for the growing season by raking it to the inter-row alleys. There it provides weed suppression and a comfortable walking surface for pickers. After

harvest, it is tilled into the soil, providing organic matter.

- Mulch is applied to the field in late November or early December and removed in early spring as soon as the plants begin to show some growth (late March or early April).
- Mulch application is usually a mechanized practice in most cases and worker contact with pesticide treated surfaces is negligible.

Row-cover Installation

- Some growers (38% of New England strawberry growers) use spun bonded row covers on some parts of fields in order to speed up growth and fruit development by creating a 'greenhouse' environment.
- If used, these covers are spread over the field in March or April and removed as soon as the plants beneath them reach bloom. They must be removed at bloom to allow for wind and insect pollination of the flowers.
- No pesticides are applied prior to the setting out of row covers, and workers are generally not contacting plants during this operation, so worker exposure to pesticide treated surfaces is negligible.

Irrigation

- Irrigation is used for three potential purposes in strawberry production. The first, chronologically, is for frost protection. The second is to deliver water (and sometimes fertilizer) to plants. The third is for evaporative cooling in the fields during the harvest period if it is severely hot.
- Irrigation for frost protection is during the bloom period, which is generally in May. Irrigation for the plants water needs can be any time of the growing season when there is inadequate rainfall to support optimal plant growth. Irrigation for evaporative cooling is carried out during the harvest period and is generally late June or early July.
- Irrigation is mostly an automated operation with either overhead sprinklers (70% of New England strawberry growers) or drip irrigation (32% of New England strawberry growers). Either system is usually set up prior to any pesticide applications to the fields, so worker exposure to treated surfaces is minimal, except where repairs may be needed.

Field Scouting for Integrated Pest Management (IPM)

- Many strawberry growers (53% of New England strawberry growers) practice IPM. This involves regular scouting of fields to determine if action thresholds for various pests have been exceeded and control measures are required to avoid economic loss.
- Detailed field sampling procedures are followed to make these determinations and fields are scouted weekly during the time beginning in late April through harvest and less frequently thereafter.
- Worker contact with potentially pesticide treated surfaces is high as they carry out field scouting. This risk is mitigated by strict adherence to restricted entry intervals. Scouts must consult WPS information prior to entering a field.

Pest Management Pesticide Use Overview:

- 97.8% of respondents reported spraying for **insects** an average of 2.12 times per season.
- 87.9% of respondents reported spraying for **mites** an average of 0.61 times per season.
- 98.9% of respondents reported spraying for **weeds** an average of 2.09 times per season.
- 96.7% of respondents reported spraying for **diseases** an average of 3.08 times per season.

II. INSECTS AND MITES

Group A – Insect and mite pests identified by New England Growers as most important
..... Tarnished plant bug, strawberry bud weevil, leaf hoppers, spittlebug

Group B – Insect and mite pests identified by New England Growers to be significant problems in some years
..... Two spotted spider mite, root weevils, strawberry sap beetle, white grubs

Group C – Insect and mite pests identified by New England Growers as infrequent pest problem
..... Strawberry root worm, strawberry leaf rollers, cyclamen mite, cutworms, thrips

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Group A – Insect and mite pests identified by New England Growers as most important

Tarnished Plant Bug *(Lygus lineolaris)*
Type of Pest: Insect
Biology: Adult tarnished plant bugs are 1/4 inch long, brownish in color and marked with yellow and black dashes. They overwinter in vegetation and stubble that provide protection from the extreme cold. In the spring the adults are attracted to flower buds and shoot tips of many plants, including strawberries. The females lay eggs in April and early May in the plant tissue. There are several generations of tarnished plant bugs each year, so adults and nymphs can be found from April or May until a heavy frost in the fall.
Frequency of Occurrence: 83.9% of respondents reported this pest occurring at least occasionally.

Control needed	Percent of growers
Annually	68%
Occasionally	16%
Rarely	9%
Never	7%

Damage Caused: The nymphs emerge in one week and feed on developing seed during and after bloom or from the receptacle of developing fruit. At the same time, their feeding kills surrounding tissue and leads to small seedy strawberries with a woody texture that fail to mature. This injury is called "button berry" and these fruits are unmarketable.
% Acres Affected: 87% of strawberry acres affected annually.
Timing of Control: Apply insecticide prior to bloom if scouting results indicate presence of egg laying females, DO NOT SPRAY INSECTICIDES DURING BLOOM. After bloom scout fields for nymphs and apply insecticide if action threshold is

exceeded. Consult Cooperative Extension for information on thresholds.
Yield Losses: 70% without management, 5% with management
Regional Differences: None identified.
Cultural Control Practices: Since they have a wide host range, reducing weeds in areas surrounding the field may aid in control these migrating pests. Avoid mowing around planting during bloom. Avoid use of broad spectrum insecticides on strawberries and surrounding crops to encourage predators (esp. spiders) and parasites. Also, row covers accelerate development and help avoid injury.
Biological Control Practices: There are several predators and parasites of tarnished plan bugs including the egg parasite *Anaphis iole* Girault, and the nymphal parasites *Leiophron uniformis* (Gahan), *Peristenus pallipes* (Curtis) and *P. pseudopallipes* (Loan) (all Hymenoptera). The native parasites seem to be more effective at parasitizing Lygus on weeds than on crops. The imported parasitoid *Peristenus digoneutis* Loan (Hymenoptera: Braconidae) is reported to have decreased tarnished plant bug abundance by 75% in New Jersey but there is no current data available for this parasitoid in New England. None are commercially available at this time. *Beauveria bassiana* (BotaniGard ES) is a fungal pathogen of Lygus bugs that is available commercially. But, these products are expensive.
Postharvest Control Practices: Reducing weeds in areas surrounding the field may aid in control these migrating pests.
Other Issues: None identified.

Chemical Controls for *Tarnished Plant Bug*:

Pesticide (listed alphabetically)	**Survey Data (% growers reporting use, % acreage, efficacy rating)**	**Typical Dose (a.i./A)**	**Of Respondents, Rate Reported**	**PHI days**	**REI hours**	**Comments & Application Notes**
azinphos methyl (Guthion 2L, Solupak, Sniper WSP)	1% growers <1% acres 100% good efficacy	0.5 lb	100% reduced rate	5	48	Restricted use material
bifenthrin (Brigade WSB)	22% growers 38.2% acres 37% excellent efficacy 63% good efficacy	0.04-0.2 lb	79% full rate 11% reduced rate	0	12	Restricted use material Broad spectrum; harmful to beneficials
carbaryl (Sevin 80S, 80WSB, XLR)	6% growers 5% acres 20% excellent efficacy 60% good efficacy 20% poor efficacy	1.5-2.0 lb	40% full rate 60% reduced rate	7	12	

endosulfan (Phaser 3EC or Thiodan EC)	44% growers 48% acres 54% excellent efficacy 33% good efficacy 13% poor efficacy	0.23-0.34 lb	78% full rate 22% reduced rate	4	24	
fenpropathrin (Danitol 2EC)	10% growers 18% acres 56% excellent efficacy 44% good efficacy	0.2 lb	67% full rate 33% reduced rate	2	24	Restricted use material Broad spectrum; harmful to beneficials
malathion (Malathion 57EC)	13% growers 15% acres 17% excellent efficacy 33% good efficacy 50% poor efficacy	0.95-1.9 lb	80% full rate 20% reduced rate	3	12	
naled (Dibrom 8EC)	9% growers 15% acres 63% excellent efficacy 37% good efficacy	0.56 lb	88% full rate 12% reduced rate	1	24	
Other Pesticides						
hydrogen Dioxide (OxiDate)	1% growers 2% acres 100% good efficacy	10.8-34.6 fl. oz.	100% full rate	0	1	OMRI listed TPB not listed on label as controlled

Strawberry Bud Weevil aka 'Clipper' *(Anthonomus signatus)*
Type of Pest: Insect
Biology: The beetles overwinter in fence rows and woodlots. Once temperatures reach 60˚F the clippers move to nearby early budding plants such as strawberries. The adults feed on the immature pollen of the blossom buds and then females deposit one egg inside the bud. The clipper girdles the bud and clips the stem, causing the bud to hang down or fall to the ground. In about a week, the egg hatches into a white, legless grub. The larva develops inside the bud and reaches maturity in three to four weeks. Adult clippers, which are dark, reddish-brown weevils about 1/10-inch long, with a head prolonged into a thin curved snout about half as long as the body; emerge from the buds in late June through July. After feeding on the pollen from various flowers for a short time, the new adults seek hibernating sites and remain there until the next spring. Only one generation of clippers appears each year.
Frequency of Occurrence: 64% of respondents reported this pest occurring at least occasionally.

Control needed	Percent of growers
Annually	44%
Occasionally	20%
Rarely	24%
Never	13%

Damage Caused: Fruit fails to develop from buds in which eggs are deposited.
% Acres Affected: 64% of strawberry acres affected annually.
Timing of Control: Apply insecticide pre-bloom if scouting results indicate presence of this pests or field history of damage is high. In some cases, border row treatments may be sufficient. DO NOT SPRAY INSECTICIDES DURING BLOOM. Consult Cooperative Extension for information on thresholds.
Yield Losses: 40% without management, <2% with management.
Regional Differences: None identified.
Cultural Control Practices: Mulches and full-canopy beds may encourage newly emerged adults to remain in the planting so that damage increases in succeeding years. Keeping field in production for no more than three years, plowing under all old beds immediately after the final harvest help to lessen the chances of clipper injury. Early renovation of established beds may reduce injury. Also, separation of fields from other hosts (esp. brambles) may reduce pest abundance. Some cultivars, e.g., 'Seneca' and 'Jewel' have been shown to strongly compensate for injury with increase size of secondary and tertiary fruit when primary buds are compromised by oviposition.
Biological Control Practices: None identified.
Postharvest Control Practices: Timely renovation or plowing in of fields not to be carried over, can help suppress populations of strawberry bud weevil.
Other Issues: Bifenthrin is a broad spectrum pyrethroid and will kill pest and beneficial arthropods. Frequent use may disrupt biological control of spider mites resulting in mite outbreaks.

Chemical Controls for *Strawberry Bud Weevil*:

Pesticide (listed alphabetically)	**Survey Data (% growers reporting use, % acreage, efficacy rating)**	**Typical Dose (a.i./A)**	**Of Respondents, Rate Reported**	**PHI days**	**REI hours**	**Comments & Application Notes**
azinphos methyl (Guthion 2L, Solupak, Sniper WSP)	20% growers 22% acres 94% excellent efficacy 6% good efficacy	0.5 lb	69% full rate 31% reduced rate	5	48	Restricted use material
bifenthrin (Brigade WSB)	20% growers 34% acres 56% excellent efficacy 44% good efficacy	0.04-0.2 lb	65% full rate 35% reduced rate	0	12	Restricted use material Broad spectrum; harmful to beneficials
carbaryl (Sevin 80S, 80WSB, XLR)	11% growers 13% acres 75% excellent efficacy 25% good efficacy	1.5-2.0 lb	67% full rate 33% reduced rate	7	12	
Other Pesticides						
chlorpyrifos (Lorsban 4E)	3% growers 4% acres 67% excellent efficacy 33% good efficacy	0.99 lb	100% full rate	21	24	Restricted use material

malathion (Malathion 57EC)	1% growers 1% acres 100% excellent efficacy	0.95-1.9 lb	100% full rate	3	12	
methoxychlor (Methoxychlor 50WP)	1% growers 2% acres 100% excellent efficacy	1.78 lb	100% reduced rate			No longer available

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Potato Leafhopper *(Empoasca fabae)*
Type of Pest: Insect
Biology: The most common leafhopper on strawberries is the potato leafhopper. Leafhoppers are approximately 1/8 inch long, green and bullet-shaped insects that take flight quickly if disturbed. Their nymphs are light green, do not fly and crawl sideways when disturbed. They feed mostly on the undersides of strawberry leaves. This feeding causes the leaves to yellow between the veins and become curled and distorted. Growth of new plantings may be severely stunted under heavy infestation. Most serious damage is done in the late spring and early summer.
Frequency of Occurrence: 56.39% of respondents reported this pest occurring at least occasionally.

Control needed	Percent of growers
Annually	23%
Occasionally	33%
Rarely	28%
Never	15%

Damage Caused: Feeding injury on leaves causes distorted growth. No direct damage to fruit, but overall plant health can be affected, especially new plantings.
% Acres Affected: 30% of strawberry acres affected annually.
Timing of Control: Generally in late summer, post-harvest.
Yield Losses: no direct impact on yield.
Regional Differences: None identified.
Cultural Control Practices: None identified.
Biological Control Practices: None identified.
Postharvest Control Practices: Postharvest is when most control measures are taken.
Other Issues: None identified.

Chemical Controls for *Potato Leafhopper*:

Pesticide (listed alphabetically)	**Survey Data (% growers reporting use, % acreage, efficacy rating)**	**Typical Dose (a.i./A)**	**Of Respondents, Rate Reported**	**PHI days**	**REI hours**	**Comments & Application Notes**
malathion (Malathion 57EC, Cythion)	21% growers 16% acres 27% excellent efficacy 73% good efficacy	0.95-1.9 lb	78% full rate 22% reduced rate	3	12	
Other Pesticides						
carbaryl (Sevin 80S, 80WSB, XLR)	8% growers 8% acres 57% excellent efficacy 43% good efficacy	1.5-2.0 lb	71% full rate 29% reduced rate	7	12	
endosulfan (Phaser 3EC or Thiodan EC)	5% growers 7% acres 25% excellent efficacy 75% good efficacy	0.23-0.34 lb	67% full rate 33% reduced rate	4	24	
pyrethrins (Pyganic EC1.4)	1.19% growers <1% acres 63% excellent efficacy 37% good efficacy	0.56 lb	100% full rate	0	12	OMRI Listed

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Meadow Spittlebug *(Philaenus spumaris)*
Type of Pest: Insect
Biology: Spittlebugs overwinter as egg masses in strawberry stubble and other hosts such as forage crops. Nymphs will emerge in April and May and complete their development in 5 to 8 weeks. Spittlebugs first feed at the base of plants but later move up to the more tender foliage and blossom clusters during bloom. They pierce the plant and suck on its sap. The soft-bodied nymphs colored from yellow to green will produce a frothy material and remain in this protective substance until developing into adults. Adult spittlebugs will lay their eggs in September and October. The eggs are inserted into the lower parts of the strawberry plant. Only one generation of spittlebugs are produced each year.
Frequency of Occurrence: 49.40% of respondents reported this pest occurring

Control needed	Percent of growers
Annually	24%
Occasionally	26%
Rarely	31%
Never	20%

Damage Caused: The feeding activity causes the plants to become stunted and berries will not attain full size. The spittle masses are bothersome to strawberry pickers.
% Acres Affected: 25% of strawberry acres affected annually.
Timing of Control: Immediate pre-bloom or post-bloom.
Yield Losses: no direct impact on yield but high populations can sap vigor of plants, thereby reducing yield. Harvest may be impeded if customers are sufficiently disturbed by spittle masses.
Regional Differences: None identified.
Cultural Control Practices: Populations are usually largest in weedy fields. Only one generation is produced per year. The leaves recover after the insects leave.
Biological Control Practices: None identified.
Postharvest Control Practices: Weed suppression.
Other Issues: None identified.

Chemical Controls for *Meadow Spittlebug*:

Pesticide (listed alphabetically)	**Survey Data (% growers reporting use, % acreage, efficacy rating)**	**Typical Dose (a.i./A)**	**Of Respondents, Rate Reported**	**PHI days**	**REI hours**	**Comments & Application Notes**
permethrin (Ambush)	3% growers 2% acres 100% excellent efficacy		100% full rate			Restricted use material Broad spectrum; harmful to beneficials
carbaryl (Sevin 80S, 80WSB, XLR)	11% growers 13% acres 33% excellent efficacy 67% good efficacy	1.5-2.0 lb	75% full rate 25% reduced rate	7	12	
Other Pesticides						
azinphos methyl (Guthion 2L, Solupak, Sniper WSP)	14% growers 2% acres 100% excellent efficacy	0.5 lb	100% full rate	5	48	Restricted use material

bifenthrin (Brigade WSB)	14% growers 6% acres 50% excellent efficacy 50% good efficacy	0.04-0.2 lb	50% full rate 50% no rate identified	0	12	Restricted use material Broad spectrum; harmful to beneficials
endosulfan (Phaser 3EC or Thiodan EC)	4% growers 4% acres 50% excellent efficacy 50% good efficacy	0.23-0.34 lb	33% full rate 67% reduced rate	4	24	

Group B – Insect and mite pests identified by New England Growers to be significant problems in some years

Two spotted spider mite (*Tetranychus urticae*)
Type of Pest: Mite
Biology: This pest can cause significant problems when severe infestations occur. The adult mite is only about 1/50 inch in length and its color varies from pale greenish yellow to dark crimson, usually with dark spots. Adults feed and deposit eggs on the underside of the leaf and in a heavy infestation, a tangle of fine, silken threads can be found there. The mites suck sap from the leaves which can cause them to lose their healthy green color and turn coppery-bronze. The life cycle of the mite varies but usually is completed in two weeks. New broods can be produced continuously from early spring to late fall. Mite population increases are more severe in hot, dry weather. The mites overwinter as mature fertile females in protected areas in the fields.
Frequency of Occurrence: 49.4% of respondents reported this pest occurring

Control needed	Percent of growers
Annually	23%
Occasionally	27%
Rarely	34%
Never	17%

Damage Caused: Mites suck sap and chlorophyll from leaves, weakening the plants. The feeding activity causes the plants to become stunted and berries will not attain full size. Webbing and presence of mites on fruit can reduce market value.
% Acres Affected: 32% of strawberry acres affected annually.
Timing of Control: post-bloom through harvest and sometimes post harvest.
Yield Losses: no direct impact on yield but high populations can sap vigor of plants, thereby reducing yield. Presence of mites on fruit can reduce sales in PYO situations.
Regional Differences: None identified.
Cultural Control Practices: Reduced nitrogen applications can suppress build-up of mite populations. Some variation among cultivars has been reported.
Biological Control Practices: Various mite predators commercially available including *Phytoseiulus persimilis* and *Neoseiulus fallacis*. Excellent control from releases of *Neoseiulus fallacis*, a mite predator, is reported if done early enough to avoid excessive pest mite populations.
Postharvest Control Practices: Predator mite releases.
Other Issues: None identified.

Chemical Controls for *Two-spotted spider mite*:

Pesticide (listed alphabetically)	**Survey Data (% growers reporting use, % acreage, efficacy rating)**	**Typical Dose (a.i./A)**	**Of Respondents, Rate Reported**	**PHI days**	**REI hours**	**Comments & Application Notes**
abamectin (Agri-Mek 0.15 EC)	13% growers 14% acres 45% excellent efficacy 55% good efficacy	0.02 lb	91% full rate 9% reduced rate	3	12	Restricted use material
bifenthrin (Brigade WSB)	5% growers 9% acres 50% excellent efficacy 25% good efficacy 25% poor efficacy	0.04-0.2 lb	50% full rate 50% reduced rate	0	12	Restricted use material Broad spectrum; harmful to beneficials
dicofol (Kelthane)	8% growers 3% acres 100% good efficacy	0.5-1.0 lb	60% full rate 40% reduced rate	3	48	
fenpropathrin (Danitol 2.4EC)	7% growers 6% acres 50% excellent efficacy 50% good efficacy	0.2 lb	80% full rate 20% reduced rate	2	24	Restricted use material Broad spectrum; harmful to beneficials
malathion (Cythion)	1% growers <1%acres 100% good efficacy	0.95-1.9 lb	100% full rate	3	12	
naled (Dibrom 8EC)	2% growers 3% acres 100% good efficacy	0.56 lb	50% full rate 50% reduced rate	1	24	
Other Pesticides						
bifenazate (Acramite 50WS)	1% growers 2% acres 100% good efficacy	0.37 – 0.5 lb	100% full rate	1	12	
paraffinic oil (JMS Stylet oil)	2% growers 3% acres 50% excellent efficacy 50% good efficacy	0.73 gal	100% full rate	0	4	OMRI listed

pyrethrins (Pyganic EC 5.0)	1% growers <1% acres 100% good efficacy	0.8 oz	100% reduced rate	0	12	OMRI listed Broad spectrum; harmful to beneficials

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Root Weevils (*Otiorhynchus* spp., *Polydrusus* spp.)
Type of Pest: Insect
Biology: Different species (but most commonly the strawberry root weevil, the black vine weevil, and the rough strawberry root weevil) attack the roots and crowns of plants while in the grub stage. All have a one-year life cycle, although some are known to live two seasons. Adults emerge about late June. Beds with heavy infestations show distinct patches or spots that appear stunted and have substantially reduced yields. The roots of injured plants are badly eaten away, and continued infestation may completely destroy the plants.
Frequency of Occurrence: 47% of respondents reported this pest occurring at least occasionally.

Control needed	Percent of growers
Annually	32%
Occasionally	15%
Rarely	32%
Never	21%

Damage Caused: Adult weevils feed on foliage in the mid-summer, but this damage usually does not significantly impact yield. Larvae of these insects feed on the roots which can both significantly weaken plants and provide entry sites for root pathogens like *Rhizoctonia*, *Pythium*, and *Phytophthora*. Although the root feeding by the larvae is of greatest concern, the adults are easier to control since they are above the ground and feeding on foliage.
% Acres Affected: 27% of strawberry acres affected annually.
Timing of Control: post-harvest and sometimes post renovation.
Yield Losses: no direct impact on yield but high populations can sap vigor of plants, thereby reducing yield. Yield losses can approach 100% due to plant mortality and/or loss of vigor.
Regional Differences: None identified.
Cultural Control Practices: Crop rotation to non-susceptible crop(s) for at least 3 years or fallowing in combination with fall cover crops for 2 years. Maintain trap crop of old infested planting at edge of field during adult migration in July to prevent spread of infestation to other fields. Some varieties appear to have more tolerance for root weevils.
Biological Control Practices: A biological larvicide (Exhibit) containing parasitic

nematodes (*Steinernema carpocapsae*) spot applied to problem areas in late September to early October, and again in late April to early May, when larvae are close to the surface.

Postharvest Control Practices: Insecticides aimed at feeding adults are applied after harvest is complete (sometimes at night) and before foliage is mowed off at renovation. Fields that are being discontinued should be plowed under as soon as possible which increases mortality of adults. Prevent migrating adults by leaving trap crop of infested plants at edge of field until after oviposition (egg laying) is complete, then plow down.

Other Issues: Bifenthrin is a broad spectrum pyrethroid and will kill pest and beneficial arthropods. Frequent use may disrupt biological control of spider mites resulting in mite outbreaks.

Chemical Controls for Root Weevils:

Pesticide (listed alphabetically)	**Survey Data (% growers reporting use, % acreage, efficacy rating)**	**Typical Dose (a.i./A)**	**Of Respondents, Rate Reported**	**PHI days**	**REI hours**	**Comments & Application Notes**
bifenthrin (Brigade WSB)	14% growers 11% acres 40% excellent efficacy 50% good efficacy 10% poor efficacy	0.04-0.2 lb	85% full rate 15% reduced rate	0	12	Restricted use material Broad spectrum; harmful to beneficials
malathion (Malathion 57EC)	4% growers 3% acres 33% excellent efficacy 33% good efficacy 34% poor efficacy	0.95-1.9 lb	67% full rate 33% reduced rate	3	12	
Other Pesticides						
carbaryl (Diazinon) (Sevin 80S, 80WSB, XLR)	1% growers 2% acres 100% good efficacy	1.5-2.0 lb	100% reduced rate	7	12	
esfenvalerate (Asana XL)	1% growers 3% acres 100% good efficacy	0.05 lb	100% reduced rate			Restricted use material Broad spectrum; harmful to beneficials

fenpropathrin (Danitol 2.4EC)	1% growers 2% acres 100% excellent efficacy	0.2 lb	100% full rate	2	24	Restricted Use Material
imidacloprid (Admire 2F)	2% growers 3% acres 50% excellent efficacy 50% good efficacy	0.38 – 0.50 lb	100% full rate	14	12	
methyl bromide + chloropicrin (Terr-O-Gas 33)	1% growers 2% acres 100% excellent efficacy	725 lbs	no rate reported			Soil Fumigation Restricted use material
Other Strategies						
predatory nematodes	6% growers 5% acres 25% excellent efficacy 25% good efficacy 50% poor efficacy	Unknown	no rate reported	0	0	

Strawberry Sap Beetle (*Stelidota geminata*)
Type of Pest: Insect
Biology: Sap beetles make cavities in ripe fruit, spread spores of decay organisms, and deposit eggs in berries. Until a few years ago sap beetles were uncommon in strawberries. Now sap beetles are becoming much more common, especially in PYO fields. Two species feed on strawberry fruits -- the common picnic beetle, 1/4 inch long with four yellow spots on the back -- and the smaller, brown strawberry sap beetle without distinctive markings.
Frequency of Occurrence: 40.3% of respondents reported this pest occurring at least occasionally.

Control needed	Percent of growers
Annually	17%
Occasionally	23%
Rarely	40%
Never	20%

Damage Caused: Adult sap beetles chew cavities in ripe fruit, making them unmarketable.
% Acres Affected: 17% of strawberry acres affected annually.
Timing of Control: post-bloom through harvest and sometimes post harvest.
Yield Losses: 40% without management, <10% with management
Regional Differences: None identified.
Cultural Control Practices: fastidious harvesting, leaving no ripe berries in the field will reduce the build-up of this pest. This is nearly impossible especially in PYO fields. Need effective affordable traps.
Biological Control Practices: None identified.
Postharvest Control Practices: Early renovation can help reduce populations.
Other Issues: Control of this pest with insecticides is difficult because of the protection afforded the insect by creating a cavity in the fruit. Contact with the pest is difficult and the pest is eating untreated tissue and because of pre-harvest interval restrictions for labeled materials. A better understanding of the life cycle and alternate hosts of this insect would aid in developing better control strategies. Also, Bifenthrin is a broad spectrum pyrethroid and will kill pest and beneficial arthropods. Frequent use may disrupt biological control of spider mites resulting in mite outbreaks.

Chemical Controls for *Strawberry Sap Beetle*:

Pesticide (listed alphabetically)	**Survey Data (% growers reporting use, % acreage, efficacy rating)**	**Typical Dose (a.i./A)**	**Of Respondents, Rate Reported**	**PHI days**	**REI hours**	**Comments & Application Notes**
bifenthrin (Brigade WSB)	11.76% growers 12.9% acres 20% excellent efficacy 60% good efficacy 20% poor efficacy	0.04-0.2 lb	50% full rate 50% reduced rate	0	12	Restricted use material Broad spectrum; harmful to beneficials
malathion (Cythion)	2.35% growers 2.8%acres 100% good efficacy	0.95-1.9 lb	50% full rate 50% reduced rate	3	12	
Other Pesticides						
carbaryl (Sevin 80S, 80WSB, XLR)	1.18% growers 2.1% acres 100% good efficacy	1.5-2.0 lb	100% reduced rate	7	12	PHI restriction may be prohibitive for controlling damage on ripe fruit

fenpropathrin (Danitol 2.4EC)	2.35% growers 4.7% acres 50% excellent efficacy 50% good efficacy	0.2 lb	100% full rate	2	24	Restricted Use Material
Other Strategies						
Keep field picked clean	3.53% growers 2.1% acres 100% good efficacy	na	na	-	-	

White grubs of various beetles (*Maladera castanea, Rhizotrogus majalis, Popillia japonica, Exomala orientalis*)
Type of Pest: Insect
Biology: White grubs can be a serious pest of strawberries, especially when turning over sod areas (e.g., pasture or hay land) to plant strawberries. White grubs may kill much of a new planting if some control measures are not taken. The May and June beetle larvae have 1-2 year life cycles. Large grubs may consume all the roots on strawberry plants. Adults are normally observed in late May to late August. Larvae are normally observed damaging roots from late September until spring.
Frequency of Occurrence: 37.4% of respondents reported this pest occurring at least occasionally.

Control needed	Percent of growers
Annually	11%
Occasionally	26%
Rarely	35%
Never	28%

Damage Caused: larvae or grubs feed heavily on strawberry roots weakening and sometimes killing plants.
% Acres Affected: 8% of strawberry acres affected annually.
Timing of Control: Insecticides applied when adults are feeding, post harvest.
Yield Losses: Plant mortality may result in 100% yield loss, especially in new plantings.
Regional Differences: somewhat more significant in southern New England than in colder regions of northern New England.
Cultural Control Practices: Good crop rotation practices or fallow and cover crop treatments before planting strawberries in high-risk locations. Annual production systems may aid in management of this pest.
Biological Control Practices: Parasitic nematode applications may be effective.
Postharvest Control Practices: Insecticide treatments generally recommended as post-harvest applications.

Other Issues: None identified.

Chemical Controls for *White Grubs*:

Pesticide (listed alphabetically)	**Survey Data (% growers reporting use, % acreage, efficacy rating)**	**Typical Dose (a.i./A)**	**Of Respondents, Rate Reported**	**PHI days**	**REI hours**	**Comments & Application Notes**
carbaryl (Sevin 80S, 80WSB, XLR)	4% growers 4% acres 33% good efficacy 67% poor efficacy	1.5-2.0 lb	100% full rate	7	12	
Other Pesticides						
imidacloprid (Admire 2F)	5% growers 3% acres 33% excellent efficacy 67% good efficacy	0.24 – 0.38 lb	100% full rate	14	12	
Other Strategies						
Parasitic nematodes	1% growers <1% acres 100% excellent efficacy	Unknown	no rate reported	0	0	
Hand picking	1% growers <1% acres 100% excellent efficacy	na	na	-	-	
Limit grass area	1% growers <1%acres	na	na	-	-	

Group C – Insect and mite pests identified by New England Growers as infrequent pest problem

Strawberry rootworm (*Paria canella*)
Type of Pest: Insect
Biology: The adults feed on the plants chiefly at night and are not commonly seen during the day. The larvae are white and are found in the soil. The adults spend the winter in ground litter or in other protected places and begin to become active in May. The first generation of beetles occurs between late May and early June. Eggs are laid during this period and developing larvae burrow into the ground, where they feed on the roots of strawberries and other related plants. They become pupae in the soil, and new adults emerge after renovation (mid-July through August) and feed on foliage the rest of the season. Damage is caused both by the adult beetles, which eat holes in the leaves, and larvae, which tunnel into the root system. When adults are abundant, leaves are riddled with holes giving the plants a ragged appearance. If heavy infestations by adults are observed, it is likely that high populations of larvae exist.
Frequency of Occurrence: 32.1% of respondents reported this pest occurring at least occasionally.

Control needed	Percent of growers
Annually	15%
Occasionally	17%
Rarely	33%
Never	35%

Damage Caused: Similar to root weevils and other indirect pests, the damage done by foliar feeding may weaken plants, but larvae feeding on the roots not only weakens plants, but provides entry wounds for pathogenic fungi like *Rhizoctonia*, *Pythium*, and *Phytophthora*.
% Acres Affected: 7% of strawberry acres affected annually.
Timing of Control: post-harvest insecticide applications recommended.
Yield Losses: no direct impact on yield but high populations can sap vigor of plants, thereby reducing yield.
Regional Differences: None identified.
Cultural Control Practices: Crop rotation and/or annual production systems may aid in management of this pest.
Biological Control Practices: None identified.
Postharvest Control Practices: Insecticides aimed at feeding adults applied after renovation (sometimes at night) are recommended. Fields that are being discontinued should be plowed under as soon as possible which increases mortality of adults.
Other Issues: Bifenthrin is a broad spectrum pyrethroid and will kill pest and beneficial arthropods. Frequent use may disrupt biological control of spider mites resulting in mite outbreaks.

Chemical Controls for Strawberry Root Worm:

Pesticide (listed alphabetically)	**Survey Data (% growers reporting use, % acreage, efficacy rating)**	**Typical Dose (a.i./A)**	**Of Respondents, Rate Reported**	**PHI days**	**REI hours**	**Comments & Application Notes**
bifenthrin (Brigade WSB)	2% growers 4% acres 50% excellent efficacy 50% good efficacy	0.04-0.2 lb	no rate reported	0	12	Restricted use material Broad spectrum; harmful to beneficials
fenpropathrin (Danitol 2.4EC)	1% growers 3% acres 100% excellent efficacy	0.2 lb	no rate reported	2	24	Restricted Use Material
imidacloprid (Admire 2F)	2% growers 1% acres 50% excellent efficacy 50% good efficacy	0.38 – 0.50 lb	no rate reported	14	12	
malathion (Malathion 57EC)	1% growers <1% acres 100% good efficacy	0.95-1.9 lb	no rate reported	3	12	
Other Strategies						
Predatory Nematodes	1% growers <1% acres 100% good efficacy	Unknown	no rate reported	0	0	
Location/rotation	1% growers <1% acres 100% good efficacy	na	na	-	-	
Plant nutrition/reduce stress	1% growers <1% acres 100% good efficacy	na	na	-	-	

Strawberry Leafroller (*Ancylis comptana fragariae*)
Type of Pest: Insect
Biology: Strawberry leafrollers over-winter as larvae or pupae in folded leaves or leaf litter. Adult moths emerge in May and deposit translucent eggs, usually on the lower surface of strawberry leaves. A second generation may occur in late summer. Moths of the summer generations are often present from late July through September. Infestations may develop in spring and early summer, but they may also build up after harvest. As larvae feed, they secrete silken threads to fold and tie strawberry leaflets together. Within these folded leaves, larvae feed on only the epidermis of each leaf, but entire leaflets usually turn brown.
Frequency of Occurrence: 30% of respondents reported this pest occurring at least occasionally.

Control needed	Percent of growers
Annually	2%
Occasionally	28%
Rarely	44%
Never	26%

Damage Caused: Heavy infestations reduce photosynthesis, therefore reducing yields.
% Acres Affected: 19% of strawberry acres affected annually.
Timing of Control: Pre-bloom or post-bloom but not within pre harvest interval restrictions.
Yield Losses: no direct impact on yield but high populations can sap vigor of plants, thereby reducing yield.
Regional Differences: None identified.
Cultural Control Practices: Crop rotation and/or annual production systems aid in management of this pest.
Biological Control Practices: Two naturally occurring parasites, *Macrocentrus ancylivrous* and *Cremastes cookii*, may kill a high percentage of strawberry leafroller larvae, especially during summer generations. BT products may also be effective.
Postharvest Control Practices: Only recommended if pest not adequately controlled prior to harvest.
Other Issues: Bifenthrin is a broad spectrum pyrethroid and will kill pest and beneficial arthropods. Frequent use may disrupt biological control of spider mites resulting in mite outbreaks.

Chemical Controls for Strawberry Leafroller:

Pesticide (listed alphabetically)	**Survey Data (% growers reporting use, % acreage, efficacy rating)**	**Typical Dose (a.i./A)**	**Of Respondents, Rate Reported**	**PHI days**	**REI hours**	**Comments & Application Notes**
azinphos methyl (Guthion 2L, Solupak)	5% growers 3% acres 50% excellent efficacy 50% good efficacy	0.5 lb	75% full rate 25% reduced rate	5	48	Restricted use material
bifenthrin (Brigade WSB)	8% growers 14% acres 14% excellent efficacy 86% good efficacy	0.04-0.2 lb	71% full rate 29% reduced rate	0	12	Restricted use material Broad spectrum; harmful to beneficials
carbaryl (Sevin 80S, 80WSB, XLR)	3% growers 3% acres 100% good efficacy	1.5-2.0 lb	100% full rate	7	12	
malathion (Malathion 57EC)	1% growers 2% acres 100% good efficacy	0.95-1.9 lb	100% full rate	3	12	
naled (Dibrom 8EC)	2% growers 1% acres 50% excellent efficacy 50% good efficacy	0.56 lb	50% full rate 50% reduced rate	1	24	

Cyclamen Mite (*Steneotarsonemus pallidus*)
Type of Pest: mite
Biology: Cyclamen mites are soft-bodied mites about 1/100" long and can vary in color from orange-pink to white or green. Adult females overwinter in the crowns. Its translucent eggs can be so abundant that they look like a white mass along the midvein of folded, newly emerging leaves. First generation mites emerge in April and increase in number during bloom, peaking during around harvest. The mites are most damaging in strawberry beds that are kept over for multiple years.
Frequency of Occurrence: 25.0% of respondents reported this pest occurring at least occasionally.

Control needed	**Percent of growers**
Annually	6%
Occasionally	19%
Rarely	35%
Never	40%

Damage Caused: The mites feed on the young leaves in the plant crown; when the leaves emerge, they are stunted, crinkled, and malformed. Blossom feeding later results in misshapen fruit.
% Acres Affected: 2% of strawberry acres affected annually.
Timing of Control: Miticide applications can be made just before bloom or at renovation. Biological controls should be applied as soon as a problem is identified.
Yield Losses: There is usually no direct impact on yield but high populations can sap vigor of plants, thereby reducing yield.
Regional Differences: None identified.
Cultural Control Practices: Crop rotation and/or annual production systems may aid in management of this pest. This pest often comes in on nursery stock. Purchase inspected plants from a reputable nursery.
Biological Control Practices: Biological control may be achieved using mite predators such as *Neoseiulus cucumeris* or *N. fallacis*.
Postharvest Control Practices: Mowing off foliage at renovation may result in high mortality of this pest. If mites recolonize the field once foliage has regrown, a late season miticide application may be made.
Other Issues: None identified.

Chemical Controls for Cyclamen Mite:

Pesticide (listed alphabetically)	**Survey Data (% growers reporting use, % acreage, efficacy rating)**	**Typical Dose (a.i./A)**	**Of Respondents, Rate Reported**	**PHI days**	**REI hours**	**Comments & Application Notes**
abamectin (Agri-Mek 0.15 EC)	7% growers 7% acres 40% excellent efficacy 60% good efficacy	0.02 lb	83% full rate 17% reduced rate	3	12	Restricted use material
endosulfan (Phaser 3EC or Thiodan EC)	16% growers 13% acres 18% excellent efficacy 82% good efficacy	0.23-0.34 lb	71% full rate 29% reduced rate	4	24	

Cutworms (*Amphipoea interoceanica* and other species)
Type of Pest: Insect
Biology: The immature stage (larvae) of these insects cause feeding injury to plants and fruit. Larvae may reach 2" long at maturity. Color and arrangement of stripes and spots varies from one species 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 fruit.
Frequency of Occurrence: 16.2% of respondents reported this pest occurring at least

occasionally.

Control needed	Percent of growers
Annually	5%
Occasionally	12%
Rarely	38%
Never	45%

Damage Caused: Feeding on flowers results in severely misshapen fruit, feeding on plants, especially in new plantings, can cause significant plant mortality.
% Acres Affected: 8% of strawberry acres affected annually.
Timing of Control: Varies with species, from soon after mulch removal through harvest
Yield Losses: No good estimates available.
Regional Differences: None identified.
Cultural Control Practices: None identified.
Biological Control Practices: *Bacillus thuringiensis* may be effective.
Postharvest Control Practices: None identified.
Other Issues: None identified.

Chemical Controls for Cutworms:

Pesticide (listed alphabetically)	**Survey Data (% growers reporting use, % acreage, efficacy rating)**	**Typical Dose (a.i./A)**	**Of Respondents, Rate Reported**	**PHI days**	**REI hours**	**Comments & Application Notes**
carbaryl (Sevin Bait)	2% growers 4% acres 50% excellent efficacy 50% good efficacy	1.5-2.0 lb	50% full rate 50% no rate reported	7	12	
Other Pesticides						
azinphos methyl (Guthion 2L, Solupak)	1% growers <1% acres 100% excellent efficacy	0.5 lb	100% full rate	5	48	
diazinon (Diazinon)	1% growers <1% acres 100% good efficacy		100% full rate			

fenpropathrin (Danitol 2.4EC)	1% growers <1% acres 100% excellent efficacy	0.2 lb	100% reduced rate	2	24	Restricted Use Material
methyl bromide + chloropicrin (Terr-O-Gas 33)	1% growers 2% acres 100% excellent efficacy	725 lbs	100% full rate			soil fumigation Restricted use material
Other Strategies						
Predatory Nematodes	1% growers <1% acres 100% excellent efficacy	Unknown	no rate reported	0	0	
Remove grass	1% growers <1% acres no efficacy rating	na	na	-	-	

Thrips (*Thysanoptera*)
Type of Pest: Insect
Biology: 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.
Frequency of Occurrence: 19% of respondents reported this pest occurring at least occasionally.

Control needed	Percent of growers
Annually	3.8%
Occasionally	15%
Rarely	40%
Never	41%

Damage Caused:
% Acres Affected: 6% of strawberry acres affected annually.
Timing of Control: pre-bloom
Yield Losses: No good estimates available.
Regional Differences: None identified
Cultural Control Practices: Growers should inspect the early blossoms on early varieties for the presence of thrips. Shake the plant with a heavy white paper under it to show whatever comes off the plant will usually allow you visually observe if thrips are present. Although an exact threshold is unknown at this time, it is suggested that control is warranted if counts of thrips exceed 10 per blossom.
Biological Control Practices: *Neoseiulus cucumeris* is said to be effective.
Postharvest Control Practices: None identified.
Other Issues: None identified.

Chemical Controls for Thrips:

Pesticide (listed alphabetically)	**Survey Data (% growers reporting use, % acreage, efficacy rating)**	**Typical Dose (a.i./A)**	**Of Respondents, Rate Reported**	**PHI days**	**REI hours**	**Comments & Application Notes**
malathion (Malathion 57EC, Cythion)	5% growers 5% acres 50% excellent efficacy 50% good efficacy	0.95-1.9 lb	100% full rate	3	12	
Other Pesticides						
carbaryl (Sevin 80S, 80WSB, XLR)	1% growers 1% acres 100% excellent efficacy	1.5-2.0 lb	100% full rate	7	12	

III. DISEASES

Group A – Diseases identified by New England Growers as most important
Gray Mold, Leaf spot, Powdery Mildew, Leaf Scorch

Group B – Diseases identified by New England Growers to be significant problems in some years
Leather Rot, Leaf Blight, Black Root Rot Complex, Red Stele

Group C – Diseases identified by New England Growers as infrequent pest problem
Bacterial Angular Leaf spot, Verticillium Wilt, Anthracnose

Group A – Diseases identified by New England Growers as most important

Gray Mold (*Botrytis cinerea*)
Type of Pest: fungal pathogen
Biology: The gray mold fungus overwinters on live leaf tissue in the field as a latent infection. In the spring, as the infected strawberry leaf begins to die, the pathogen goes into an active stage, colonizing the leaf and obtaining nutrients from the dead tissue. Spores form once environmental conditions are appropriate (between 65 to 75˚F and damp or rainy weather). They are dispersed by water splash and/or wind onto newly emerging leaves or blossoms. Blossom infections lead to diseased fruit and are of greatest concern. As with the overwintering infections, these infections are latent or quiescent until fruit begins to ripen and more sugars and amino acids are available. Once the berries begin to ripen, the fungus grows and sporulates, producing the mold often seen in the field. Control measures at this time can only suppress berry-to-berry infections. Blossom infections are considered the primary target for managing this disease. Disease is most severe in years when the bloom and harvest periods are beset with lengthy periods of cloud and rain.

Frequency of Occurrence: 86% of respondents reported this disease occurring at least occasionally.

Control needed	Percent of growers
Annually	75%
Occasionally	12%
Rarely	13%
Never	1%

Damage Caused: Fruit rot; other parts infected by the fungus include leaves, crown, petals, flower stalks, and fruit caps.

% Acres Affected: 87% of strawberry acres affected annually.
Timing of Control: 10% bloom, mid-bloom and late bloom fungicide applications; later applications needed only if weather is wet.
Yield Losses: >50% without management, <10% with management.
Regional Differences: None identified.
Cultural Control Practices: Narrow rows and good row spacing to promote air circulation, do not over-fertilize with nitrogen, which promotes dense canopy growth (poor air circulation) and soft fruit. Use less susceptible cultivars such as 'Earliglow' and 'Jewel'.
Biological Control Practices: None commercially available.
Postharvest Control Practices: Good renovation practices that promote narrow rows and good air circulation aid in managing this disease.
Other Issues: Fungicide resistance is a concern and materials of differing chemistries should be alternated in a spray program to avoid resistance development.

Chemical Controls for *Gray Mold*

Pesticide (listed alphabetically)	**Survey Data (% growers reporting use, % acreage, efficacy rating)**	**Typical Dose (a.i./A)**	**Of Respondents, Rate Reported**	**PHI days**	**REI hours**	**Comments & Application Notes**
azoxystrobin (Quadris, Abound)	12% growers 12% acres 55% excellent efficacy 45% good efficacy	0.25 lb	60% full rate 40% reduced rate	0	4	Labeled for suppression only
captan (Captan 50W, Captec and others)	60% growers 70% acres 54% excellent efficacy 43% good efficacy 3% poor efficacy	2.25 lb	85% full rate 15% reduced rate	0	24	
cyprodinil + fludioxinil (Switch 62.5WG)	29% growers 41% acres 76% excellent efficacy 24% good efficacy	0.48 lb	92% full rate 8% reduced rate	0	12	
fenhexamid (Elevate 50WDG)	27% growers 38% acres 69% excellent efficacy 31% good efficacy	0.75 lb	91% full rate 9% reduced rate	0	12	
fenhexamid + captan (various formulations)	25% growers 34% acres 67% excellent efficacy 33% good efficacy	2.88 lb	83% full rate 17% reduced rate	0	24	

fenhexamid + thiram (Elevate 50WDG + Thiram 65WSB)	<1% growers 6% acres 100% good efficacy	2.25 lb	100% full rate	3	24	
pyraclostrobin (Cabrio EG)	14% growers 24% acres 75% excellent efficacy 25% good efficacy	2.8 oz	100% full rate	0	24	Labeled for suppression only
thiophanate methyl (Topsin-M)	15% growers 14% acres 50% excellent efficacy 50% good efficacy	0.70 lb	85% full rate 15% reduced rate	1	12	
thiophanate methyl + captan (Topsin-M +captan)	23% growers 25% acres 46% excellent efficacy 46% good efficacy 8% poor efficacy	2.75 lb	100% full rate	1	24	
thiophanate methyl + thiram (Topsin-M + thiram)	4% growers 9% acres 67% excellent efficacy 33% good efficacy	3.5 lb	100% full rate	3	24	
thiram (Thiram 65WSB)	7% growers 12% acres 50% excellent efficacy 33% good efficacy 17% poor efficacy	3.25	80% full rate 20% reduced rate	3	24	
Other Pesticides						
benomyl (Benlate 50W)	1% growers 1% acres 100% good efficacy	0.5 lb	100% full rate			
captan + fenhexamid (Captivate 68WDG)	1% growers <1% acres 100% good efficacy	3.0 lb	100% full rate	0	24	
hydrogen dioxide (Oxidate)	1% growers 2% acres 100% excellent efficacy	22.0 lb	100% full rate	0	12	OMRI listed

pyraclostrobin + boscalid (Pristine)	5% growers 13% acres 100% excellent efficacy	0.5 lb	100% full rate	0	24	
Other Strategies						
Clean pick field	1% growers 2% acres no efficacy rating	-	na	-	-	
Keep rows narrow	2% growers <1% acres no efficacy rating	-	na	-	-	
Molasses	1% growers <1% acres 100% excellent efficacy	1 qt	na	-	-	
Use sticker	1% growers <1% acres no efficacy rating	varies w/ product	na	-	-	

Leaf Spot (*Mycosphaerella fragariae*)
Type of Pest: fungal pathogen
Biology: Spores overwinter in lesions on living leaves. Symptoms of leaf spot first appear as circular, deep purple spots in May. The spots enlarge and the centers turn grayish to white on older leaves and light brown on young leaves. A definite reddish purple to rusty brown border surrounds the spot.
Frequency of Occurrence: 66.7% of respondents reported this disease occurring at least occasionally.

Control needed	Percent of growers
Annually	35%
Occasionally	32%
Rarely	23%
Never	10%

Damage Caused: Leaf lesions, which can be severe on susceptible varieties in some years. Sometimes fruit infections also occur but this is rare.
% Acres Affected: 44% of strawberry acres affected annually.
Timing of Control: Early spring, as soon as canopy matures, through harvest and sometimes a late summer fungicide application after post-renovation regrowth has matured.
Yield Losses: No documented direct yield impact, but may weaken plants and reduce yield indirectly.
Regional Differences: None identified.
Cultural Control Practices: Mowing at renovations helps suppress this disease. Narrow rows and good row spacing to promote air circulation, no over-fertilization with nitrogen which promotes dense canopy growth (poor air circulation), and use of resistant cultivars.
Biological Control Practices: None identified.
Postharvest Control Practices: Good renovation practices that promote narrow rows and good air circulation aid in managing this disease. Sometimes spray applications are made in late summer to manage this disease.
Other Issues: Fungicide resistance is a concern and materials of differing chemistries should be alternated in a spray program to avoid resistance development. Also, reducing the number of fungicide applications for controlling Botrytis Gray Mold may result in a collateral increase of foliar diseases previously suppressed by these fungicides.

Chemical Controls for *Leaf Spot*

Pesticide (listed alphabetically)	**Survey Data (% growers reporting use, % acreage, efficacy rating)**	**Typical Dose (a.i./A)**	**Of Respondents, Rate Reported**	**PHI days**	**REI hours**	**Comments & Application Notes**
azoxystrobin (Quadris Abound)	14% growers 12% acres 25% excellent efficacy 75% good efficacy	0.25 lb	73% full rate 27% reduced rate	0	4	Should be rotated with materials with other chemistries to prevent resistance
captan (Captan 50W, Captec and others)	24% growers 33% acres 40% excellent efficacy 60% good efficacy	2.25 lb	85% full rate 15% reduced rate	0	24	
dodine (Syllit FL)	1% growers 2% acres 100% excellent efficacy	1.30	100% full rate	14	48	
pyraclostrobin (Cabrio EG)	15% growers 24% acres 54% excellent efficacy 46% good efficacy	2.8 oz	77% full rate 23% reduced rate	0	24	
thiophanate methyl (Topsin-M)	15% growers 16% acres 33% excellent efficacy 58% good efficacy 9% poor efficacy	0.35 lb	67% full rate 33% reduced rate	1	12	
Other Pesticides						
cyprodinil + fludioxinil (Switch 62.5WG)	1% growers 3% acres no efficacy rating	0.48 lb	100% reduced rate	0	12	
myclobutanil (Nova 40W)	2% growers 3% acres 100% excellent efficacy	0.125 lb	100% full rate	0	24	

Powdery Mildew (*Sphaerotheca macularis*)
Type of Pest: fungal pathogen
Biology: Symptoms include white powdery growth on the lower leaf surface, causing the leaf edges to roll upward. (Note: Some herbicides will also cause leaf rolling on certain varieties.) Infected flowers and ripe fruit may also become covered with white growth; and infected green fruit may fail to ripen and remain hard.
This fungus overwinters on living infected leaves. Infection periods are favored by dry weather and temperatures between 58 and 68˚F. Thus, if a severe foliar infection occurs, it does so late in the season. Controlling these foliar infections with fungicides does not apparently increase yields. However, by controlling foliar infections, the amount of inoculum available to infect the spring growth is reduced. Crop losses occur as a result of flower and fruit infections.
Frequency of Occurrence: 64% of respondents reported this disease occurring at least occasionally.

Control needed	Percent of growers
Annually	34%
Occasionally	29%
Rarely	22%
Never	14%

Damage Caused: Leaf infections which lead to cupping, some flower and fruit infections can occur but are rare.
% Acres Affected: 52% of strawberry acres affected annually.
Timing of Control: Typically late season, post-harvest/renovation.
Yield Losses: No documented direct yield impact, but may weaken plants and reduce yield indirectly.
Regional Differences: None identified.
Cultural Control Practices: Narrow rows and good row spacing to promote air circulation, and use of resistant cultivars.
Biological Control Practices: None identified.
Postharvest Control Practices: Good renovation practices that promote narrow rows and good air circulation aid in managing this disease. Sometimes spray applications are made in late summer to manage this disease.
Other Issues: Fungicide resistance is a concern and materials of differing chemistries should be alternated in a spray program to avoid resistance development.

Chemical Controls for *Powdery Mildew*

Pesticide (listed alphabetically)	**Survey Data (% growers reporting use, % acreage, efficacy rating)**	**Typical Dose (a.i./A)**	**Of Respondents, Rate Reported**	**PHI days**	**REI hours**	**Comments & Application Notes**
azoxystrobin (Quadris, Abound)	20% growers 18% acres 56% excellent efficacy 44% good efficacy	0.25 lb	75% full rate 25% reduced rate	0	4	
pyraclostrobin (Cabrio EG)	15% growers 23% acres 83% excellent efficacy 17% good efficacy	2.8 oz	100% full rate	0	24	
sulfur (Kumulus DF and other formulations)	2% growers 2% acres 50% good efficacy 50% no rating	4.0 lb	50% full rate 50% reduced rate	14	48	
thiophanate methyl (Topsin-M)	23% growers 24% acres 50% excellent efficacy 50% good efficacy	0.35 lb	89% full rate 11% reduced rate	1	12	
Other Pesticides						
captan (Captan 50W, Captec and others)	2% growers 2% acres 100% good efficacy	2.25 lb	100% full rate	0	24	
harpin protein (Messenger STS)	1% growers 2% acres no efficacy rating	0.011 lb	100% reduced rate	0	4	
hydrogen dioxide (Oxidate)	1% growers <1% acres 100% good efficacy	22.0 lb	100% full rate	0	12	OMRI listed
myclobutanil (Nova 40W)	2% growers 4% acres 100% good efficacy	0.125 lb	100% full rate	0	24	
pyraclostrobin + boscalid (Pristine)	1% growers 1% acres 100% excellent efficacy	0.5 lb	100% full rate	0	24	
Other Strategies						

Molasses	1% growers <1% acres 100% good efficacy	1 qt	no rate reported	-	-	

Leaf Scorch (*Diplocarpon earliana*)
Type of Pest: fungal pathogen
Biology: Symptoms of this disease consist of numerous small, irregular, purplish spots on leaves. The center of the blotches may become brownish. Blotches may coalesce, covering the leaflet, which then appears purplish to reddish to brown.
Fruiting structures are produced in the spring on lower leaf surfaces of dead leaves. Spores are produced most abundantly in midsummer. Oldest and middle-aged leaves are infected more readily than young ones.
Frequency of Occurrence: 50.1% of respondents reported this disease occurring at least occasionally.

Control needed	Percent of growers
Annually	22%
Occasionally	28%
Rarely	34%
Never	16%

Damage Caused: Leaf infections, some flower and fruit infections can occur but are rare.
% Acres Affected: 21% of strawberry acres affected annually.
Timing of Control: Typically late season, post-harvest/renovation.
Yield Losses: No documented direct yield impact, but may weaken plants and reduce yield indirectly.
Regional Differences: None identified.
Cultural Control Practices: Narrow rows and good row spacing to promote air circulation, and use of resistant cultivars.
Biological Control Practices: None identified.
Postharvest Control Practices: Good renovation practices that promote narrow rows and good air circulation aid in managing this disease. Sometimes spray applications are made in late summer to manage this disease.
Other Issues: Fungicide resistance is a concern and materials of differing chemistries should be alternated in a spray program to avoid resistance development. Also, reducing the number of fungicide applications for controlling Botrytis Gray Mold may result in a collateral increase of foliar diseases previously suppressed by these fungicides.

Chemical Controls for *Leaf Scorch*

Pesticide (listed alphabetically)	**Survey Data (% growers reporting use, % acreage, efficacy rating)**	**Typical Dose (a.i./A)**	**Of Respondents, Rate Reported**	**PHI days**	**REI hours**	**Comments & Application Notes**
dodine (Syllit FL)	1% growers <1% acres 100% good efficacy	1.30	100% full rate	14	48	
thiophanate methyl (Topsin-M)	15% growers 15% acres 33% excellent efficacy 58% good efficacy 9% poor efficacy	0.35 lb	67% full rate 33% reduced rate	1	12	
Other Pesticides						
captan (Captan 50W, Captec and others)	2% growers 2% acres 50% excellent efficacy 50% good efficacy	2.25 lb	100% full rate	0	24	
myclobutanil (Nova 40W)	2% growers 3% acres 50% excellent efficacy 50% good efficacy	0.125 lb	100% full rate	0	24	
pyraclostrobin + boscalid (Pristine)	1% growers 3% acres 100% excellent efficacy	0.5 lb	100% full rate	0	24	
Other Strategies						
Good rotation	1% growers 3% acres 100% good efficacy	-	na	-	-	

Group B – Diseases identified by New England Growers to be significant problems in some years

Leather Rot (*Phytophthora cactorum*)
Type of Pest: fungal pathogen
Biology: This fungus is a common soil inhabitant that attacks many species of trees, shrubs, and perennial or annual herbs. The leather rot organism also causes a serious crown rot. Rainy weather promotes infection by splashing the fungus spores along with soil particles onto flowers or fruit. Maturing fruit in contact with wet soil may also become infected. Frequent fog or morning dew may supply adequate moisture for the "swimming" spores to cause infection. Fruits may be affected at all stages from blossom to maturity.
Frequency of Occurrence: 53% of respondents reported this disease occurring at least occasionally.

Control needed	Percent of growers
Annually	15%
Occasionally	37%
Rarely	31%
Never	17%

Damage Caused: Symptoms include fruit with dull and lifeless appearance; infected areas of immature fruit are brown to dark brown, while infected areas on ripe fruit appear bleached to lilac to normal in color; infected fruit is tough and has a bitter taste. After harvest white fuzzy growth may appear under moist packaging conditions.
% Acres Affected: 34% of strawberry acres affected annually.
Timing of Control: Bloom to preharvest.
Yield Losses: 30% without management, <1% with management.
Regional Differences: May be more prevalent in Southern New England.
Cultural Control Practices: Minimizing soil puddling through site selection, avoiding ruts and soil compaction; and providing a supplemental layer of straw mulch between rows throughout the fruiting season (the mulch provides a physical barrier between the soil-borne leather rot fungus and the susceptible fruit).
Biological Control Practices: None identified.
Postharvest Control Practices: Maintaining and/or improving soil drainage so as to avoid puddling of water.
Other Issues: None identified.

Chemical Controls for *Leather rot*

Pesticide (listed alphabetically)	**Survey Data (% growers reporting use, % acreage, efficacy rating)**	**Typical Dose (a.i./A)**	**Of Respondents, Rate Reported**	**PHI days**	**REI hours**	**Comments & Application Notes**
azoxystrobin (Quadris, Abound)	7% growers 7% acres 60% excellent efficacy 40% good efficacy	0.25 lb	100% full rate	0	4	labeled for suppression only
captan (Captan 50W, Captec and others)	22% growers 27% acres 56% excellent efficacy 38% good efficacy 6% poor efficacy	2.25 lb	94% full rate 6% reduced rate	0	24	
fosetyl aluminum (Aliette WDG)	2% growers 4% acres 50% good efficacy 50% no efficacy rating	2-4 lb	100% reduced rate	0	12	
mefenoxam (Ridomil Gold EC)	4% growers 3% acres 100% good efficacy	0.25 lb	33% full rate 67% reduced rate	30	48	
thiram (Thiram 65WSB)	1% growers 2% acres 100% poor efficacy	3.25	100% full rate	3	24	
Other Pesticides						
hydrogen dioxide (Oxidate)	1% growers <1% acres 100% good efficacy	22.0 lb	100% full rate	0	12	OMRI listed
nutraphos mg (Leffingwell)	1% growers 2% acres 100% excellent efficacy	5.9	100% full rate	0	0	Foliar fertilizer

Leaf Blight (*Phomopsis obscurans*)
Type of Pest: fungal pathogen
Biology: Symptoms of leaf blight infections begin as one to six circular reddish-purple spots on a leaflet. Spots enlarge to V-shaped lesions with a light brown inner zone and dark brown outer zone. Lesions follow major veins progressing inward. The whole leaflet may turn brown. In severe cases, stolons, fruit trusses and petioles may become infected which may girdle and kill the stem.
The fungus overwinters as mycelium or fruiting structures on the old leaves that remain attached to the plant. Spores are spread by rain splash early in the spring.
Frequency of Occurrence: 41% of respondents reported this disease occurring at least occasionally.

Control needed	Percent of growers
Annually	17%
Occasionally	24%
Rarely	39%
Never	21%

Damage Caused: Leaf blight is most destructive to older leaves in the late summer. Infected leaflets develop V-shaped lesions which may encompass the entire leaf. Calyxes and fruit may also be infected but this is rare.
% Acres Affected: 22% of strawberry acres affected annually.
Timing of Control: Prebloom to harvest. Occasionally post harvest.
Yield Losses: No yield impact data available.
Regional Differences: None identified.
Cultural Control Practices: Planting certified, disease-free plants in a location exposed to all-day sun; the use of resistant varieties; avoidance of overhead irrigation, except for frost protection; and proper renovation (in matted-row plantings) that includes narrowing the rows and clipping excess foliage.
Biological Control Practices: None identified.
Postharvest Control Practices: Renovation helps suppress disease inoculum. Some fungicide applications may be needed if disease reoccurs late in the summer.
Other Issues: Reducing the number of fungicide applications for controlling Botrytis Gray Mold may result in a collateral increase of foliar diseases previously suppressed by these fungicides.

Chemical Controls for *Leaf Blight*

Pesticide (listed alphabetically)	**Survey Data (% growers reporting use, % acreage, efficacy rating)**	**Typical Dose (a.i./A)**	**Of Respondents, Rate Reported**	**PHI days**	**REI hours**	**Comments & Application Notes**
dodine (Syllit FL)	1% growers <1% acres 100% good efficacy	1.30	100% full rate	14	48	
thiophanate methyl (Topsin-M)	15% growers 19% acres 23% excellent efficacy 77% good efficacy	0.35 lb	67% full rate 33% reduced rate	1	12	
Other Pesticides						
captan (Captan 50W, Captec and others)	1% growers 2% acres 100% good efficacy	2.25 lb	100% full rate	0	24	
myclobutanil (Nova 40W)	4% growers 3% acres 100% excellent efficacy	0.125 lb	100% full rate	0	24	
thiram (Thiram 65WSB)	1% growers 2% acres 100% good efficacy	3.25	100% full rate	3	24	

Black Root Rot Complex (*Rhizoctonia spp., Pythium spp., Pratylenchus penetrans*)
Type of Pest: fungal pathogen plus phytopathogenic nematode
Biology: Black root rot has no simple causes or remedies. It is a disease complex, involving several pathogens combined with plant stress. The key pathogens include *Rhizoctonia, Pythium,* and lesion nematode. The pathogens involved in this disease are commonly found in soils but usually don't cause disease symptoms on healthy plants. Stressed plants are a different story. Strawberry plants may be stressed in a number of ways, such as drought, winter injury, root feeding insects or nematodes, poor nutrition, soil compaction, or improper herbicide use. Stresses reduce the plant's resistance to disease. Long after the initial stress, root rotting pathogens may infect and continue to damage the plant's roots and crown.
Frequency of Occurrence: 40% of respondents reported this disease occurring at least occasionally.

Control needed	Percent of growers
Annually	13%
Occasionally	27%
Rarely	39%
Never	21%

Damage Caused: Symptoms of black root rot are a general lack of vigor and eventual collapse of plants especially during dry weather. Underground symptoms consist of blackened feeder roots and, eventually, structural and perennial roots. Structural roots will rot from the outside to the center, leaving the core white for a period of time, unlike red stele where the core is usually red.
% Acres Affected: 11% of strawberry acres affected annually.
Timing of Control: Primarily pre-plant site preparation and plant stress reduction (e.g., irrigation during drought) during planting years.
Yield Losses: No yield impact data available.
Regional Differences: None identified.
Cultural Control Practices: Practices that reduce soil compaction, improve aeration, and promote good drainage are frequently beneficial. Rotating a field out of strawberries for at least 2-3 years before replanting is strongly recommended to minimize black root rot damage. Measures to control *Phytophthora* frequently help alleviate black root rot.
Biological Control Practices: None commercially available.
Postharvest Control Practices: Irrigation and proper fertilization can help suppress black root rot. Crop rotation is important, too.
Other Issues: Soil fumigation may be effective, but some evidence of poor effectiveness also exists.

Chemical Controls for *Black Root Rot*

Pesticide (listed alphabetically)*	**Survey Data (% growers reporting use, % acreage, efficacy rating)**	**Typical Dose (a.i./A)**	**Of Respondents, Rate Reported**	**PHI days**	**REI hours**	**Comments & Application Notes**
1,3 dichloropropene (Telone II)*	0% growers 0% acres	345 lbs	*	na	5 days	Soil Fumigant Restricted Use Material
1,3 dichloropropene + chloropicrin (Telone C17, Telone C35)*	0% growers 0% acres	435 lbs	*	na	5 days	Soil Fumigant Restricted Use Material
methyl bromide	0% growers	725 lbs	*	na	48	Soil Fumigant

+ chloropicrin (Terr-O-Gas 33)*	0% acres					Restricted Use Material
metam-sodium (Vapam HL)*	0% growers 0% acres	320 lbs	*	na	48	Soil Fumigant Restricted Use Material
Other Pesticides						
bifenthrin (Brigade WSB)	1% growers 3% acres no efficacy rating	0.04-0.2 lb	100% reduced rate	0	12	Restricted use material Indirect control by controlling root feeding insects
mefenoxam (Ridomil Gold EC)	1% growers <1% acres 100% good efficacy	0.25 lb	na	30	48	
imidacloprid (Admire 2F)	1% growers 1% acres 100% good efficacy	0.38 – 0.50 lb	na	14	12	
nutraphos mg (Leffingwell)	1% growers 2% acres 100% excellent efficacy	5.9	100% full rate	0	0	Foliar fertilizer
fosetyl aluminum (Aliette WDG)	1% growers 2% acres 100% good efficacy	2-4 lb	na	0	12	
Other Strategies						
raised beds	1% growers 5% acres 100% excellent efficacy	na	na	-	-	
Rotate every two years	3% growers 3% acres 100% good efficacy	na	na	-	-	
crop varieties (resistant)	1% growers 1% acres no efficacy rating	na	na	-	-	

*listed materials not included in survey, so results may not reflect actual use.

Red Stele (*Phytophthora fragariae*)
Type of Pest: fungal pathogen
Biology: This fungus causes a root rot and wilt, and is a major disease of strawberries where cool, wet soil conditions occur. The fungal spores "swim" and need water in the soil in order to travel and infect new roots. The fungus enters the main perennial roots and grows along the stele, the plant's food and water transport system. Roots begin to rot from the tip within a few days after infection. Depending on the extent of the infection and the plant's resistance, stunting or wilting and collapse of the plant will result.
Frequency of Occurrence: 33% of respondents reported this disease occurring at least occasionally.

Control needed	Percent of growers
Annually	12%
Occasionally	21%
Rarely	42%
Never	26%

Damage Caused: Symptoms of red stele infection are numerous: wilting; young leaves with a bluish-green tint; and older red, orange or yellow leaves. Severely diseased plants may die or remain stunted, producing few runners and small berries. When roots are cut open lengthwise, the core will show a reddish-brown discoloration; however, a reddish core does not guarantee that red stele is present. Plants showing symptoms usually occur in patches where the soil is wettest.
% Acres Affected: 8% of strawberry acres affected annually.
Timing of Control: Pre-bloom or post-harvest.
Yield Losses: No yield impact data available, but reduced vigor and plant mortality can lead to losses >50%.
Regional Differences: None identified.
Cultural Control Practices: Planting certified disease-free plants in a location with well drained soil; improve soil drainage prior to planting; use raised beds; use of resistant varieties.
Biological Control Practices: None identified.
Postharvest Control Practices: None identified.
Other Issues: May be confused with winter injury.

Chemical Controls for *Red Stele*

Pesticide (listed alphabetically)	**Survey Data (% growers reporting use, % acreage, efficacy rating)**	**Typical Dose (a.i./A)**	**Of Respondents, Rate Reported**	**PHI days**	**REI hours**	**Comments & Application Notes**
fosetyl aluminum (Aliette WDG)	2% growers 4.0% acres 50% excellent efficacy 50% good efficacy	2-4 lb	50% full rate 50% reduced rate	0	12	
mefenoxam (Ridomil Gold EC)	2% growers <1% acres 100% poor efficacy	0.25 lb	100% full rate	30	48	
Other Pesticides						
methyl bromide + chloropicrin (Terr-O-Gas 33)	1% growers <1% acres 100% excellent efficacy	725 lbs	100% full rate	na	48	Restricted Use Material
nutraphos mg (Leffingwell)	1% growers 1.9% acres 100% excellent efficacy	5.9	100% full rate	0	0	Foliar fertilizer
Other Strategies						
Crop rotation	4% growers 3% acres 33% excellent efficacy 67% good efficacy	na	na	-	-	
Resistant varieties	6% growers <1% acres 100% good efficacy	na	na	-	-	

Group C – Diseases identified by New England Growers as infrequent pest problem

Bacterial Angular Leaf Spot (*Xanthomonas fragariae*)
Type of Pest: bacterial pathogen
Biology: Inoculum for the first lesions in the spring comes from infected dead leaves. The bacteria are very resistant to drying and other harsh conditions, and may survive for a long time in the old leaves or in buried plant tissue in the soil. The pathogen does not move in the soil, or survive free in the soil. The bacteria may move from new lesions to other plants. It can be spread by rain or irrigation, or carried from plant to plant when fields are being worked. Wet, cool weather in the spring encourages the bacteria to build up to damaging levels. Long periods of rain, or frequent irrigation at times when the day temperatures are around 65˚ F, and night temperatures near 35˚ F, will encourage growth and spread of this disease.
Frequency of Occurrence: 32% of respondents reported this disease occurring at least occasionally.

Control needed	Percent of growers
Annually	13%
Occasionally	19%
Rarely	41%
Never	27%

Damage Caused: Symptoms of infection first appear as small, water-soaked lesions on the lower leaf surface. The lesions enlarge and become angular spots, usually bordered by small veins. Under moist conditions, lesions often have a wet appearance on the lower leaf surface. The lesions may grow together and cover large portions of the leaf. At this point the lesions become visible on the upper leaf surface as irregular, reddish brown spots. Heavily infected leaves my die, especially if major veins are infected. Fruit calyxes may also be infected which effects marketability.
% Acres Affected: Unknown % of strawberry acres affected annually.
Timing of Control: No controls available.
Yield Losses: No yield impact data available.
Regional Differences: May be more prevalent in southern New England.
Cultural Control Practices: Avoid irrigation or time it so that plants dry from overnight moisture prior to starting irrigation, and stop irrigation with time for plants to dry before nightfall thereby breaking the moisture cycle and avoiding infection periods. This practice alone will not control infection but may help limit it to some degree.
Biological Control Practices: None identified.
Postharvest Control Practices: None identified.
Other Issues: None identified.

Chemical Controls for *Bacterial Angular Leaf Spot*

Pesticide (listed alphabetically)	**Survey Data (% growers reporting use, % acreage, efficacy rating)**	**Typical Dose (a.i./A)**	**Of Respondents, Rate Reported**	**PHI days**	**REI hours**	**Comments & Application Notes**
None available						
Other Pesticides						
None identified						
Other Strategies						
None identified						

Verticillium Wilt (*Verticillium albo-atrum*)
Type of Pest: fungal pathogen
Biology: This fungus has a wide host range among annual and perennial crops and weeds. *Verticillium* is spread from field to field by water, wind or on infected planting stock, and crop and weed debris. Plants that are fruiting are affected more severely, and the first symptoms are noticeable as temperatures increase in late spring.
Frequency of Occurrence: 25% of respondents reported this disease occurring at least occasionally.

Control needed	**Percent of growers**
Annually	3%
Occasionally	2%
Rarely	48%
Never	27%

Damage Caused: Symptoms of Verticillium wilt are marginal and interveinal browning and eventually collapse of outer leaves; inner leaves are stunted and may wilt but tend to remain green until the plant dies. Symptoms tend to be spotty in a field – clusters of plants widely distributed.
% Acres Affected: 6% of strawberry acres affected annually.
Timing of Control: Pre-bloom or post-harvest.

Yield Losses: No yield impact data available.
Regional Differences: None identified.
Cultural Control Practices: Avoid planting strawberries in land previously planted to solanaceous crops (tomato, potato, peppers, eggplant). Many weeds are hosts of the Verticillium fungus. Nightshade, groundcherry, redroot pigweed, lambsquarters, and horsenettle should be strictly controlled in current and future planting sites to keep Verticillium population low.
Biological Control Practices: None commercially available.
Postharvest Control Practices: None recommended.
Other Issues: None identified.

Chemical Controls for *Verticillium Wilt*

Pesticide (listed alphabetically)*	**Survey Data (% growers reporting use, % acreage, efficacy rating)**	**Typical Dose (a.i./A)**	**Of Respondents, Rate Reported**	**PHI days**	**REI hours**	**Comments & Application Notes**
fosetyl aluminum (Aliette WDG)	1.% growers 3% acres 100% excellent efficacy	2-4 lb	100% reduced rate	0	12	
Other Pesticides						
methyl bromide + chloropicrin (Terr-O-Gas 33)*	1.% growers <1% acres 100% excellent efficacy	725 lbs	100% full rate	na	48	Restricted Use Material
Other Strategies						
Crop rotation	2% growers <1% acres 100% excellent efficacy	na	na	-	-	
Resistant Varieties	1% growers <1% acres 100% good efficacy	na	na	-	-	

Anthracnose (*Colletotrichum acutatum, C. gloeosporioides* and *C. fragariae*)
Type of Pest: fungal pathogen
Biology: The incidence of anthracnose fruit rot may be directly related to unusually warm weather in spring. Spore production, germination, and host infection are all favored by warm, humid environmental conditions. Spread of the fungus from infected tissues to uninfected fruit and crowns occurs primarily by splash dispersal and is aided by wind-driven rain. However, spread may also occur on runners and by the movement of people or equipment through the field, especially in wet weather.

Frequency of Occurrence: 27%* of respondents reported this disease occurring at least occasionally.
*Determined from pesticide application data

Control needed	Percent of growers
Annually	na%
Occasionally	na%
Rarely	na%
Never	na%

Damage Caused: Symptoms of this disease include circular, sunken, water-soaked tan to brown lesions on both green and ripe fruit. In wet or humid weather, creamy pink to salmon colored spore masses occur in the centers of these lesions, and the fungus can produce fluffy white growth at the border of the lesion and healthy tissue. Under dry conditions, or if secondary organisms do not cause soft rots, the fruit may become mummified and black. *Colletotrichum acutatum* is more commonly associated with fruit rot, but has also been associated with crown rot. *Colletotrichum gloeosporioides* tends to be associated with the crown rot phase of anthracnose but can also cause fruit rot. *Colletotrichum fragariae* causes crown rot and is not commonly a problem on fruit. In addition to fruit, this fungus may also attack stolons, petioles, and strawberry crown tissues. The same fungus has been reported to cause fruit rots of crops such as apples, blueberries, raspberries, grapes, peppers and tomatoes.
% Acres Affected: 35% of strawberry acres affected annually.
Timing of Control: Pre-bloom to harvest.
Yield Losses: No yield impact data available.
Regional Differences: None identified.
Cultural Control Practices: Purchase certified plant material; sanitation to avoid spread; good drainage and mulch to reduce splashing.
Biological Control Practices: None commercially available.
Postharvest Control Practices: None recommended.
Other Issues: Azoxystrobin (Quadris, Abound) and pyraclostrobin (Cabrio) have a similar mode of action and improper use will make the fungicide ineffective for the control of anthracnose if the problem pathogens acquire resistance. Resistance management is an essential component of using the strobilurins.

Chemical Controls for *Anthracnose*

Pesticide (listed alphabetically)	**Survey Data (% growers reporting use, % acreage, efficacy rating)**	**Typical Dose (a.i./A)**	**Of Respondents, Rate Reported**	**PHI days**	**REI hours**	**Comments & Application Notes**
azoxystrobin (Quadris, Abound)	13% growers 14% acres 67% excellent efficacy 33% good efficacy	0.25 lb	89% full rate 11% reduced rate	0	4	
captan (Captan 50W, Captec and others)	21% growers 28% acres 57% excellent efficacy 43% good efficacy	2.25 lb	87% full rate 13% reduced rate	0	24	
cyprodinil + fludioxinil (Switch 62.5WG)	17% growers 25% acres 67% excellent efficacy 33% good efficacy	0.48 lb	92% full rate 8% reduced rate	0	12	
thiram (Thiram 65WSB)	7.% growers 10% acres 20% excellent efficacy 80% good efficacy	3.25	80% full rate 20% reduced rate	3	24	
pyraclostrobin (Cabrio EG)	13% growers 17.3% acres 78% excellent efficacy 22% good efficacy	2.8 oz	100% full rate	0	24	
thiophanate methyl (Topsin-M)	13% growers 13.1% acres 44% excellent efficacy 56% good efficacy	0.70 lb	78% full rate 22% reduced rate	1	12	
Other Pesticides						
fenhexamid (Elevate 50WDG)	3% growers 4% acres 50% excellent efficacy 50% good efficacy	0.75 lb	100% full rate	0	12	

Cultural practices used to control strawberry diseases and their efficacy (write-in responses; 69% survey recipients report using these methods overall).

Practice	% growers using	% excellent efficacy	% good efficacy
Crop rotation	14%	35%	62%
Cultivation	5%	33%	67%
Weed control	10%	25%	75%
Black plastic	6%	33%	67%
Wide plant spacing	8%	40%	60%
Well drained soils	8%	60%	40%
Compost	2%	no rating	no rating
Drip irrigation	6%	25%	75%
Raised beds	25%	31%	69%
Narrow rows	22%	43%	57%
Water in daytime	11%	67%	33%
Straw mulch	14%	12%	88%
Hay mulch	2%	100%	0%
Mulch	13%	38%	62%
Hand weeding	8%	50%	50%
Resistant varieties	3%	50%	50%
Mow leaves after harvest	3%	0%	100%
Renovation	6%	33%	67%
Proper fertilization	3%	50%	50%
Good air circulation	3%	0%	50%
Hills	2%	0%	100%
Fall planting	2%	0%	100%
Remove host plants	2%	0%	100%
Plant in fallow ground	2%	0%	100%
Mow edge of field	2%	0%	100%
Soil testing	2%	100%	0%
Reduce compaction	2%	0%	100%
Wide walkways	2%	0%	100%

IV. Weeds

General Description of Damage: Weeds reduce yields by competing with the crop for water, light, and nutrients. Weeds can also serve as alternate hosts for insects, diseases, and nematodes. They can inhibit spray penetration, air circulation, and drying conditions. They can also promote infestations by small vertebrate pests such as voles and mice. In a perennial planting, a variety of weed types and species are often found, including summer and winter annual broadleaf weeds and grasses, and perennial broadleaf weeds and grasses. Practices for each category are summarized below.

Annual Grass Weeds

Frequency of Occurrence: 98% of survey respondents report occurrence with 85% reporting the need for annual control, 11% reporting the need for occasional control, and 4% reporting annual grass weeds are rarely a problem.
Damage Caused: See General Description of Damage above.
Percent acres affected: undetermined
Timing of Control: pre and post emergence.
Yield Losses: undetermined
Regional Differences: none identified.
Biological control: none identified
Other Issues: none identified

Annual Broadleaf weeds

Frequency of Occurrence: 99% of survey respondents report occurrence with 92% reporting the need for annual control, 7% reporting the need for occasional control, and 1% reporting annual broadleaf weeds are rarely a problem.
Damage Caused: See General Description of Damage above.
Percent acres affected: undetermined
Timing of Control: pre and post emergence.
Yield Losses: undetermined
Regional Differences: none identified.
Biological control: none identified.
Other Issues: none identified.

Perennial Grass weeds

Frequency of Occurrence: 93% of survey respondents report occurrence with 61% reporting the need for annual control, 31% reporting the need for occasional control, and 8% reporting perennial grass weeds are rarely a problem.
Damage Caused: See General Description of Damage above.
Percent acres affected: undetermined
Timing of Control: pre and post emergence.
Yield Losses: undetermined
Regional Differences: none identified.
Biological control: none identified.
Other Issues: none identified.

Perennial Broadleaf weeds

Frequency of Occurrence: 96% of survey respondents report occurrence with 79% reporting the need for annual control, 17% reporting the need for occasional control, and 4% reporting perennial broadleaf weeds are rarely a problem.
Damage Caused: See General Description of Damage above.
Percent acres affected: undetermined
Timing of Control: pre and post emergence.
Yield Losses: undetermined
Regional Differences: none identified.
Biological control: none identified.
Other Issues: none identified.

Cultural Control Practices: A variety of cultural control practices are employed for weed control in strawberries. These practices are used for all types of weeds listed above and are summarized below:

Practice	% growers using	% excellent efficacy	% good efficacy	% poor efficacy
Mowing	42%	14%	65%	21%
Mulching	76%	21%	75%	4%
Cultivation	86%	25%	74%	1%
Hand weeding	89%	40%	58%	2%
Hoeing	78%	36%	62%	2%
Living mulch in aisles	13%	27%	64%	9%
Weeder geese	1%	0%	0%	100%

Preplant cover crops are also employed by 52% of New England strawberry growers. The following cover crops and their efficacy for weed suppression have been reported by survey respondents:

Cover Crop	% growers using	% excellent efficacy	% good efficacy	% poor efficacy
Winter rye	40%	17%	78%	5%
Oats	32%	41%	41%	18%
Ryegrass	2%	50%	50%	0%
Buckwheat	8%	57%	43%	0%
Red Clover	3%	33%	67%	0%
White Clover	2%	0%	50%	50%
Hairy vetch	1%	100%	0%	0%
Other				
Wheat	1%	100%	0%	0%
Sorghum Sudangrass	4%	50%	50%	0%
Millet	1%	0%	100%	0%
Dwarf perennial ryegrass	1%	na	na	na
Mixed grass, legume	1%	na	na	na

General description of herbicide practices: Weed infestations occur in mixed populations (i.e., annual and perennial grasses and broadleaf weeds). Herbicide applications are made often to control a range of weeds. Success in weed management can start with preplant site preparation practices including herbicide applications. Herbicide use is described below in table summarizing preplant applications and post plant preemergence and postemergence herbicide applications.

Pre-plant Chemical Controls for all weeds

Pesticide (listed alphabetically)	**Survey Data (% growers reporting use, % acreage, efficacy rating)**	**Typical Dose (a.i./A)**	**Of Respondents, Rate Reported**	**PHI days**	**REI hours**	**Comments**
glyphosate (Roundup Ultra 4S)	34% growers 39% acres 65% excellent efficacy 30% good efficacy 5% poor efficacy	3.12 lb	81% full rate 19% reduced rate	14	12	
paraquat (Gramoxone Max)	2% growers 3% acres 50% excellent efficacy 50% no efficacy rating	0.49 lb	100% full rate	21	24	Restricted use material
Other Pesticides						
DCPA (Dacthal F, W75)	1% growers <1% acres 100% poor efficacy	7.5 lb	100% full rate	na	12	
metam-sodium (Vapam HL)*	1% growers 2% acres 100% excellent efficacy	320 lbs	100% full rate	na	48	Soil Fumigant Restricted Use Material
methyl bromide + chloropicrin (Terr-O-Gas 33)	4% growers 4.8% acres 33% excellent efficacy 67% good efficacy	725 lbs	100% full rate	na	na	Soil Fumigation Restricted use material
Other Fumigation	1% growers 3% acres 100% excellent efficacy		100% full rate			

oxyfluorfen (Goal 2XL)	1% growers 1% acres 100% excellent efficacy	0.5 lb	100% full rate	na	24	
terbacil (Sinbar)	1% growers 1% acres 100% excellent efficacy	0.4 lb	100% full rate	70	12	

Pre-Emergence Weed Control in Established Plantings

Pesticide (listed alphabetically)	**Survey Data (% growers reporting use, % acreage, efficacy rating)**	**Typical Dose (a.i./A)**	**Of Respondents, Rate Reported**	**PHI days**	**REI hours**	**Comments**
napropamide (Devrinol 50DF)	64% growers 65% acres 19% excellent efficacy 73% good efficacy 8% poor efficacy	2.0 lb	76% full rate 24% reduced rate	na	12	
oxyfluorfen (Goal 2XL)	7% growers 12% acres 33% excellent efficacy 50% good efficacy 17% poor efficacy	0.5 lb	57% full rate 43% reduced rate	na	24	
terbacil (Sinbar)	1% growers 1% acres 100% excellent efficacy	0.4 lb	100% full rate	70	12	
Other Pesticides						
2,4-D (Formula 40, Amine 4)	1% growers 3% acres 100% good efficacy	0.95 lbs	100% full rate	ns	48	
DCPA (Dacthal F, W75)	16% growers 15% acres 23% excellent efficacy	7.5 lb	77% full rate 23% reduced rate	na	12	

	54% good efficacy 23% poor efficacy					
methyl bromide + chloropicrin (Terr-O-Gas 33)	1% growers 1% acres 100% excellent efficacy	725 lbs	100% full rate	na	na	Soil Fumigation Restricted use material
paraquat (Gramoxone Max)	1% growers <1% acres 100% good efficacy	0.49 lb	100% reduced rate	21	24	Restricted use material
Other Strategies						
Black Plastic	1% growers 1% acres 100% excellent efficacy	na	na	na	na	

Post-Emergence Weed Control in Established Plantings

Pesticide (listed alphabetically)	**Survey Data (% growers reporting use, % acreage, efficacy rating)**	**Typical Dose (a.i./A)**	**Of Respondents, Rate Reported**	**PHI days**	**REI hours**	**Comments**
2,4-D (Formula 40, Amine 4)	41% growers 38% acres 28% excellent efficacy 65% good efficacy 7% poor efficacy	0.95 lbs	88% full rate 12% reduced rate	ns	48	Broadleaf weeds only
clethodim (Select 2EC)	15% growers 27% acres 9% excellent efficacy 91% good efficacy	0.125 lb	92% full rate 8% reduced rate	4	24	
paraquat (Gramoxone Max)	12% growers 17% acres 73% excellent efficacy 27% good efficacy	0.49 lb	50% full rate 50% reduced rate	21	24	Restricted use material
pelargonic acid (Scythe)	2% growers 1% acres 50% excellent		100% full rate			

	efficacy 50% no efficacy rating 4% poor efficacy					
sethoxydim (Poast)	35% growers 29% acres 24% excellent efficacy 72% good efficacy 4% poor efficacy	0.47 lb	78% full rate 22% reduced rate			
Other Pesticides						
glyphosate (Roundup Ultra 4S)	1% growers <1% acres 100% excellent efficacy	3.12 lb	100% full rate	14	12	
napropamide (Devrinol 50DF)	1% growers 3% acres 100% excellent efficacy	2.0 lb	100% full rate	na	12	
oxyfluorfen (Goal 2XL)	1% growers 3% acres 100% excellent efficacy	0.5 lb	100% reduced rate	na	24	
terbacil (Sinbar)	2% growers 4% acres 100% good efficacy	0.4 lb	100% reduced rate	70	12	

V. Vertebrate Pests

Whitetail Deer (*Odocoileus virginianus*)

Type of pest: large vertebrate

Biology: White-tailed deer breed from mid-September through late February, with peak breeding occurring during mid-November. Fawns are born in the spring after 200 days gestation. Does (and occasionally fawns) usually produce a single fawn during their first pregnancy. Twins are typically born in subsequent years in areas with adequate food resources. Triplets may also occur.

Bucks begin antler development in spring and antler size depends on both age and nutrition. The growing bone is covered with hairy skin called velvet which nourishes the antler. The bone hardens and the velvet is rubbed off in the fall. Bucks shed their antlers each winter.

Deer consume a variety of vegetative foods and show considerable preferences for individual plants and plant parts. Commonly-eaten foods include grasses, fruits, nuts, herbs and mushrooms, as well as leaves and stems from trees and shrubs. Deer concentrate their feeding on woody materials when herbaceous plants are unavailable. Strawberries provide early green forage for deer in the spring.

Frequency of Occurrence: 63.5% of respondents reported this pest occurring at least occasionally.

Control needed	Percent of growers
routine annual control	48%
occasional control	15%
rarely a problem	17%
never a problem	20%

Damage Caused: Deer may occasionally trample crops, but the primary form of damage consists of feeding on selected plant parts. Deer readily browse strawberries in the early spring when few alternative foods are available. Without control measures, damage levels may severely reduce crop yields on many sites especially in sites near woods or other refugia.

Deer browsing damage is readily distinguished from that caused by rabbits or rodents. Deer leave a ragged, broken end on browsed crowns or rip crowns out of the ground, compared to the cleanly-nipped terminal left by other wildlife.

Percent acres affected: undetermined

Timing of Control: Early season control is the most important, especially in newly planted fields. But, year-round control must be maintained in high pressure locations.

Yield Losses: undetermined

Regional Differences: none identified

Cultural Control Practices:

Practice	% respondents using	% excellent efficacy	% good efficacy	% poor efficacy
Electric fence	21%	31%	54%	14%
Shooting	29%	21%	58%	21%
Fence (non-electric)	15%	10%	60%	30%
Deer repellent	3%	0%	50%	50%
Dogs	6%	25%	75%	0%
Noise	2%	0%	100%	0%
Soap	5%	0%	33%	67%
Human hair	3%	50%	0%	50%
Garlic	2%	0%	0%	100%

Biological control: None identified
Postharvest Control Practices: Deer do not feed on fruit, so control is not related to the harvest period.
Other Issues: Efficacy and affordability of control measures need to be addressed by research.

Mice and Voles (*Peromyscus sp, Microtus pennsylvanicus, Microtus pinetorum*)

Type of pest: small vertebrate
Biology: White-footed mice are commonly found in diverse habitats including open, grassy, brushy and wooded areas. They spend the winter as a family group in a nest made of stems, leaves, sticks and roots and lined with fur, feathers or shredded cloth. Nests are found underground or in protected areas such as old burrows, under boards, hollow logs or buildings. Breeding occurs from spring to fall, with two to four litters of one to eight young per year. Mice born in spring or summer may breed that same year. White-footed mice feed in an area from 1/3 to 4 acres.
Voles are active day and night the entire year. They construct a complex tunnel system with surface runways and numerous burrow entrances. A single tunnel system may contain several adults and young.
Voles have short life spans, ranging from two to sixteen months. Breeding occurs primarily in spring and summer, producing from one to five litters of three to six young per year. Females mature in 35 to 40 days.
Frequency of Occurrence: 22.7% of respondents reported this pest occurring at least occasionally.

Control needed	Percent of growers
routine annual control	9%
occasional control	13%
rarely a problem	33%
never a problem	44%

Damage Caused: Mice and voles feed on underground plant parts. When populations are high, crop damage to roots and crowns can be extensive. In addition to direct feeding on the strawberry plants, their extensive tunnel systems cause root destruction and interfere with crop irrigation, as well. In late summer and fall, voles store seeds, tubers, bulbs and rhizomes in their tunnels which can add to weed control problems in the field.
Percent acres affected: Undetermined
Timing of Control: Early season control is the most important, especially in newly planted fields. But, year-round control must be maintained in high pressure locations.
Yield Losses: Undetermined
Regional Differences: none identified

Cultural Control Practices:

Practice	% respondents using	% excellent efficacy	% good efficacy	% poor efficacy
Cats	2%	0%	100%	0%
Traps	2%	0%	100%	0%
Poison Bait	6%	0%	100%	0%
Cannon	2%	0%	0%	100%

Biological control: None identified
Postharvest Control Practices: Mice and voles do not feed on fruit, so control is not related to the harvest period.
Other Issues: None identified.

Birds (*various species*)

Type of pest: small vertebrate
Biology: Various
Frequency of Occurrence: 57.7% of respondents reported this pest occurring at least occasionally.

Control needed	Percent of growers
routine annual control	30%
occasional control	28%
rarely a problem	30%
never a problem	13%

Damage Caused: Birds (especially Cedar Waxwings, *Bombycilla cedrorum*) feed on ripe fruit in the field by pecking at it. This damage renders the fruit unmarketable. Feeding damage varies widely by location and year.
Percent acres affected: Undetermined
Timing of Control: Early season control so that birds do not begin feeding on fruit. Once feeding has started, bird management is much more difficult.
Yield Losses: Undetermined
Regional Differences: bird pressure varies a lot with location, but a method for predicting high pressure locations, aside from field history, has not been established to date.

Cultural Control Practices:

Practice	% respondents using	% excellent efficacy	% good efficacy	% poor efficacy
Scare eye balloons	11%	0%	71%	29%
Owl	2%	0%	0%	100%
Shooting	9%	17%	50%	33%
Mylar tape	4%	0%	0%	100%
Scare devices	4%	0%	0%	100%
Chasing out	4%	0%	50%	50%
Dog	2%	0%	100%	0%
Fire crackers	4%	0%	50%	50%
Bird bangers	4%	0%	50%	50%
Propane cannon	2%	0%	100%	0%
Reflective mirror	2%	0%	100%	0%

Biological control: None identified
Postharvest Control Practices: None identified.
Other Issues: None identified.

Other vertebrate pests

Turkey: 8% of respondents reported this pest occurring.
Squirrel: 6% of respondents reported this pest occurring.
Woodchuck: 4% of respondents reported this pest occurring
Chipmunk: 3% of respondents reported this pest occurring.
Moose: 2% of respondents reported this pest occurring
Skunk, Cedar Waxwings, Cows: 2% of respondents reported these as pests.

VI. Acknowledgements and Contacts

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