

New England Pepper Crop Profile 2005

Compiled for the PRO New England Pest Management Network
Candace L. Bartholomew
University of Connecticut
1800 Asylum Ave.
West Hartford, CT 06117
Phone: 860-570-9067
Email: Candace.Bartholomew@UConn.edu

With Assistance from:
David Stanley
IPM Consultant
Belchertown, MA
and
Glen Koehler
University of Maine Cooperative Extension

Note: This profile is a comprehensive list of pests that may be encountered by new England Pepper growers, and the approved pesticides that may be used to control them. Only a few pests actually require treatment on an individual farm in a single year. For each pest the available effective options are listed. If treatment is needed, only one of those options would be used per application. Some pests require multiple applications to accomplish acceptable control; others only require a single application.

I. Introduction

Peppers comprise a surprisingly large portion of the American diet. According to Economic Research Service/USDA, (ERS/USDA), Commodity Spotlight December 2001, "24 percent of Americans consume at least one food containing bell peppers per day." ERS further believes that this consumption is higher today than during the 1994-1996 survey period. The 2001 ERS document states that "Fresh-market bell peppers are used on any given day by 10 percent of consumers while processed peppers (frozen, canned, and dried), appear on the plates of 16 percent of U.S. consumers daily."

This crop profile provides a snapshot of current pest management practices for a crop. It has the basic production statistics, synopses of cultural and worker activities in producing the crop as they relate to pest management, a summary for each pest describing its severity and frequency, the damage it causes, and how it is managed. For each pest, there is a table of descriptive information on the controls used. For each pesticide active ingredient, there is information from the pest management tactic survey, Extension guidelines, and labels on how frequently it is used, how it is applied, application rates, and restrictions.

Information for this crop profile was collected from a survey of New England pepper growers. The survey results are available at <http://pronewengland.org/INFO/PROInfoSurvey.htm>. Survey questions shown in this report asked growers to choose the single most appropriate answers unless noted as "Circle all that apply".

A. The Survey Process

A mailing list of vegetable growers from each New England state was obtained from vegetable specialists at the Land Grant Universities. Using the Dillman (2000) survey method, 456 surveys were sent to people on the mailing lists in March of 2006. Fifty two percent (242) of growers responded to either the first or second mailing. Of these, 49% identified themselves as actively producing peppers. The total number of usable responses was 221 representing 140.5 acres of peppers grown in New England.

Pepper Pest Management Survey Returns Returns

State	# Surveys Sent	# Surveys Returned	% Returned	# Growing Peppers	# Pepper Acres
CT	86	42	49	10	1.1
MA	136	60	44	40	88.4
ME	40	30	75	20	6.5
NH	58	29	50	11	8.5
RI	108	45	42	4	32.1
VT	30	15	50	7	3.984
Total	456	221	49	92	140.5

B. Production Facts

The USDA National Agricultural Statistics Service New England Fruits and Vegetable 2002 Crop survey indicates that in the six New England states 735 farms produced 1,027 acres of bell peppers and 379 farms produced 337 acres of chile peppers (chile peppers represent all peppers except bell). Ninety percent of the growers responding to our survey produced sweet peppers on 126 acres. Ten percent produced hot peppers including cubanella on 15 acres. New England produces 0.002 % of the peppers grown in the U.S. according to the 2002 U.S. Census.

Growers produced estimated an average yield of 565 bushels of peppers per acre per year. Many growers did not know the yield of their pepper crops.

Over the past five years, what is your average annual yield of harvested peppers per acre? (N=68)*

Number of Growers Reporting average bushel/acres	39
Percent of Growers	42%
Number of Acres	69
Percent of Acres	49%
Total Bushels/Year	57,547
Average Bushels/Acre	565
Number of growers (percent) reporting that they don't know yield	27 (29%)

*N is used throughout the entire document and refers to the number of growers who answered the question.

What percentage of your pepper crop is: (N=92)

Type	Percent of growers	Acres	Percent of Acres
Sweet Peppers	100	126	90
Hot Peppers	77	13	9
*Other (Cubanelle)	7	1	<1

In New England Peppers are grown by local diversified fresh market vegetable producers. Ninety eight percent of peppers are grown for the wholesale or retail fresh market.

Question A4. What percentage of your pepper crop is sold through each of these markets? (N= 92)

Markets	#Acres	%Acres
Fresh market, wholesale	89	64
Fresh market, retail	49	35
Processing	2	1
U-Pick/Pick Your Own	<1	<1
*Other	<1	<1

*Community Supported Agriculture (CSA) and Home kitchen

Most growers use informal rather than on formal, scheduled pest sampling. Of the growers surveyed, 51% considered themselves as using IPM, 26% said they were organic and 17% called themselves conventional growers.

II. Basic Commodity Information

Production Statistics

Acres Harvested per State: (2002 Census of Agriculture)

Connecticut	531
Maine	86
Massachusetts	519
New Hampshire	63
Rhode Island	127
Vermont	78
Total:	1,404 Acres

Cash value: The New England Agricultural Statistics 2005, reported price data only for Maine, Massachusetts, New Hampshire and Vermont. The average price per pound was \$0.82. The 2005 USDA Vegetables and Melons Situation and Outlook Yearbook estimated the national 2004 season average price per cwt as \$34.30, i.e. \$0.34 per pound.

Cultural Practices

In New England, pepper seedlings are generally started in greenhouses and planted in the field as transplants. Transplant production takes 6 to 8 weeks. One week before field setting, transplants are hardened off to reduce transplant shock and speed establishment in the field.

Field establishment of peppers may be accomplished by several methods: planting into flat or raised plastic mulched beds, and either transplanting or direct seeding into flat, bare ground. Each system has advantages and disadvantages.

Which of the following practices do you use? (Circle all that apply.)
(N= 92)

Practices	#Growers	%Growers
Transplanted in flat mulched beds	31	34
Transplanted into raised mulched beds	35	38
Transplanted into unmulched ground	29	33
Direct seeded into unmulched ground	0	0
Reduced or No-till planting	0	0
Fresh manure	4	4
Composted manure	19	21
Trickle irrigation	52	57
Overhead irrigation	26	28
None of the above	0	0
*Other	7	8

* silver plastic, dried chicken manure, soy meal, row cover at transplant with wire, leaf based compost

If raised, plastic covered beds are used; these beds are generally dome-topped. These raised beds are mulched with black or reflective colored polyethylene film. Trickle irrigation is laid under the poly film. This planting system reduces the destructive potential of Phytophthora blight as long as the irrigation system is monitored for leaks. Raised beds are planted 5 to 6 feet apart on center, and plants set 15 inches apart in double staggered rows spaced 15 to 18 inches apart. Advantages of this planting method include increased yields due to enhanced water and nutrient management with trickle irrigation and reduced stress on plants. Thirty eight percent of growers reported using this method of raising peppers.

Flat, plastic-mulched beds are managed similarly to the raised, mulched beds except that raised beds are not formed. Trickle irrigation is not usually used with flat bed planting systems. Flat beds may encourage Phytophthora establishment during rainy periods because of the reduced drainage characteristic of the flat bed. Thirty four percent of growers planted into flat mulched beds.

Peppers can also be transplanted into flat bare ground. In this system, plants are set in single rows 3 to 5 feet apart with plants 12 inches apart in the row. Thirty one percent of growers reported planting in this fashion.

Peppers can be seeded in single rows 4-5 feet apart or in double rows., with plants set 12 inches apart. None of the growers responding to the survey directed seeded peppers.

None of the growers who responded the survey used reduced or no-till planting techniques. Fifty two percent of growers used trickle irrigation while 26% used overhead irrigation.

Soil sampling for fertility needs is conducted every one to two years by 67% of growers, 24% of growers do not sample for fertility needs.

Do you use tissue analysis to determine fertilizer needs in most years?
(N=92)

Soil sample frequency	#Growers	%Growers
More than 1 time each year	4	4
Once every year	30	32
Once every 2 years	32	35
Once every 3 years	3	3
General soil sampling not specific for peppers	3	3
No soil sampling for fertility needs	22	24

Worker Activities

Workers may come in contact with treated plants while conducting four separate tasks during production. First, transplants are moved from the greenhouse to the field by hand for planting once all danger of frost has passed.

Often pepper bedding plants are treated for aphids. If these plants are destined for retail sale it is more likely that the transplants will have been treated. Up to two sprays for aphids may be made to transplants before they go to the field. The most commonly used materials for aphid control and their restricted entry intervals (REI) are; Lannate L (48 hours), Orthene 75S (24 hours), Provado (12 hours), and Admire 2F (12 hours).

The second activity, hand weeding, is occasionally conducted in fields where peppers are grown using plastic mulch to remove any vigorously competing weeds. Fields without mulch are usually hoed to control weeds twice during the season.

The third activity where pesticide exposure is likely is harvesting. Most harvesting is done by hand. In 2005 several Massachusetts growers used machines for harvesting peppers that were to be processed.

Exposure is also possible during pesticide applications. While most pesticide applications are made by boom sprayers, some spot treatments are made with backpack sprayers. Wearing protective clothing can pose a serious hazard in summer heat, and heat stroke risk can pose a more immediate and severe health concern than pesticide exposure.

Prolonged day to harvest intervals like Orthene (7dh) and Asana (7dh) can create problems at harvest. Growers have been encouraged to use alternative insecticides.

III. Pest Management Overview

New England growers identified diseases as the most frequent reason for using pesticides.

Please estimate your average number of pesticide applications for peppers used in a typical year: (N=90)

Pest	#Average Number of Sprays
Disease	2.3
Weeds	2.1
Mites	0.6
Insects	0.3

Diseases

Bacterial leaf spot and Phytophthora are the two most important disease problems. Bacterial soft spot, anthracnose, cucumber mosaic virus and Pythium were less important, but still problems for many growers. Overall 18 diseases were identified that require annual management, occasional management, or are never a problem to growers.

Which of these diseases require routine annual management, require occasional management, or are never a problem on your farm? (N=87)

Rank	Disease	Weighted Value*
1	Bacterial leaf spot	114
2	Phytophthora	98
3	Bacterial soft spot	52
4	Anthracnose	40
5	Cucumber Mosaic Virus	36
5	Pythium	36
7	Rhizoctonia	30
7	Sclerotinia	30
9	Alternaria	28
9	Cercospora leaf spot	28
11	Tomato spotted Virus	26
11	Tobacco Mosaic Virus	26

13	Potato Virus	16
14	Tobacco Etch Virus	14
14	Stubby Root Nematodes	14
16	Northern Root Knot Nematodes	12
16	Lesion Nematodes	12
18	Alfalfa Mosaic Virus	8

*The weighted value was determined by multiplying number of growers who chose routine annual management by 4, occasional management by 2, and never a problem by 0.

Which of the following practices do you use to manage diseases?
(Circle all that apply.) N=90

# Growers	% Growers	Practices used to manage diseases
67	73	Weed management practices to minimize disease risk
67	73	Use disease resistant varieties
49	53	Elimination of overwintered inoculum sources such as leaves or other plant materials from previous season
47	51	Avoid any highly susceptible plant varieties
39	42	Fertilization practices to minimize disease risk
33	36	Plant spacing or pruning to open canopies and promote air circulation
25	27	Spring/Summer monitoring of disease infection periods
22	24	Pruning out infected tissues, scouting to remove infected plants as symptoms appear
9	10	Pre-season assessment of disease inoculum levels and/or infection risk
7	8	Crop rotation
5	5	Thinning to promote air circulation
1	1	Compost manure

While few growers use formal crop monitoring for diseases, none of them apply disease controls on a calendar basis. Only 8% of growers used crop rotation, one of the most important practices for controlling the main diseases of peppers. Water management is the most important practice to control Phytophthora but was not listed as a practice to be chosen in the survey.

What kinds of pest monitoring do you use for disease management decisions? (N=89)

# Growers	% Growers	Pest Monitoring Practices
0	0	No monitoring, spraying made on preplanned calendar basis
44	48	Informal observations influence decisions, but no special field visits for pest observations
49	53	Field visits made for purpose of pest observations, but not following a standard procedure and threshold
9	10	Infection period duration or intensity estimated, leaf or fruit sampling for symptoms.
2	2	Detailed infection period tracking and sampling, and/or use of disease models

Weeds

Growers had almost as much pesticide input for weed control as for diseases. They reported making 2.1 sprays per year to control weeds.

Which of these pests require routine annual management, require occasional management, or are never a problem on your farm?
(Please circle your answers) (N=90)

Rank	Weeds	Annual Management	Weighted Value
1	Annual broadleaf	72	302
2	Annual grasses	59	262
3	Perennial broadleaf	32	168
4	Perennial grasses	29	160

Which of the following weed management practices did you use for peppers? (N=92)

Practice	#Growers	%Growers	Excellent	Good	Poor
Mechanical cultivation	73	79	32	38	2
Hand pulling	72	78	43	28	0
Hoeing	61	66	37	23	0
Shielded application (between rows)	20	22	13	6	1
Banded herbicide application (over the row only)	7	8	1	5	1
Spot Treatment	7	8	2	4	1

Please select the option that best describes your use of monitoring for weed management. (N=88)

# Growers	% Growers	Pest Monitoring Practices
15	16	Treatment made on calendar basis
66	72	Decisions based on informal observations, but no formal weed scouting or weed mapping
11	12	Weed scouting records or weed map used for at least some plantings

Insects and mites

Which of these insects/mites require routine annual management, occasional management, or are never a problem on your farm? (N= 89)

Rank	Insect/Mite	Weighted Value*
1	European corn borer	180
2	Aphids	128
3	Pepper maggot	110
4	Colorado potato beetle	90
5	Corn earworms	88
6	Flea beetles	78
7	Fall armyworms	58
8	Common stalk borer	50
9	Hornworms	46
10	Black cutworms	40
10	Two spotted spider mite	40
12	Japanese/Asiatic	38
13	Leafminers	36
14	Thrips	32
15	Plant/Stink Bugs	30
16	Pepper weevil**	26
16	Caterpillars	26
16	Wireworms	26
19	Slugs	24
20	Beet armyworms	18
21	Cyclamen mites	14
22	Grasshoppers	6

* Weighted value was determined by multiplying routine annual management by 4, occasional management by 2, and never a problem by 0.

** There are no pepper weevils in New England, growers are misidentifying this pest.

Which of the following practices do you use to manage insects and/or mite pests? (Circle all that apply.) (N= 82)

#Growers %Growers Practices used to manage insect and mite pests

62	67	Elimination of plant material from previous season as source of overwintered pests
60	65	Field monitoring of pest and beneficial populations
55	60	Weed management practices to minimize insect/mite pest risk
32	35	Fertilization practices to minimize insect/mite pest risk
15	16	Trapping for monitoring or direct control
7	8	Use degree-day or other pest models to time applications
7	8	Perimeter crop trapping
5	5	Crop rotation
4	4	Release predatory mites and insects

What kinds of pest monitoring do you use for insect or mite pest management decisions? (Please circle the answer that fits best) (N=86)

#Growers %Growers Pest Monitoring Practices

3	3	No monitoring, spraying made on preplanned calendar basis
36	39	Informal observations influence decisions, but no special field visits for pest observations
47	51	Field visits made for purpose of pest observations, but not following a standard procedure and threshold
5	5	Sampling according to standard procedures or traps, and comparing observations to pest threshold
8	9	Use of pest forecast and tracking models and equipment to determine need or adjust timing for sampling or control measures

Information Sources

Growers use the *New England Vegetable Production Guide*, off-season educational meetings, newsletters, University/Extension Staff, other growers and twilight meetings as the most important sources of pest management information. There is limited use of web sites for supporting information. Trade publications and technical bulletins, pesticide dealers/field persons were identified as the least important sources of information for making pest management decisions.

New England pepper growers cite applicator hazard as the primary consideration in choosing a pesticide, with cost per treatment ranked #7 out of 10 options.

How important are these factors to you when choosing pesticides for use on your farm? (N=85)

Factors for choosing Pesticides	Rank	Weighted Value*	Very important	Somewhat important	Not imp.
Applicator hazard (toxicity to humans)(protective equipment)	1	272	60	16	2
Effectiveness against pest compared to alternative products	2	258	58	13	3
Customer relations (food safety concerns)	3	256	56	16	6
Potential non-target and environmental impact	4	240	48	24	2
Impact on beneficial species (parasites, predators, pollinators)	5	232	45	26	1
Label restrictions (reentry and pre-harvest intervals)	6	244	52	18	5
Cost per treatment	7	170	25	35	11
Size or type of packaging	8	136	15	38	21
Storage requirements	9	122	16	29	27
Formulation (liquid vs. dry, water soluble bags) Conventional liquid or dry concentrate vs. measured doses (tip and pour, tablets or water soluble packets)	10	96	12	24	36

*Weighted value was determined by multiplying very important by 4, somewhat important by 2, and not important by 0.

A complete summary of responses to the survey is online at:

<http://pronewengland.org/Content/PROInfoSurvey.htm>

Diseases

Group A – Diseases identified by survey as most important

Which diseases require routine annual management, require occasional management, or are never a problem on your farm? (N= 87)

Rank	Disease	Weighted Value*
1	Bacterial leaf spot	114
2	Phytophthora	98
3	Bacterial soft spot	52
4	Anthracnose	40
5	Cucumber Mosaic Virus	36
5	Pythium	36
7	Rhizoctonia	30
7	Sclerotinia	30
9	Alternaria	28
9	Cercospora leaf spot	28
11	Tomato spotted Virus	26
11	Tobacco Mosaic Virus	26
13	Potato Virus	16
14	Tobacco Etch Virus	14
14	Stubby Root Nematodes	14
16	Northern Root Knot Nematodes	12
16	Lesion Nematodes	12
18	Alfalfa Mosaic Virus	8

*The weighted value was determined by multiplying routine annual management by 4, occasional management by 2, and never a problem by 0.

General Management and Control of Pepper Diseases

Because no field-applied fungicides are effective enough to stop the major pepper diseases, especially during prolonged periods of wet weather, preventive practices are essential to profitable pepper production in New England.

Bacterial Leaf Spot (BLS)

Type of Pest: Bacteria

Bacterial leaf spot (BLS) is a bacterial foliar disease of peppers caused by *Xanthomonas campestris* pv. *vesicatoria*. BLS does not have a protected spore stage and requires continuous moisture and susceptible plant tissue to remain infective. After two years in the soil in the absence of host crops, it is destroyed by normal soil flora and fauna. When introduced into a field it will spread under warm humid conditions aided by rain splashes and wind that move the bacterial slime from plant to plant. High powered air blast spray rigs can accomplish the same thing.

Frequency of Occurrence:

It is the most common disease of peppers in the Eastern United States.

Damage Caused:

Leaf spots are water-soaked initially, then turn brown and become irregularly shaped. Affected leaves tend to crinkle around brown spots, turn yellow and drop. Yield is reduced because defoliation reduces plant productivity and fruit becomes vulnerable to sunscald. Fruit may also develop raised, scab-like spots. There have been instances in recent years of complete crop failure due to this disease.

% Acres Affected:

	Number	Percent
Acres Treated	85	61
Growers	24	26

Regional Differences:

Six important races of the pathogen exist in the United States. Three, races; 1, 2, and 3 have been found in New England.

Cultural Control Practices:

Selection of resistant varieties, especially those with resistance to more than one race of the disease is recommended.

Use only certified disease-free seed or transplants produced from certified seed.

The Bacterial Leaf Spot pathogen can survive in infected crop debris. It takes two years for infected crop debris to completely breakdown. Rotate out of susceptible crops for at least two years. Do not rotate pepper with other solanaceous plants such as tomato, eggplant or potato.

IPM

Prevention is the best control. One of the most important sources of the bacterium that causes leaf spot in pepper is infested seed. Infested crop debris from previous plantings of solanaceous vegetables harbors the bacteria as do solanaceous weeds. Rain and irrigation play a significant role in spreading the disease once in the field. Also, overhead irrigation can spread the disease when leaves endure long wetting periods.

Prevention involves all of the following cultural controls: Use of hot-water treated seed (chemical seed treatments are only effective against pathogens on the seed surface); use of a 2-year rotation into non solanaceous crops; and control of solanaceous weeds such as nightshade, horsenettle and jimsonweed. Properly manage plant nutrition because healthy plants resist the disease. Low N levels predispose plants to BLS, as do high magnesium levels. Growers should use high calcium lime instead of dolomitic lime on peppers. Use pepper varieties that are resistant to as many races of BLS as possible such as: Boynton Bell (Harris Moran), Commandant (Rogers NK), Enterprise and Goldcoast (Asgrow), Summer Sweet 870 and 880 (Abbott & Cobb), and X3R Camelot, X3R Lancelot and X3R Wizard (Petoseed). As much as 1/3 of Connecticut acreage is already planted into BLS resistant peppers.

There can be substantial differences in yield between resistant and susceptible varieties grown in the presence of BLS. Harvested fruit weight from Boynton Bell was 2.6 times greater than Camelot in one experiment and 29 times greater than North Star in another experiment. Research has shown that resistant varieties prevent yield reduction from BLS more effectively than all chemical controls.

During the growing season, plants should be scouted for BLS weekly. Even resistant varieties should be scouted in case of seed failure or in the event that a new race or a resistant strain of the bacterium was introduced. When disease is found in a field, infected non-resistant plants should be rogued and buried and copper applied with boom or hydrostatic sprayer on a 7-10 day schedule. Spraying can be delayed indefinitely if daytime relative humidity drops below 50% or when night time low temperatures drop below 60°F. Once these conditions become the norm in late summer, spraying can be discontinued.

Copper can cause yield reductions of up to 2% per application, do not spray unless necessary (i.e. BLS found on susceptible varieties). While chemical control can be effective, it is not foolproof. Failure can occur when conditions are very favorable for disease development and when plants are infected with a bacterial strain that is resistant to copper.

Bacterial soft spot (N=88)

Pesticide	#Growers	%Growers	#Acres	%Acres	Exc.	Good	Poor
Kocide 4.5F	17	19	81	58	7	8	1
Manex	7	8	42	30	4	2	1
Basicop	3	3	18	13	3	0	0
Champ	2	2	1	<1	2	0	0
Other Strategies							
Disease resistant varieties	17	19	56	40	5	11	0
Hot water treatment for seeds	2	2	3	2	0	2	0

Agri-Mycin 17, Agri-Strep, and Chlorine were not used by growers.

Phytophthora diseases

Type of Pest: Fungus

Frequency of Occurrence:

Phytophthora blight is nearly ubiquitous in New England soils. The genus contains many destructive species that cause blights, cankers and rots. The name means "plant destroyer". Several Connecticut growers experienced near complete loss of solanaceous and cucurbit fields in 1996.

Damage Caused:

Phytophthora blight often causes stem or branch lesions that first appear water-soaked but rapidly girdle and kill the plant beyond the wound. The first symptom a grower may notice is the rapid wilting and death of plants following more than two inches rain. The disease often starts in low areas that remain flooded for at least 48 hours. Prolonged soil saturation causes resting spores from previous outbreaks to erupt and release swimming spores (zoospores). They travel through the water around saturated soil particles until they encounter host tissue. It is common to see several newly infected plants wilting along the row on either side of an earlier infected plant.

Infected fruit produce a white fungal growth on the skin. Successive heavy rainfalls can spread secondary spores throughout a field or on the wind to nearby sites. Heavy fruit infections are a sign that heavy crop losses will be suffered if the same field is planted into susceptible crops in following seasons unless IPM procedures are strictly followed (water management and use of resistant varieties).

% Acres Affected:

	Number	Percent
Acres Treated	70	50
Growers	20	22

IPM

Phytophthora spp. have true soil borne, resting spores that survive in the absence of hosts for many years. Once the spore numbers rise to destructive levels, even long rotations of five or more years will not necessarily reduce them. Recent outbreaks have demonstrated that even heavy use of all known chemical controls will not protect susceptible crops in heavily infested fields during periods of prolonged soil saturation. Therefore, the only sure control for Phytophthora blight is prevention.

Cultural Control Practices:

To avoid eventually ruining fields with heavy spore build up, growers are advised to rotate out of vine and solanaceous crops for a minimum of two years. Good rotation crops include corn and small grains. Do not compost rotting vegetables from off-site sources in fields. When using plastic mulch, the use of dome shaped instead of flat topped raised beds provides better water drainage in the plant root zone. Creating a waterway system of swales by ditching low "valleys" and the ends of rows limits the accumulation of standing water between beds and in fields. Use resistant varieties if infested fields can not be avoided. When enhancing drainage, put cover crops in swales to reduce top soil erosion. They can be small grains or combinations of small grains and nitrogen fixing cover crops like crimson clover or hairy vetch.

Chemical Controls:

Bravo (chlorothalonil), Ridomil (metalaxyl)/Bravo, and Manex are registered for Phytophthora on pepper fruit but have no effect on the soil-borne stem girdling form of the disease.

Phytophthora Crown Rot and Blight (N=89)

Pesticide	# Growers	% Growers	# Acres	% Acres	Exc.	Good	Poor
Ridomil Gold EC	9	10	43	30	2	6	1
Ridomil Gold Copper	7	8	50	36	1	3	3
Manex	6	7	48	34	1	2	3
Tanos	2	2	3	2	0	1	1
Vapam	1	1	2	1	0	1	0
Acrobat	1	1	1	<1	0	1	0
Phospet	1	1	<1	<1	0	0	0
Oxidate	1	1	<1	<1	0	1	0
Other Strategies							
Resistant varieties	4	4	7	5	2	1	1
Raised bed	1	1	1	<1	0	1	0

Group B – Diseases identified by survey as significant problems in some years

Bacterial Soft Rot *Erwinia carotovora* pv. *carotovora*.

Type of Pest: Bacteria

Soft rot in peppers is caused by opportunistic bacteria that enter through wounds.

Frequency of Occurrence:

Soft Spot is worst in wet weather because the bacteria are splashed from the ground onto the fruit. Epidemics of soft rot in New England fields are always associated with heavy insect damage (e.g. European corn borer, pepper maggot).

Damage Caused:

Soft spot usually begins in the stem end of the fruit. The internal tissue softens, and the pepper turns into a watery mass. The pepper often has a foul smell.

Timing of Control:

Since bacterial soft rot enters fruit via wounds it is important to prevent damage to the fruit. Harvest practices which lead to wounded fruit can spread bacterial soft spot.

IPM

Control the insect pests that cause soft rot by following the IPM recommendations outlined in the Insect Pests section below. Consider disease risk from post-harvest wash water that can spread the bacterium from contaminated to healthy fruit.

Anthracnose

Type of Pest: Fungus

Several species of the fungus *Colletotrichum*

Frequency of Occurrence:

Anthracnose is found on and in pepper seed and residue from diseased plants. The disease is favored by wet conditions and high temperatures.

Damage Caused:

Water-soaked, shrunken lesions are usually found on ripe fruit. The lesions have dark brown or black fungal spores in them. The center of the lesions may develop pustules of salmon colored spores. Small necrotic spots may occur on the underside of leaves.

Timing of Control:

Start by using certified disease free seed and crop rotation.

IPM

Control the insect pests that cause soft rot by following the IPM recommendations outlined in the Insect Pests section below.

Group C – Diseases identified by survey as infrequent pest problems

Viruses

Cucumber, Tobacco, Tomato, and Tomato Spotted Wilt Mosaic Viruses
(N=87)

Pesticide	#Growers	%Growers	# Acres	% Acres	Exc.	Good	Poor
Zerotol	1	1	4	3	1	0	0
Champion	1	1	1	<1	1	0	0
Amarcarb	1	1	1	<1	1	0	0
Other Strategies							
Pull plants that had symptoms	1	1	3	2	0	0	0

Chlorine was not used by growers

Type of Pest: Viruses

Frequency of Occurrence:

Viruses enter plants through wounds which result from mechanical damage during transplanting or pruning or sometimes through wounds caused by insects. Cucumber mosaic virus is transmitted by aphids.

Damage Caused:

It is difficult to distinguish single or multiple virus infections in the field. Most of these viruses induce degrees of mosaic, mottle, vein banding, and plant stunting. Malformation, leaf cupping, and fruit distortion may also be encountered. Accurate diagnosis is dependent on laboratory tests involving serology or viral inclusion examination.

Tobacco Mosaic Virus: Reduced vigor of the plant and a yellow chlorotic spotting of foliage is a sign of tobacco mosaic virus. Plants may be stunted and distorted with curled leaves and stems.

Cucumber Mosaic Virus: Symptoms vary, but plants generally show an overall lighter color (alternating light and dark green areas) especially on young leaves. The main leaf vein is often distorted and somewhat zigzag in appearance. Plants are generally stunted with curling leaves. Fruit may be malformed and have concentric rings or spots.

Tomato Spotted Wilt Virus: This virus is transmitted by thrips. Infected plants are chlorotic, stunted with dead (necrotic) spots on leaves or terminal shoots. Fruits show chlorotic spots, red and/or green areas surrounded by yellow halos, concentric rings that may become necrotic.

% Acres Affected

	Number	Percent
Acres Treated	5	4
Growers	2	2

IPM

Plant resistant varieties of peppers and practice crop rotation. A clean weed free field is one way to control viruses which may be harbored among weeds. These viruses are known to survive in numerous weed hosts such as ground cherries (*Physalis* spp.), nightshades (*Solanum* spp.) common groundsel (*Senecio* sp.), wild tobacco (*Nicotiana* sp.), toadflax (*Linaria* sp.), sicklepod (*Cassia* sp.), and jimson weed (*Datura* sp.).

Immediately remove any plants which appear to be infected and destroy them by burying them far from production areas. Viruses can remain viable in the soil for many years.

Control the insect pests that cause soft rot by following the IPM recommendations outlined in the **Major Insect Pests** section below.

Workers handling plants should wash hands with strong soap and water or 70% alcohol before handling plants.

Pythium and Rhizoctonia

Type of Pest: Soil or water born fungi often referred to as “Damping Off”

Frequency of Occurrence:

Pythium occurs most commonly in the greenhouse but occasionally in wet fields. High soil fertility and high moisture increase the severity of the disease.

Pythium root rot generally occurs after peppers are transplanted in polyethylene mulch/drip irrigation culture.

Damage Caused:

Pythium is a root rot disease. The disease spreads upwards, infected plants fall over as tissues become soft and mushy.

Rhizoctonia causes root or crown rot. It is an aggressive pathogen to young plants and a minor pathogen to older plants. Transplants that develop cankers in the greenhouse may perform poorly or not survive when planted into the field.

Timing of Control and IPM:

Control starts with cleanliness and disease-resistant seed. Care should be taken to prevent contamination of growing medium with infected tools, hoses or hands. Sanitize all infected equipment including flats and benches, etc. Dispose of all infected plant material including roots.

GENERAL DISEASE MANAGEMENT

Cultural Practices

Growers can implement many disease control measures at the time of site selection and field layout. Other cultural practices can reduce periods of foliar wetting and soil saturation. Some of the following cultural practices may be incompatible with other sustainable practices such as no-till and soil conservation. Grower must adapt conflicting strategies to each other based on the unique characteristics and needs of the farm.

1. Rotate out of solanaceous crops for 2 years (all pepper diseases)
2. Select disease tolerant or resistant varieties (Phytophthora, bacterial leaf spot, and viral diseases)
3. Plant disease free seed and transplants (Phytophthora, bacterial leaf spot, and viral diseases)
4. Hot water seed treatment (bacterial leaf spot)
5. Use a clean seedbed (Phytophthora, bacterial leaf spot, damping off)
6. Break up hardpans and plow pans by sub-soiling or V-ripping every few years to increase soil drainage. (Phytophthora)
7. Choose sites with good soil drainage and without low areas where water can pool. This reduces soil saturation. (Phytophthora)
8. Break beds to allow water to escape from low areas.
9. Choose sites with good air drainage like hill tops and gentle slopes. This reduces wetting periods (Phytophthora, bacterial leaf spot, and viral diseases)
10. Precisely manage fertility especially N and soil pH (bacterial leaf spot, blossom end rot)
11. Avoid over watering (Phytophthora, bacterial leaf spot)
12. Spot-till small areas of infected plants to reduce secondary spread through the air. (Phytophthora, bacterial leaf spot)
13. Control European corn borer and pepper maggot (soft rot)
14. Control or avoid fields with solanaceous weeds (bacterial leaf spot, viral diseases)
15. Avoid working in wet crop (Phytophthora, bacterial leaf spot)
16. Incorporate crop residue (bacterial leaf spot, viral diseases)
17. Clean all equipment (Phytophthora, bacterial leaf spot).
18. Do not compost rotting vegetables from off-farm in fields.

Seed and Seedling Treatment

There are some fungal antagonists on the market that can help

prevent seedling diseases by competing for space or consuming the pathogens themselves. Mycostop is a product labeled only for use in greenhouses that inhibits damping off.

Hot water treatment eliminates bacterial diseases such as bacterial leaf spot that reside within the seed. Seed companies do not hot water treat pepper seed but growers can do it themselves. Generally, seed company guarantees are rendered null and void when growers use hot water treatment so it is important to follow extension guidelines. Proper equipment is needed, including a precision thermometer, insulated vessel and stirring hot plate with a magnetic stir bar so that uniform temperatures are maintained. Equipment for hot water treatment of seed can be purchased for less than \$350 at various biological supply houses such as Fischer Scientific, Connecticut Valley Biological Supply and Nasco.

Have a container of cool water handy to prevent the temperature from getting too high. Treat pepper seed for 25 minutes at 122°F. Make sure the hotplate is maintaining the water at 122°F before beginning. Wrap seed loosely in cheesecloth or a piece of cotton cloth and add a metal bolt or sinker to keep the seed submerged. Check the temperature and time elapsed continuously using a piece of paper if necessary. Upon removing, cool the seed under tap water then spread the seed out on paper towels to air dry at 70-75°F. Due to the expense of hybrid seed, it is recommended to treat sample lots of 100 seeds and conduct a germination tests in the greenhouse until satisfied with the results before exposing the whole batch to the high temperature bath.

Natural/Biological Disease Controls

Interactions among and between soil arthropods and microbes are exceedingly complex and difficult to study. Present understanding of these interactions has yielded products like Mycostop and will likely yield new crop protection products and inspire new cultural practices in the future. Numerous species of tiny beetles and mites found in compost and healthy soils consume bacteria and fungal mycelium and spores. Some secretions of antagonistic fungi and bacteria (often found in properly prepared compost) are known to interfere with plant pathogens and may become the basis for future naturalyte fungicides or soil inoculations.

Chemical Control of Diseases

The cultural practices and seed treatments listed offer the best control. Available fungicides only offer suppression.

Summary of Fungicides Used on Peppers

Mycostop (*Streptomyces griseoviridis*)

Rate: 3 grams/lb. of seed

5 to 10 grams/ 1,000 seedlings

Biofungicide/Fungal Competitor; REI 12h

A biofungicide for vegetable & ornamental crops grown in greenhouses, also used on crops grown for transplanting in the field, but only while they are still in the greenhouse. For control of *Fusarium* and *Alternaria* damping-off, root rot and *Phomopsis*. It is formulated as a wettable powder and contains living spores and mycelium of a selected strain of naturally occurring *Streptomyces* soil bacterium. The microbe colonizes plant roots in advance of pathogenic fungi and deprives them of living space and nourishment. Application should begin by treating seed and a soil drench should be applied every 3 to 6 weeks. Apply at the rate of 5 grams per 540 square feet of "root area" (approximately 5 grams per 1,000 plants).

Copper Hydroxide (Kocide)

Rate: 2lb. /A

Fungicide, Bacterial suppression; REI 48h

Use to slow the spread of bacterial leaf spot on pepper foliage. Apply after first symptoms scouted and apply on a 7 to 10 day schedule until weather conditions become unfavorable to the disease. Yield losses of up to 10% per season are associated with this material so only use when disease is present. Do not use on bacterial leaf spot resistant varieties except on the rare occasions of hail in conjunction with very humid air (dewpoints above 68°F). Use this material only once on resistant varieties after these circumstances occur.

Manex

Rate: 1.5 to 2lb. /A

Dithiocarbamate; REI 24h, 7 Days to Harvest

Does not enhance effectiveness of copper no longer recommended. Newer copper formulations put more ions in suspension. Does not affect soil borne *Phytophthora*. Toxic to fish.

Chlorothalonil (Bravo Ultrex 82 WP) (Chlorothalonil is no longer registered for use on peppers)

Rate: 1.4lb./A

REI 48h, 7 Days to Harvest

Does not enhance effectiveness of copper. Does not affect soil borne Phytophthora. Read label for replant restrictions. Toxic to fish.

Metalaxyl plus Chlorothalonil (Ridomil/Bravo) (Chlorothalonil is not registered for use on peppers)

Rate: 1.5 to 2lb. /A

REI 48h, & Days to Harvest

Does not enhance effectiveness of copper. Does not affect soil borne Phytophthora. Do not replant any crop not registered for Ridomil/Bravo for 12 months. Read label for other replant restrictions. Toxic to fish.

V. Weeds

General Management and Control of Problem Weeds.

Fields must be kept weed-free between 2 and 10 weeks after transplanting into bare-ground culture, and between 4 and 10 weeks in plasticulture to maintain high pepper yields. Hairy galinsoga may build up in pepper production fields over time because this weed is not controlled by most herbicides registered for use in pepper and because it resists cultivation. Rotate to crops where effective triazine herbicides are registered for use, such as sweet corn, to reduce the number of short-lived galinsoga seeds in the soil. Eliminate small patches of *Solanaceous* weeds, such as jimsonweed and horsenettle, prior to transplanting peppers because they are in the same plant family as pepper and can serve as alternate hosts and sources for disease and insect pests.

Stale Seedbed (N=89)

	Number	Percent
Acres Treated	26	19
Growers	11	12

Pesticide	# Growers	% Growers	# Acres	% Acres	Exc.	Good	Poor
Gramoxone Extra 2.5WS	2	2	<1	<1	1	1	0
Poast 1.5E	1	1	3	2	0	1	0
Roundup Ultra	4	4	6	5	3	1	0
Command	1	1	<1	<1	0	1	0
Other Strategies							
Mechanical cultivation	1	1	14	10	0	0	0
Stale bedded in 2004	1	1	1	<1	0	0	0

Scythe was not used by growers.

Pre-emergence herbicide (N=90)

	Number	Percent
Acres Treated	93	66
Growers	27	29

Pesticide	# Growers	% Growers	# Acres	% Acres	Exc.	Good	Poor
Command 4EC	3	3	44	32	0	3	0
Devrinol 50-DF, 2E	17	18	82	58	5	11	1
Prefar 4E	2	2	35	25	0	1	1
Treflan 4E	10	11	43	31	1	8	1
Sandea	3	3	8	6	2	1	0
Dual	1	1	6	4	1	0	0

Post-emergence herbicide (N=80)

	Number	Percent
Acres Treated	16	11
Growers	10	11

Pesticide	# Growers	% Growers	# Acres	% Acres	Exc.	Good	Poor
Dual 8E	2	2	7	5	0	2	0
Dual Magnum 7.62 E	3	3	4	3	0	3	0
Select	1	1	2	1.4	0	1	0
Devrinol	1	1	1	<1	0	1	0
Poast	1	1	1	<1	1	0	0
Gramoxone	1	1	<1	<1	1	0	0
Scythe	1	1	<1	<1	1	0	0

Group A – Insect and mite pests identified by survey as most important

Question C.2. Insects/mites that require routine annual management, require occasional management, or are never a problem on your farm? (N= 89)

Rank	Insect / Mite	Weighted Value*	Rank	Insect/Mite	Weighted Value*
1	European corn borer	180	12	Japanese/Asiatic	38
2	Aphids	128	13	Leafminers	36
3	Pepper maggot	110	14	Thrips	32
4	Colorado potato beetle	90	15	Plant/Stink Bugs	30
5	Corn earworms	88	16	Pepper weevil	26
6	Flea beetles	78	16	Caterpillars	26
7	Fall armyworms	58	16	Wireworms	26
8	Common stalk borer	50	19	Slugs	24
9	Hornworms	46	20	Beet armyworms	18
10	Black cutworms	40	21	Cyclamen mites	14
10	Two spotted spider mite	40	22	Grasshoppers	6

*The weighed number was determined by multiplying routine annual management by 4, occasional management by 2, and never a problem by 0.

Note: While reported by some growers, Pepper weevil does not occur in New England.

European Corn Borer (ECB)

Ostrinia nubilalis (Hubner)

Type of Pest: Insect

The European corn borer (ECB) is an introduced pest that attacks more than 200 host plants, including many common weeds and crops. It over-winters in New England as a last instar larva. The adult female is a creamy, yellowish-brown moth approximately 0.75 inches (20mm) long. When resting, the wings are 0.6 inches (15 mm) wide and are marked by 2 dark serrated lines running side to side on the hind third of the wings. The male's wings are darker and the end of his tufted abdomen sticks out beyond the wings. Midway along the front margin of the forewing, the adult male also has a small, light-colored triangular patch with a dark dot in the center.

Frequency and Regional Differences:

In southern New England, ECB has two generations and it is the second generation that causes the most important damage to peppers. The second moth flight starts between mid-July and mid-August, varying by as much as three weeks between cool and warm locations in the same season. In northern New England the ECB has one generation emerging in mid to late summer. (Bell peppers and other sweet or mild varieties suffer higher infestations than do hot peppers.)

Damage Caused:

Young larvae feed for a brief period on foliage, then migrate to 1 inch or more diameter fruit and enter under the stem cap (calyx). Entry holes are usually marked by an accumulation of brown, sawdust-like excrement at the edge of the calyx.

Once inside, larvae begin to feed on the flesh and seed head, ruining the fruit. They pass through 5 molts and can reach a length of nearly 1 inch (25mm) before pupating.

Larval entry holes become the entry site for infection with the soft rot bacteria, *Erwinia carotovora*, which requires a wound for invasion. This disease causes a watery decomposition of the flesh, starting at the calyx end which progresses until the fruit falls from the plant. The decomposing fruit becomes uninhabitable for the developing caterpillar within and it leaves its home and bores into the side of an adjacent pepper. A single larva may spread the soft rot disease to several fruit, compounding the losses associated with direct caterpillar feeding.

% Acres Affected:

European Corn Borer treatments (N=91)		
	Number	Percent
Acres Treated	114	81
Growers	50	54

IPM

Monitoring:

In peppers, European Corn Borer is difficult to find in the field until severe damage is already present. Therefore, IPM practicing growers successfully use white plastic Sentry Heliothis pheromone traps to delay insecticide applications as long as possible. If insecticide applications can be delayed until August, and or/if selective insecticides are used, beneficial arthropods will usually keep aphids from reaching damaging population levels. Traps are placed with the opening and lures at plant height in the weeds along the borders of

pepper fields. Trap height and placement are critical for the traps to function properly.

For most growers, traps are set up before the second generation moth flight, usually around the 3rd week of July. Farms located in the warmest New England locations which expect to begin harvest in mid-July may have to control late-hatching, first generation larvae in some years. These growers should put their traps up when the primary fruits are flowering.

Because there are two biotypes of ECB, it is necessary to put up 2 traps on the farm: one with the Iowa (Z or I) lure, and the other with the New York (E or II) pheromone blend. The traps should be separated by at least 50 feet. An additional pair of traps should be used for each field separated by more than a mile or two. Individual traps should have only one of the pheromone types during the entire growing season and be well marked to avoid cross contamination. The traps must be checked every week for captured males and the pheromones changed every 3 to 4 weeks.

Action Threshold:

The ECB action threshold for peppers is meant to confirm the start of the second generation moth flight. Initiate insecticide applications one week after the combined ECB count in traps equals or exceeds 7 moths per week. This threshold allows plenty of time to control the pest and prevent crop damage because there is a two week lag between moths captured in traps and fruit infestation by larvae. Peak moth flight and its decline should also be monitored.

Field observations on commercial farms indicate that toward the end of each flight, pepper crops are no longer at risk and spraying should stop one week after a combined total of 20 moths are captured in the traps. Perhaps an even higher population level can be tolerated toward the end of each generation because egg-laying ceases well before the moths die off.

Cultural Control

Background populations of ECB can be reduced if corn stubble, which provides an excellent site for larvae to survive the winter, is plowed down prior to moth emergence. Early stalk and stubble destruction must be conducted on an area-wide basis to significantly lower the population.

Biological Control

Several species of lady beetles and the minute pirate bug feed on ECB eggs causing up to 50% mortality. Pentatomid stink bugs, damsel bugs (Nabidae), spiders and hover fly larvae (Syrphidae) feed on young caterpillars. Researchers have demonstrated that with periodic mass releases, ECB egg parasitism can be as high as 80% in peppers with the parasitic wasp *Trichogramma nubilale*.

The background population of ECB may be reduced by some natural enemies not usually found in peppers. An imported parasitic wasp, *Macrocentrus grandii* (ichneumonidae) may kill up to 18% of the ECB larvae in southern New England and the naturally-occurring microsporidian pathogen, *Nosema pyrausta*, substantially reduces borer populations on corn in some years.

Post Harvest Control Practices:

Eliminate plant material from previous season as it is a source of overwintered pests.

Chemical Controls for European Corn Borer (N=91)

Pesticide	# Growers	% Growers	# Acres	% Acres	Excel- lent	Good	Poor
Ambush 2E, 25W	8	9	26	18	6	2	0
Asana XL2	8	9	13	9	5	3	0
Baythroid 2E	2	2	31	22	0	2	0
Dipel 2X	10	11	9	7	3	7	0
Entrust	6	7	4	3	5	1	0
Intrepid 2F	2	2	2	1	0	2	0
Lannate LV, SP	14	15	68	48	6	8	0
Mustang	1	1	<1	<1	1	0	0
Orthene 75SP, 97	5	5	43	31	3	2	0
Pounce 3.2EC, 25WC	10	11	16	11	6	4	0
Sevin 50W,80S,XLR	6	7	14	10	1	5	0
SpinTor 2SC	14	15	23	16	10	4	0
Warrior	2	2	3	2	1	1	0
Malathion	1	1	<1	<1	-	-	-

Capture 2EC and Confirm 2F were not used by growers

Note: Dipel 2X is not registered on peppers

Chemical Control:

It is critical to keep all pepper plants with susceptible fruit protected while ECB moth populations are high. Do not exceed the effective residual period (longevity) of an insecticide before making the next application. Growers can protect their peppers from ECB, practice resistance management, and protect natural enemies that control

secondary pests by alternating between selective insecticides. Intrepid IGR (1dh) and SpinTor (1dh). Organic growers can achieve the same results by alternating between Entrust (1dh) and B.t. (0dh). Intrepid should be applied every 10-14 days, SpinTor and Entrust every 7 days, and B.t. at least twice a week during ECB egg hatch. Certain materials are registered for corn borer in peppers but give unacceptably poor, or no, control, because of the way ECB attacks the fruit

Intrepid is an insect growth regulator with a 4 hour REI and a 14 day to harvest interval. Intrepid has no effect on any other insects except Lepidoptera larvae.

Products that contain *Bacillus thuringiensis* (Bt), in formulations providing some protection from UV light (Mattch, Dipel 2X, MVP, MVP II, Javelin), provide acceptable control if applied every 3 to 5 days. Peppers can be harvested just four hours after applying a B.t. product.

Spinosad (SpinTor) and Entrust are naturalyte insecticides that spare predators and controls ECB if used on a 7 day schedule. It has a different mode of action than the Bts and so growers can manage resistance by rotating to another natural enemy conserving naturalyte. IPM Growers who use Intrepid alternating with spinosad will benefit from natural enemies against aphids and ECB. Organic growers who use Bts alternating with spinosad will benefit from natural enemies against aphids and ECB.

The acephate (Orthene) label has a seven day-to-harvest (DH) restriction. This material should be used on a 10 to 14 day schedule. Acephate can be used on bell or non-bell type peppers. It does not do as much harm to beneficials as synthetic pyrethroids (i.e. permethrin) and is a popular choice on IPM practicing farms for the first, and sometimes second, ECB spray. This is the only material that kills both pepper maggot adults and corn borer larvae.

Permethrin, Pounce and Ambush, have a 3dh restriction others have 5-7 days. This material can be used on a 7 to 10 day schedule but is not recommended in an IPM Program because it is hard on natural enemies. Permethrin is registered for bell peppers only. Asana (esfenvalerate) provides similar control on all pepper types but has a 7DH restriction and requires almost immediate reapplication after picking.

On all materials, the shorter intervals listed should be used during summer heat waves and when borer egg hatches are peaking (one to two weeks after peak moth flight based trap catch data).

Aphids

(Green Peach Aphid, *Myzus persicae*; Melon Aphid, *Aphis gossypii*; Potato Aphid, *Macrosiphum euphorbiae*)

Type of Pest: Insect

Aphids, especially the Green Peach Aphid, can become a problem starting at the beginning of harvest when unnecessary applications of organophosphate, carbamate and synthetic pyrethroid insecticides have been used. These insecticides, especially when used early in the season, limit the build up of natural enemies of aphids in the field and leave the grower to depend on immigrating aphid predators and additional insecticide. Early-season broad-spectrum sprays to control pepper maggot flight will also stop the build up of the natural enemies that control aphid populations

Frequency and Biology:

Aphids have many generations per year. During the hot summer they reproduce by parthenogenesis, or without mating. Offspring produced via parthenogenesis are young wingless females. Both males and females develop and mate in the fall. After mating eggs are laid and overwinter on alternate host plants such as wild cherry or other *Prunus spp.* When populations are heavy, winged forms are produced which spread to other less populated sites.

Damage Caused:

Aphids cause damage by sucking the sap from plants. They insert their piercing sucking mouth parts into the plant and remove sap from leaves making them appear stippled and in heavy infestations chlorotic, curled or distorted, and may reduce the photosynthetic capacity of the leaves. Additionally, aphids exude a clear sweet liquid called "honey dew" on which a black or gray fungus called "sooty mold" may grow. Peppers with sooty mold fungus are unmarketable. Aphids also spread viral diseases such as cucumber mosaic virus. The virus can be spread from field to field as aphids move about.

% Acres Affected:

Aphid treatments (N=88)

	Number	Percent
Acres Treated	91	64
Growers	33	36

Timing and Control:

Controls should be delayed until fruit set. Using carbamate, organophosphate or pyrethroid type pesticides before this time to control other major pests usually destroys the parasites and predators of aphids. Based on monitoring information before fruit set, if aphid infestations remain between 5 and 10 per leaf, for 2 or more consecutive weeks, pesticide applications should be made to prevent economic loss. After fruit set, if populations average 5 per leaf, applications should be made to prevent indirect damage from sooty mold on fruit.

Regional Differences:

There are no regional differences.

Cultural Control:

Plastic mulches will delay and reduce aphid infestations. Reflective aluminum coated mulch is most effective followed by white and finally black. The use of plastic mulches along with applications of horticultural oil can reduce aphid populations and reduce the spread of viruses but usually does not eliminate damage.

Reducing weed populations and removing winter host species such as wild cherry from around the field may also help reduce aphid populations.

Biological Control Practices:

When pepper plantings are not treated early in the season, beneficial species are allowed to populate the planting and will help keep aphids in check. Beetles such as the Lady "Bug" beetle and ground beetle species, along with bugs such as the flower, big-eye and damsel bugs, and midges, hover flies, and lacewing larvae all feed on aphids. Other parasitic wasps, spiders and fungal pathogens also help control aphid populations. Also, precise management of nitrogen will slow the rate of aphid population increase, which further aids available natural enemies. Tolerating a few aphids also enhances biological control of corn borer since many of the aphid predators also feed on borer eggs and small larvae.

Post Harvest Practices:

Reducing weed populations and removing winter host species such as wild cherry from around the field may also help reduce aphid populations.

Chemical Control:

The best way to manage aphids is to minimize spraying for major insect pests such as ECB and PM and to use only selective insecticides for ECB and Aphids. If aphid sprays are needed, it is important to alternate between effective materials to help slow the development of resistance. Aphids have a propensity for developing resistance because of their high reproductive rate, feeding habits, and cryptic nature (feed on underside of leaves). Effective selective insecticides include Fulfill and neonicotinoid insecticides such as Assail, Safari, Venom, Admire, Provado, Actara and Platinum. Neonicotinoid insecticides may be particularly toxic to bees.

Chemical Controls for Aphids (N=88)

Pesticide	# Growers	% Growers	# Acres	% Acres	Excellent	Good	Poor
Admire 2F	5	5	4	3	4	1	0
BotaniGard ES 22WP	1	1	<1	<1	0	1	0
Dimethoate 4EC	1	1	3	2	0	1	0
Fulfill	2	2	2	2	1	1	0
Horticultural Oil	1	1	<1	<1	0	0	1
Knack	1	1	<1	<1	0	1	0
Lannate L	7	8	50	39	4	3	0
Malathion 5EC, 8EC, 50W, 25W	3	3.3	2	2	3	0	0
M-Pede	1	1	1	<1	0	1	0
Orthene 75S	7	8	61	43	2	5	0
Provado	5	5	12	9	4	1	0
Thiodan 3EC, 50W	7	8	19	13	2	4	1
Vydate L	1	1	5	4	0	1	0

Assail 70WP, Azatin XL; Diazinon AG500, Metasystox-R, Mycotrol ES, and Neemix 4.5 were not used by growers.

Note: Knack works for whiteflies and needs to be mixed with an aphicide. M-Pede doesn't work alone, Thiodan3EC or 50W doesn't work, and Vydate L drops flowers.

Pepper Maggot

Zonosemata electa (Say)

Type of Pest: Insect

Frequency of Occurrence:

Pepper Maggot has one generation per year. Infestations by the pepper maggot are patchy and sporadic. Even on farms with a history of this pest, fruit may be infested only on one side of a large field, or in one or two pepper fields on a farm (but not all fields), or not at all in a given year. On the other hand, 100% of the fruit on a farm can be infested when fly populations are high. Also, the adult fly has been known to migrate up to a half mile to infest fields with no previous history of pepper maggot.

Damage Caused:

Egg laying begins approximately one week after the flies emerge and maggots mature about a month later. Eggs are deposited under the skin of the fruit and protrude into the interior. The maggots hatch into the pepper and migrate to the seed head and begin to feed. Often, the egg laying site heals over completely and is not noticeable, even if there is a big maggot inside.

Occasionally, maggots tunnel in the flesh of the pepper, just under the skin, leaving an opaque scar on the side wall which is visible from the exterior of the fruit.

If the maggots are allowed to mature, the seedhead becomes riddled with tunnels and discolored from the feeding. Larger maggots may be detected by customers or may contaminate processed products made with the peppers. As the full grown maggots leave the fruit to pupate in the soil, exit wounds, like with European corn borer, become contaminated with soft rot bacteria. This often causes extra-large green fruit or fruit left unharvested to mature into red peppers to melt into a watery-rot during late August or early September. Soft rot may be misidentified as the problem and the grower may further add to pepper maggot costs by making unnecessary and ineffective fungicide or copper applications.

% Acres Affected:

Pepper maggot treatments (N=89)

	Number	Percent
Acres Treated	89	63
Growers	25	27

Timing of Control:

Pepper maggot flies emerge from the soil over a 10-14 day period in July and may survive well into August or even into early September. Emergence time may vary by two three weeks as a result of yearly variations in soil temperature. One to three insecticide applications may be needed depending upon the level of pest pressure at a particular site. Applications should start within a week of detecting adults on traps or strings on fruit.

Yield Losses:

Yield losses can reach 100% if pepper maggot is not controlled.

Regional Differences:

The pepper maggot fly (PM) is a pest native to the Eastern United States and ranges as far north as southern New Hampshire. It attacks the seed containing fruits of several solanaceous plants, preferring pepper, horse nettle, and occasionally eggplant. PM over winters as a pupa in the soil.

Cultural Control:

Perimeter trap cropping is the most important and successful way to control this insect. It is more successful than well timed full-field sprays. Pepper fields with a history of pepper maggot damage can be surrounded with hot-cherry pepper plants spaced at 50 yards apart. All the hot pepper plants should be located in the outermost row of bell peppers along the margins of the fields. The early-set and high attraction of the chile peppers makes them excellent indicator plants for detecting the start of egg laying. Cherry pepper fruit should be checked every three to four days for stings which are easily recognized on the high-gloss, smooth surface of the indicator pepper as a shallow indentation of the fruit surface with a tiny scar in the center. Within a week of detecting stings, chemical control should begin.

Biological Control:

Several predators may feed on pepper maggot puparia while in the soil or on the adult flies before they are detected. These potential natural enemies include ground beetles, jumping spiders, robber flies and

birds. Certain soil types may promote puparial mortality from diseases and naturally occurring entomophagous nematodes. However, the eggs and larvae are well protected from attack from natural enemies. Once flies or stings are detected, only chemical control will prevent infestations

Chemical Controls:

Monitoring is important. All the materials effective against the flies decrease the natural enemies of aphids and other secondary pests, so chemical control should be avoided if not necessary. Based on recent research conducted at the University of Connecticut, a rectangular, yellow, sticky-trap (available commercially as a Apple Maggot Trap), baited with a vial of 27-31% liquid ammonia, should be hung 20 feet high in any sugar maple tree found around the margin of the pepper field. Once flies are no longer found, chemical control should be discontinued

Control options need to target the adult Pepper Maggot fly because eggs are deposited under the skin of the fruit and are hard to kill, as are the maggots inside the pepper. Flies all emerge within a 10 day period and can be controlled with 1-2 well timed sprays of a systemic insecticide, 8 – 10 days apart. In cooler seasons and when using materials with shorter residual periods of effectiveness, up to 3 applications may be necessary to control the fly.

Chemical Controls for Pepper Maggot (N=89)

Pesticide	# Growers	% Growers	# Acres	% Acres	Excel- lent	Good	Poor
Dimethoate 4EC	4	4	13	9	1	3	0
Malathion 5EC, 8EC, 50W, 25W	6	7	9	7	4	2	0
Thiodan 3EC, 50W	10	11	66	47	3	7	0
Asana	2	2	6	4	1	1	0
Other Strategies							
Trap crop	1	1	<1	<1	-	-	-

* Warrior, Dipel, Orthene, Entrust, Sevin, and Lannate were all used by at least one grower but on less than 1% of the pepper acreage. Mustang was not used by growers.

Dimethoate (e.g. DiMate, 1DH) and malathion (e.g. Malathion 8E, 3DH) Thionex and Mustang are all registered for pepper maggots on peppers. Dimethoate and malathion usually provides excellent control of this pest. Experience with malathion is limited. Acephate (e.g.

Orthene 7DH) is registered on peppers to control European corn borer and aphids and will control pepper maggots if applied throughout the adult emergence period. In fields where acephate has been applied for corn borer with the correct timing for pepper maggot, it usually provides excellent control. Dimethoate and acephate are systemic materials and have a relatively long residual period while malathion is a stomach and contact poison only, with much shorter periods of activity and therefore must be applied more frequently. Thionex (endosulfan) is registered for use on peppers but is not effective, probably due to resistance and low residual activity. Other commonly used pepper insecticides are not registered for pepper maggot control and will not provide protection from this pest.

Group B – Insect and mite pests identified by survey as significant problems in some years

Colorado Potato Beetle (CPB)

Leptinotarsa decemlineata

Type of Pest: Insect

Frequency of Occurrence:

Colorado Potato Beetle is primarily a pest of eggplant and potato. Damage to peppers can occur when adults leave eggplant or potato fields that are in decline in search of food. This may take place in late July through mid August. Growers in the survey ranked Colorado Potato Beetle as the fourth most important insect pest.

Damage Caused:

Defoliation of pepper plants.

Cultural Control:

The most effective method of preventing CPB infestations is to refrain from planting peppers in fields that previously had tomatoes, eggplant or potatoes. Eggplant can be used as a trap crop because they are much more attractive to CPB than are peppers.

Biological Control:

There are many predators that contribute to CPB under control in peppers. *Podisus maculiventris* (the spined soldier bug) attacks all stages of the CPB larvae. *Coleomegilla* ladybird beetles are effective egg predators.

Chemical Controls:

Spinosad (SpinTor and Entrust) are effective against CPB larvae. These and other materials should not be used unless there are more than 5 small larvae per plant in order to manage resistance to insecticides. Imidacloprid and other neonicotinoids are registered for use against CPB in peppers but are highly toxic to bees, especially if used around the time of flowering.

Growers were not asked about specific pest management practices for controlling Colorado Potato Beetle.

Corn Earworm, Fall Armyworm, and Beet Armyworm

Heliocoverpa zea, Spodoptera frugiperda, Spodoptera exigua

Type of Pest: Insects

These three moths are infrequent pests of peppers. Each of these three pests cause similar damage and are therefore easily misidentified when only glancing at the damaged fruit. Therefore, growers may be unsure which is actually causing damage.

Frequency of Occurrence:

Corn Earworm only occasionally causes damage to peppers in New England. Growers in the survey ranked Corn Earworm as the fifth most important insect pest in peppers. Corn Earworm damage is similar to fall armyworm and beet armyworm. Corn Earworm does not successfully overwinter in New England most years. Adult Earworms migrate from the south and begin to reach New England in July. Numbers significantly increase in late August and September.

Fall Army worm is a late season pest which migrates from the south reaching New England in July. It is a pest of sweet corn and can jump over to peppers when local sweet corn growing has stopped.

Beet Armyworm also migrates to New England from the south appearing late in the summer. It is a sporadic pest in peppers and very rare in New England.

Damage Caused:

Larvae of Corn Earworm and Fall Armyworm feed within the pepper. Early instar larvae enter near the cap of the pepper and feed. As larvae grow they generate large amounts of frass inside the pepper. Larger larvae may occasionally leave one fruit and begin feeding on another entering the fruit anywhere leaving large entrance holes. Infested fruit may become infected with soft rot.

Beet Armyworm larvae feed on foliage, stems and fruit. Small larvae spin webs that tie foliage together. A Number of larvae will feed inside the structure. More mature larvae will feed on stems and fruit. They may also enter the fruit the same way Corn Earworm and Fall Armyworm do.

% Acres Affected:

Corn Earworm, Fall Armyworm,
and Beet Armyworm Treatments (N = 85)

	Number	Percent
Acres Treated	64	45
Growers	14	15

Timing of Control:

Corn earworm is a mid to late summer pest. Fall Armyworm is a mid summer pest. Beet Armyworm is a late summer pest. Fall Armyworm can be detected by the use of a green pheromone baited bucket trap.

Regional Differences:

Because Corn Earworm, Fall Armyworm, and Beet armyworm migrate from the south, the northern reaches of New England may not experience as much pressure from this pest as the southern regions. Beet Armyworm is extremely rare even in southern New England.

Chemical Controls:

Many insecticides used for later generations of corn borer will also control Corn Earworm. However, Orthene does not control Corn Earworm or Fall Armyworm. Using blacklight traps, control measures should be taken when catches reach 20 moths per night.

Fall armyworm can be managed like corn borer with the exception that Orthene (acephate) is ineffective.

Chemical Controls for Corn Earworm, Fall Armyworm,
and Beet Armyworm (N = 85)

Pesticide	# Growers	% Growers	# Acres	% Acres	Excel- lent	Good	Poor
Asana XL	6	7	19	13	3	3	0
Dipel	2	2	1	<1	0	1	0
Entrust	2	2	2	2	1	1	0
Kryocide	1	1	1	<1	1	0	0
Lannate LV, SP	9	10	54	38	4	5	0
Sevin 50W, 80S XLR	3	3	2	2	1	1	0

Plus							
SpinTor 2SC	2	2	9	7	1	1	0

Intrepid, Baythroid 2E, Confirm 2F, Crymax, and Javelin were not used by growers.

IPM

Fall Armyworm can be detected by the use of a green pheromone baited trap placed in the field after corn borer is gone.

Black Cutworm

Agrotis ipsilon et al.

Type of Pest: Insect

Frequency of Occurrence:

There are two to three generations a year. Most cutworms migrate from the south beginning in late March through June. Occasionally pupae may overwinter in the soil in southern regions of New England.

Damage Caused:

Young transplants can be damaged or killed by cutworms. Cutworms typically leaf feed only but can cut off seedlings or young plants at or just below ground level, especially at the margins of fields. They often drag plant parts partially underground to feed on them. Losses can be especially serious in fields that have an abundance of coarse organic matter on the soil surface which attracts moths to deposit eggs.

Larvae usually hide in the soil under debris, or under clods during the day and come out at night to feed. Older larvae drop to the ground, tunnel into the soil and emerge at night to feed while temperatures are over 60°F.

% Acres Affected:

Black Cutworm Treatments (N = 82)

	Number	Percent
Acres Treated	15	11
Growers	8	8

Cultural Control:

Fields should be plowed at least 2 weeks prior to planting and fields that were previously in alfalfa or hay should be prepared the previous fall and put into a cereal cover for the winter. Another cultural management option is fall plowing to reduce winter or spring annual and perennial weeds which serve as attractive egg laying sites the following spring.

Increased organic matter may attract adult moths, while at the same time, cover crops could shelter more ground dwelling predators than bare ground.

Biological Control:

Many natural enemies attack Cutworm, including ground beetles, rove beetles, night-hunting spiders, entomophagous nematodes and some wasps which dig for their prey.

Cutworms are susceptible to commercially available entomophagous nematodes such as the prey-seeking *Heterorhabditis bacteriophora* and the ambushing *Steinernema carpocapsae*. The latter store well and is easy to handle but requires warm temperatures (70°F) for optimum infectivity. Nematodes can be applied to the base of the plants along the row as a soil drench.

Chemical Controls:

If the larvae are big or if whole plants are taken down and mostly consumed, a quick knock down insecticide should be used. If the damage is only foliar or if killed plants are only partially eaten, a Bt or beneficial nematode product may be used.

If the larvae are big or if whole plants are taken down and mostly consumed, a quick knock down insecticide should be used. This is best applied after dark when the temperature is conducive to cutworm activity. It should be applied by banding it over the row.

IPM

After transplanting, field perimeters should be walked and 100 plants sampled for leaf and stem feeding. If more than 5% of plants show damage, control may be necessary. Once damage is found on the borders of fields, the interior portions of the fields can be sampled to determine if field wide control is necessary or just a border spray. Fields that were formerly in hay or were weedy before tilling should be thoroughly sampled both along the margin and through the interior. Black cutworm can be detected by the use of a yellow and white pheromone baited bucket trap.

Chemical Controls for Black Cutworm (N = 87)

Pesticide	# Growers	% Growers	# Acres	% Acres	Excel -lent	Good	Poor
Lannate LV, SP	1	1	<1	<1	0	1	0
Mustang	1	1	<1	<1	1	0	0
Sevin 50W, 80SXR Plus	3	3	<1	<1	3	0	0

Warrior	2	2	9	6	2	0	0
Diazinon	1	1	5	4	0	1	0

Ambush 2E, Ambush 25W, Confirm 2F, Pounce 3.2EC, and Pounce 25WC were not used by growers.

Tobacco Hornworm

Tobacco hornworm does not generally reach damaging population levels on pepper in New England. Selective materials such as Intrepid, SpinTor, Entrust and Bt will control hornworms.

Summary of Insecticides Used on Peppers

Note: the following materials are those used on peppers by Integrated Pest management growers. In peppers, IPM is the most cost effective strategy for controlling pests, both in terms of minimizing the total cost of pesticides used and in terms of minimizing loss of income from pests.

Other pest insects may be on the label of a material listed below, but, due to pest resistance or due to the availability of equally effective and safer materials, these insects may not be listed. Other insecticides registered for pepper pests offer no advantages over the materials listed below and may cause secondary pest problems. Avoidable secondary pest problems will lower yields or cost the grower the expense of additional insecticide applications.

Intrepid 2F (Dow Agrosciences)

Rate: 4 – 8 (0.06 – 0.12 lb ai/acre) for early season only to young crops and small plants, 8 – 16 (0.12 – 0.25 lb ai/acre) mid- to late season applications, heavier infestations and when thorough coverage is more difficult.

Insect Growth Regulator, REI 4hrs, 1 day to harvest

All Peppers.

Must be ingested, effective on all Lepidopterous larvae but contains a Group 18 insecticide.

SpinTor 2SC Entrust (Spinosad, a mixture of spinosyn A and spinosyn D) (Dow AgroSciences)

Rate: 1.5 to 8.0oz./A

Foliar Naturalyte/Contact Insecticide; REI 4h, 1 Day to Harvest

All Peppers. Naturalyte with a different mode of action than Bt. For European corn borer and fall army worm (4 to 8 oz. /A). Use on

hatching larvae before they bore into peppers. For hornworms (3 to 6 oz. /A). For Colorado potato beetle larvae (2.25 to 4.5 oz. /A). Use higher rates in specified ranges when infestations are moderate to heavy or if worms are large. To manage resistance, do not apply more than 3 times in a 30 day period. Rotate with material with another mode of action or use no treatment for the next 30 days. Tank mixing with any insecticide that will kill predators and parasites may reduce the full benefit of SpinTor to an IPM program. Do not apply more than 0.45 lb. ai/A (29 oz. of product/A) per season. Do not apply through irrigation. Toxic to bees and aquatic invertebrates and moderately toxic to fish. This material is still being tested for efficacy on other pests of peppers. Conserves natural enemies.

Dimethoate (2.67, 4EC, 4E, E267, 267) (Cheminova, Platte, Wilbur-Ellis, Riverside Terra, Drexel, Gowan, Helena)

Rate: 0.75 - 1 pt. 2.67, 267, E267/A

0.5 - 0.66 pt. 4E, 4EC/A

Carbamate, REI 48h, 2 Days to Harvest

For use against pepper maggot fly adults and aphids. Will not control European corn borer. Apply within a week of finding flies on traps or stings are found on fruit. Apply every 8 - 10days throughout adult emergence period. Toxic to fish and bees.

Acephate (Orthene 75S, 75WSP) (Valent)

Rate: 0.33 to 0.66lb. /A

Organophosphate; REI 24h, 7 Days to Harvest

For use on all peppers against European corn borer, hornworms and aphids. Check label for rates as they vary for different pests. Do not use in irrigation. Use at 10 to 14 day intervals while ECB is over threshold. Effective for pepper maggots if applied throughout 14d adult emergence period. Highly toxic to bees.

Malathion (57EC, 5EC) (Platte, Helena, Drexel, Prentiss)

Rate: 0.625 to 1.5 lb a.i. /A, 1 to 2.5 pt. 57EC, 5ECA

Organophosphate: REI 12h, 3 days to harvest.

For use on peppers against pepper maggot, because of shorter residual than other pepper maggot materials, malathion may need to be applied more often while PM is flying (5d intervals). Repeated use can contribute to secondary pest outbreaks by killing natural enemies. Toxic to fish and bees.

Dipel (Bt var. kurstaki) (Abbott Laboratories) (2X not registered on peppers, other Dipel formulations not registered for ECB)

Rate: 0.5 to-2pt. /A

Foliar Naturalyte/Stomach Poison; REI 12h, 0 Days to Harvest
All Peppers.

For European corn borer (apply full rate). Use on hatching larvae before they bore into peppers. Do not apply through irrigation. Rotate with material with another mode of action to manage resistance.

Javelin WG (Bt var. kurstaki) (Sandoz)

Rate: 0.125 to 1.50 pt. /A

Foliar Naturalyte/Stomach Poison; REI 12h, 0 Days to Harvest
All Peppers.

For European corn borer (apply full rate). Use on hatching larvae before they bore into peppers. Do not apply through irrigation. Rotate with material with another mode of action to manage resistance.

Agree (WSP) (Bt var. aizawai) (Ciba)

Rate: 1 to 2lb. /A

Foliar Naturalyte/Stomach Poison; REI 12h, 0 Days to Harvest
All Peppers.

For European corn borer (apply full rate). Use on hatching larvae before they bore into peppers. Do not apply through irrigation. Rotate with material with another mode of action to manage resistance.

XenTari WDG (Bt var. aizawai) (Abbott Laboratories)

Rate: 0.5 to 2lb. /A

Foliar Naturalyte/Stomach Poison; REI 12h, 0 Days to Harvest
All Peppers.

For European corn borer (apply full rate). Use on hatching larvae before they bore into peppers. Do not apply through irrigation. Rotate with material with another mode of action to manage resistance.

Mattch (Bt var. aizawai with Bt var. kurstaki) (Mycogen)

Rate: 0.5 to 2lb. /A

Foliar Naturalyte/Stomach Poison; REI 12h, 0 Days to Harvest
All Peppers.

For European corn borer (apply full rate). Use on hatching larvae before they bore into peppers. Do not apply through irrigation. Rotate with material with another mode of action to manage resistance

Asana XL (esfenvalerate) (DuPont)

Rate: 5.8 to 9.6fl.oz./A

Synthetic Pyrethroid, REI 12h, 7 Days to Harvest

For use against European corn borer on all peppers, do not exceed 0.35 lb. ai. per acre per season. Do not feed treated plant parts (foliage) to livestock. Short residual product. If ECB moth catches are

still over threshold 7 days after application, this or another material should be applied immediately. Repeated use can contribute to secondary pest outbreaks by killing natural enemies. Toxic to bees, highly toxic to fish. Highly flammable (flash point at 150°F) and may give off hydrogen cyanide fumes when vapors burn.

Ambush 2E, 25W. (ZENECA))

Rate: 12.8 fl. oz. 2E, 12.8 oz. 25W/A

Synthetic Pyrethroid; REI 24h, 3 Days to Harvest.

For use against European corn borer on bell peppers only, do not exceed 1.6 lb. ai. per acre per season. Repeated use can contribute to secondary pest outbreaks by killing natural enemies.

M-Pede (Potassium salts of fatty acids) (Dow Agroscience)

Rate: 1 to 2% v/v solution

Insecticidal Soap; REI 12h, 0 Days to Harvest

Does not harm hard bodied natural enemies of aphids. Do not use if soft bodied aphid predators such as syrphid fly and aphid-midge larvae are numerous. (Note: Rotenone not allowed on organic farms.)

Predators, Parasitoids: Target Pest Prey

Ladybird Beetles: Aphids, all types of eggs and small larvae

Damsel Bugs (Nabids): Small caterpillars

Minute Pirate Bugs: Aphids, all types of eggs and small caterpillars

Trichogramma nubilale and *T. ostrinae*: European corn borer eggs

Jumping Spiders: Small caterpillars, pepper maggot fly

Robber Flies: Pepper maggot fly

Syrphid larvae: Aphids

Lacewings: Aphids, small caterpillars

Aphidiid wasps: Aphids

Wasps and Hornets: Cutworms

Carabid Ground Beetles: Cutworms

Nematodes: Cutworms

Braconid Wasps: Tomato hornworm

Cultural practices and Natural Enemy Conservation

Certain classes of chemicals which are known to cause flare-ups of non-target pests should be avoided. The grower can reduce pesticide use by taking care to:

- * Avoid using synthetic pyrethroid and other broad spectrum materials.
- * Use trap crops (pepper maggot) when possible.
- * Treat only those fields that have reached the economic injury level and do not treat those that have not, whenever possible.

- * Segregate crops so non-host plants are not needlessly sprayed.
- * Be able to identify and monitor all beneficials.
- * Use B.t.s and other class III & IV materials (naturalytes)
- * Precisely manage Nitrogen: too much N can stimulate aphid reproduction.

VI. Vertebrate Pests

Question C5. Which of these pests require routine annual management, require occasional management, or are never a problem on your farm? (Please circle your answers) (N- 87)

Rank	Vertebrate	Annual Mgmt.	Occasional Mgmt.	Weighted Value
1	Deer	23	21	134
2	Woodchuck	8	11	54
3	Raccoons	3	4	20
4	Skunks	1	3	10
5	Birds	2	1	10
6	Groundhogs	1	1	6
7	Turkeys	1	1	6
8	Voles, Chipmunks, Flying squirrel, Coyote	1	-	4
9	Mice	-	2	4
10	Rabbit, porcupine	-	1	2

Question G1. Vertebrate Pests and Strategies (Please list vertebrate, list strategies used and circle their effectiveness) (N=21)

Pest and Strategy	# Growers	Excellent	Good	Poor
Deer				
electric fence	6	1	5	-
fence	4	2	2	-
shoot	4	2	2	-
dog	2	-	1	-
reflector	1	-	1	-
Woodchuck				
smoke bomb	4	1	2	1
flooding	1		1	
dog	1		1	
fence	1			1
reflector	1		1	
electric fence	1		1	
shoot	1	1		

VII. Acknowledgements and Contacts

References

2006 Florida Plant Disease Management Guide: Pepper Specific Common Diseases, Ken Pernezny and Tim Momol, 2006 University of Florida IFAS <http://edis.ifas.ufl.edu/PG052>

Biological Control: A Guide to Natural Enemies in North America; Weeden, Shelton, Hoffmann, eds.; Cornell University Press

Biological Control Information Center, Department of Entomology, North Carolina State University, <http://cipm.ncsu.edu/ent/biocontrol/>

Chile Pests and Problems, Dave DeWitt and Paul W. Bosland, <http://www.fierly-foods.com/dave/pests2.asp#Bacterial%20Soft%20Rot>

Commodity Spotlight December 2001, Economic Research Service/USDA

Farm Chemicals Handbook, 2006. R. T. Meister, G. L. Berg, C. Sine, S. Meister, and J. Poplyk, eds. Meister Publishing Co., Willoughby, OH.

How to Conduct Your Own Survey, Dillman, D.A. and P. Salant, 1994 John Wiley & sons, Inc. N.Y

Minor Diseases of Pepper, 1999, Robert L. Wick, University of Connecticut IPM website: <http://www.hort.uconn.edu/IPM/veg/htms/mnrdisppr.htm>
Originally published in Proceedings. 1999. New England Vegetable & Berry Growers Conference and Trade Show, Sturbridge, MA. p.101-103.

Natural Enemies of Vegetable Insect Pests. Hoffmann, M.P. and Frodsham, A.C., 1993, Cooperative Extension, Cornell University, Ithaca, NY. 63 pp.

New England Vegetable Management Guide: 2004-2005. Cooperative Project from University of Connecticut, University of New Hampshire, University of Maine, University of Rhode Island, University of Massachusetts and University of Vermont.

<http://www.nevegetable.org/index.cfm?objectid=E0129EE0-8C7F-4CFE-5962993E1747CCCB>

Northeast Pepper Integrated Pest Management (IPM) Manual. 2001. Ed. T. Jude Boucher and Richard A. Ashley, University of Connecticut, Cooperative Extension System. 136pp.

Pepper Viruses—Survey Update, Baameur, Aziz, in *2005 Growing Pepper in Sensitive Environments*. Gilroy, April 7, 2005

<http://ucce.ucdavis.edu/files/filelibrary/2030/19610.pdf>

Pepper Disease Control -It Starts with the Seed, Thomas A. Zitter, Cornell University Vegetable MD Online

<http://vegetablemdonline.ppath.cornell.edu/NewsArticles/PepDiseaseCon.htm>

Personal Communication, Boucher, J. 2007, University of Connecticut, Department of Extension.

Personal Communication, Pundt, L. 2007, University of Connecticut, Department of Extension

The National Agricultural Statistics Service, USDA, Vegetable Crops,

http://www.nass.usda.gov/Census/Pull_Data_Censushttp

The Vegetables and Melons Situation and Outlook Yearbook/VGS- 2005/July 21, 2005, ERS, USDA

Key Contacts and Resources

Commodity Experts in New England:

University of Connecticut
Jude Boucher (860) 875-3331
Jude.Boucher@UConn.edu

University of Massachusetts
Ruth Hazzard, (413) 545-3696.
rhazzard@umext.umass.edu

University of Maine
Mark Hutton, 207-933-2100
mhutton@umext.maine.edu

University of New Hampshire
Alan.Eaton@unh.edu
[Alan Eaton](mailto:Alan.Eaton@unh.edu) (603) 862-1734

University of Rhode Island
Kristen Dame, (401) 874-2967
kdame@mail.uri.edu

University of Vermont
Vern Grubinger (802) 257-7967
vernon.grubinger@uvm.edu

Reviewers

Jude Boucher
University of Connecticut

Glen Koehler
University of Maine Cooperative Extension

William Lord
University of New Hampshire Cooperative Extension

Ann Hazlerigg
University of Vermont

Sarah Kingsley Richards
University of Vermont

Margaret Siligato
University of Rhode Island