2008 New England Pepper Pest Management Strategic Plan

Compiled for the PRONewEngland Pest Management Network
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Key Pest Name Abbreviations

Insects
ECB = European Corn Borer
Aph = Aphids
PM = Pepper Maggot

Diseases
BLS = Bacterial Leaf Spot
Phyt = Phytophthora

Weeds
PP = Pre-plant
Pre = Pre-emergent
Post = Post-emergent
Executive Summary

The list of key pests for pepper in New England consists of three insects, two diseases, and the weeds and vertebrates common to agricultural settings. These key pests are persistent problems that need to be managed every year when and where they occur.

Pepper growers in New England are aware of the need to protect food sources and provide for food security in the region today. Overlying specific pest management needs are concerns about climate change and its impacts on pest behavior and expanding geographical range of pests. In addition, increasing vertebrate wildlife management issues are a growing concern.

The distribution and numbers of farms in New England, in combination with a limited number of available extension agents and private consultants, make it difficult for growers to receive on-site pest management support. This is especially true among smaller and diversified farms that grow peppers and other vegetables. Research and extension being done at universities is helpful but more pest management research is needed and the information flow to growers can be expanded.

The following outlines the most critical research, regulatory, and educational issues as determined by a review group of pepper growers, researchers, and industry stakeholders during the Pest Management Strategic Plan process.

Research Needs
- Develop more Phytophthora resistant varieties.
- Explore the uses of grafting in achieving Phytophthora resistance.
- Explore methods of notifying and alerting growers of new information.
- Determine thresholds for nematode damage.

Regulatory Needs
- Loss of carbamate pesticides (carbaryl, methomyl, etc.) would impact management of many other crops found on a diversified farm.
- Direct funds towards development and continuation of models, forecasts, & newsletters that are useful to growers.
- Provide incentives to increase the research and extension that is beneficial to commercial growers.
- Create grant funding opportunities for newer researchers who may not yet have the background to as effectively compete for other funding.
- Encourage the infrastructure (fertilizers, suppliers, consultants) to support small farms.
Education Needs

- Provide information on pest lifecycles, pest movement and dispersal, and variations, such as race, that are critical to management.
- Promote awareness of critical periods when crop must be kept weed-free.
- Encourage proper identification of European Corn Borer and Pepper Maggot injury in comparison to diseases.
- Clarify the differences between systemic and topical material efficacy.
- Notify growers of models that are available for predicting and tracking pest activity.
- Spread awareness of pests that are likely to spread into and within New England due to climate change.
- Clarify chemical families of materials to avoid confusion when combining and to discourage development of resistance.
I. Introduction

Background of Pepper in New England

The six New England states combine to comprise a total of 1404 acres of peppers according to the 2002 Census of Agriculture. (NASS 2002) A recent survey (ProNewEngland 2006) indicated that the crop is split between 90% sweet and 9% hot peppers. Most (99%) of these peppers are grown for the fresh market with the remainder sent for processing. 64% of the fresh market peppers are sold to wholesale distributors and 35% for retail markets. While only contributing 0.0019% to the national production of peppers (NASS 2002), the pepper field is an integral part of the New England economy both in direct value and in its attraction and appeal as part of the New England landscape.

Peppers are susceptible to many pests including insects, diseases, weeds, and vertebrates. It is critical that these pests be effectively managed to maintain adequate yields of quality fruit that is acceptable to consumers. New England pepper growers have adopted innovative integrated pest management (IPM) and other cultural practices designed to manage these pests while reducing pesticide use, improving worker and food safety, and protecting environmental quality. While these methods do allow pesticides to be used more efficiently, they neither eliminate the need for pesticides nor reduce the critical importance of pesticides in pepper production. The loss of important pesticide tools due to pest resistance, regulatory, and consumer-driven pressures is a concern for the entire pepper industry.

How this plan was created

A review group of Pepper growers, researchers, and industry stakeholders throughout New England met for two days in March of 2008 to develop this Strategic Plan based on the 2008 New England Pepper Crop Profile. Key pests driving pesticide use were suggested by the 2006 New England Pepper Survey which was used to generate the Crop Profile. The survey was sent to 456 growers throughout New England and had a 52% return rate. The list of key pests was edited/approved by the review group.

The review group discussed the efficacy and practicality of current pesticides and pest management methods, identified acceptable alternative pest management methods, and listed the necessary research, regulatory and education needed to transition toward the use of these new methods. The pros and cons of each available option, along with opportunities for new technologies, were considered and contingency plans were discussed to prepare for possible future regulatory changes.
Benefits to the New England Pepper Industry

The New England Pepper Pest Management Strategic Plan will identify at-risk pesticides and propose future research, regulatory, and education priorities necessary to establish alternative pest management methods in the event of loss. These priorities will be used to inform EPA and state agency decisions and outline a development path for pest management researchers and educators. This information will be of great value in the pursuit of funding to address research and education needs identified through the Strategic Plan. The research and education necessary to establish effective alternative pest management methods requires this funding to account for the diversity of pests and the variety of habitats in pepper fields. The current pest management programs will be made more effective through implementation of actions proposed in this plan.
II. Summary

Key Pepper Pest Strategic Issues


Insects

European Corn Borer (*Ostrinia nubilalis* (Hubner))
This is an annual pest that attacks more than 200 host plants, including many common weeds and crops. It over-winters in New England and may have up to two generations in a season. Young larvae feed for a brief period on foliage then migrate to fruit where they feed on the flesh and seed head. Larval entry holes become the entry site for infection with the soft rot bacteria. A single larva may spread the soft rot disease to several fruit. Management with protective sprays targeted at larvae based on adult pheromone trap thresholds usually occurs in mid-late summer. Destruction of alternate hosts, especially corn stubble, is also common practice.

Aphids (Numerous species)
These are annual pests that have many generations per year. Aphids cause damage by sucking the sap from plants, making leaves appear stippled, chlorotic, distorted, and may reduce photosynthetic capacity. Additionally, aphids exude a clear sweet liquid on which a fungus called ‘sooty mold’ may grow. Peppers with sooty mold fungus are unmarketable. Aphids also spread viral diseases such as cucumber mosaic virus. Growers may preserve aphid parasites and predators by using selective insecticides against other pests, limiting applications to perimeter trap crops when possible, and by eliminating the use of broad-spectrum materials on resistant plants. Management with protective sprays based on monitoring thresholds may occur. Destruction of alternate hosts is also common practice.

Pepper Maggot (*Zonosemata electa* (Say))
This is an annual pest where established. Infestations can be complete or sporadic even within a single field. Adults emerge in July and eggs are deposited under the skin of the fruit. Often, the egg laying site heals over completely and is not noticeable. The maggots hatch a month later and migrate to the seed head to feed. Occasionally, maggots tunnel in the flesh, leaving an opaque scar which is visible from the exterior of the fruit. Larval exit wounds become the entry site for infection with the soft rot bacteria. Maggots in green peppers may be visually unappealing in fresh fruit or may contaminate processed products. Management with protective sprays targeted at adults based on baited trap thresholds usually occurs in mid-late summer. Perimeter trap cropping is also common practice.
Diseases

**Bacterial Leaf Spot (Xanthomonas campestris pv. Vesicatoria)**
This is the most common disease of peppers in New England. When introduced into a field it will spread under warm humid conditions aided by rain and wind. Leaf spots are water-soaked initially, then turn brown and become irregularly shaped. Affected leaves tend to crinkle, turn yellow and drop. Defoliation reduces plant productivity and fruit becomes vulnerable to sunscald. Fruit may also develop raised, scab-like spots. Management with protective sprays may occur following detection. However, use of resistant varieties and certified disease-free seed or transplants, sanitation, and crop rotation are common practices. In the absence of host crops, the disease is presumed destroyed by normal soil flora and fauna after two years.

**Phytophthora** (Numerous species)
The genus contains many destructive species, including *P. capsici* and *P. parasitica*, and is nearly ubiquitous in New England soils. The disease often starts following heavy rain or in low areas that remain flooded. Prolonged soil saturation causes release of swimming spores (zoospores) that travel to nearby hosts. Stem or branch lesions appear water-soaked then rapidly girdle and kill the plant beyond the wound. Infected fruit produce a white fungal growth on the skin. Successive heavy rainfalls can spread secondary spores throughout a field and to nearby sites. Management with protective sprays may occur following detection. However, use of resistant varieties, crop rotation, and proper water management are most effective in management of this disease.

Weeds

Weeds reduce yields by competing with the crop for water, light, and nutrients. Weeds serve as habitat and alternate hosts for insects, diseases, nematodes, and small vertebrate pests. They can inhibit spray penetration, air circulation, and drying conditions. Fields must be kept weed-free to maintain yields only during weeks 2-10 after transplanting into bare-ground or during weeks 4-10 when using plasticulture.

Weed infestations occur in mixed populations including annual grasses, annual broadleaf, perennial grasses, perennial broadleaf, woody perennial and vine weeds. Hairy galinsoga may build up in fields over time because this weed is not controlled by most herbicides registered for use in pepper and because it resists cultivation. Management with cultivation, crop rotation, and herbicides is common from pre-plant through post-plant pre-emergence and post-emergence applications.

Vertebrates

**Whitetail Deer (Odocoileus virginianus)**
Deer may occasionally trample crops, but the primary form of damage consists of feeding on plants. Damage levels may severely reduce crop yields on many sites especially those near woods. Management with various cultural control practices is common.
Strategic Issues of Specific Pest Management Tactics

Insecticides

**acephate (Orthene) - Aph, ECB**
- Inexpensive
- Less detrimental to beneficials (than synthetic pyrethroids)
- Longer residual effect
- Systemic (Aph only)
- Broad spectrum - harmful to beneficials
- Long PHI (7 days)
- Resistance developing
- More useful for late-harvest peppers that have longer time in field
- Only useful early in season for early-harvest peppers due to Long PHI
- Used to be standard use material

**azadirachtin (Aza-Direct) - ECB**
- Immediate plus residual effects in combination with Pyganic
- OMRI listed
- Expensive
- Becoming common to combine with Pyganic

**Bacillus thuringiensis kurstaki (Dipel) - ECB**
- Not detrimental to beneficials
- Not toxic to mammals
- OMRI listed
- Easily washed off by rain and photodegrades
- Narrow window of efficacy (only newly-hatched larvae susceptible)
- Requires frequent application
- Can be effective if applied properly and repeatedly
- More effective when applied with certain “stickers”
- Used in rotation with spinosad in organic program
- Very important for organic growers

**Beauvaria bassiana (BotaniGard, Mycotrol) - Aph**
- OMRI listed (Mycotrol only)
- Efficacy drops with age of material
- Foliage damage (phytotoxicity) possible with liquid formulation

**borax (Prev-Am) - Aph**
- Only registered for use in CT
- Should not apply during mid-day sun
- New material
carbaryl (Sevin) - ECB
- Labeled for multiple crops
- Low toxicity to mammals
- Relatively inexpensive
- Broad spectrum - harmful to beneficials - leads to increased aphid population
- Especially harmful to pollinators of other crops
- Long PHI (5-7 days)
- Poor efficacy
- Should not be applied to wet plants
- Material more effective against beetles

chlorpyrifos (Warrior) – Aph, ECB
- Labeled for multiple crops
- Relatively inexpensive
- Harmful to beneficials
- Long PHI (5 days)
- Severe dermal reactions possible
- *The* material against ECB in sweet corn

cyflurin (Baythroid) – Aph, ECB
- Labeled for multiple crops
- Relatively inexpensive
- Harmful to beneficials
- Long PHI (5 days)
- Part of rotational insecticide arsenal

dimethoate (Dimethoate) – Aph, PM
- Systemic
- Very effective (PM only)
- Broad spectrum - harmful to beneficials (PM only)
- Harmful to beneficials - leads to increased aphid population (Aph only)

dimethyl phosphorothioate (MSR) - Aph
- Systemic
- Very toxic to mammals when compared to other materials
- Effective older material

dosulfan (Thiodan, Thiodex) - Aph, PM
- Highly toxic to mammals
- Poor efficacy
- Unpleasant to use
- Labeled for use on eggplant (PM only)
esfenvalerate (Asana) - ECB
- Labeled for multiple crops
- Relatively inexpensive
- Harmful to beneficials
- Long PHI (7 days)
- Severe dermal reactions possible
- No advantage over other pyrethroids

horticultural oil (Trilogy, JMS, Golden, etc.) - Aph
- OMRI listed
- Fungicidal properties
- Phytotoxicity possible
- Requires very good spray coverage

imidacloprid (Admire, Provado) - Aph
- Systemic
- Other neonicotinoids: Safari - Greenhouse use only, Venom - Field use

insecticidal soap (M-Pede) - Aph
- OMRI listed
- Phytotoxicity possible

malathion (Malathion) – Aph, PM
- Relatively inexpensive
- Short PHI (1 day)
- Not particularly effective against multiple insect pests
- Offensive odor
- Requires frequent application
- May be harmful to beneficials (no data, Aph, PM)

methomyl (Lannate) – Aph, ECM
- Broad spectrum
- Usually effective against melon aphid (but not always effective) (Aph only)
- Extreme protective equipment required (storage, loading, applying)
- Harmful to beneficials
- Highly toxic to mammals
- Phytotoxicity possible with certain varieties
- Requires frequent application (ECB only)
- Resistance developing (ECB and Green Peach Aphid)
- Old material
- Identification of pest important prior to use (Aph only)
- One of only a few materials available for aphids in corn
- Restricted use
methoxyfenozide (Intrepid) - ECB
- Labeled for multiple crops
- Longer residual effect
- Low toxicity to mammals
- Not detrimental to beneficials
- Short PHI (1 day)
- Difficult to validate effect - no immediate kill
- Only effective against Lepidoptera
- Relatively expensive
- Insect growth regulator
- Used in rotation with spinosad

oxamyl (Vydate) - Aph
- May cause blossom drop
- Harmful to beneficials
- Toxic to mammals
- Not recommended

permethrin (Ambush, Pounce) - ECB
- Labeled for multiple crops
- Relatively inexpensive
- Harmful to beneficials
- Long PHI (5 days)

pymetrozine (Fulfil) - Aph
- Best material available
- Labeled for multiple crops
- Not detrimental to beneficials
- Not systemic
- Only labeled for aphids
- EPA designated reduced risk material
- Unique chemistry

pyrethrins (Pyganic) - ECB
- No PHI
- OMRI listed
- Expensive
- Requires frequent application

Pyriproxyfen (Knack) - Aph
- Systemic
- Not effective against adult stages
- Insect growth regulator
- New material
spinosad (Entrust, SpinTor) - ECB
- Not detrimental to predators
- OMRI listed (Entrust only, ECB)
- Short PHI (1 day)
- Harmful to beneficial parasitic wasps
- Large volume packaging sometimes problematic for small acreage
- Used in rotation with Intrepid and B.t. materials

zeta-cypermethrin (Mustang) – Aph, ECB, PM
- Labeled for multiple crops
- Relatively inexpensive
- Short PHI (1 day)
- Harmful to beneficials

Fungicides, Bactericides

basic copper sulfate (Basicop) - BLS
- Relatively inexpensive (compared to other copper materials)
- Probably not as effective as newer materials
- Older material
- The copper is the effective component

copper hydroxide (Champ, Kocide) - BLS
- New formulation (Kocide 3000) promising greater ease of use

cymoxanil + fumoxidone (Tanos) - Phyt
- One of the better materials available
- Poor efficacy
- Resistance development possible
- Foliar spray effective against secondary spread
- Must apply before symptoms appear

dimethomorph (Acrobat, Forum) - Phyt
- Some efficacy
- Systemic
- Resistance development possible
- Not as effective as Tanos
- Foliar spray effective against secondary spread
- Not widely used
- Different chemical family
fosetyl aluminum (Aliette) and others (Phostrol, PhosPhyte, ProPhyte) - Phyt
- Inexpensive
- Moderately effective
- Newer materials to market

hydrogen dioxide (Oxidate) – BLS, Phyt
- OMRI listed
- Expensive
- Requires frequent application
- Copper materials are more convenient to use (BLS only)
- Not widely used

maneb (Manex) - BLS, Phyt
- Some efficacy (Phyt only)
- Not as effective as Tanos (Phyt only)
- Not recommended (Phyt only)
- The old recommendation was to mix with copper – new copper materials work better alone (BLS only)
- Useful against downy mildew on cucurbits (Phyt only)

mefenoxam (Ridomil Gold) - Phyt
- Almost useless on newer mating types
- Expensive
- Apply prior to planting

mefenoxam + copper hydroxide (Ridomil Gold + copper) - Phyt
- Almost useless on newer mating types
- Expensive
- Added benefits of copper
- Foliar spray against secondary spread

sodium methyldithio-carbamate (Vapam) - Phyt
- Soil fumigant

streptomycin (Streptomycin) - BLS
- Must apply to transplants before planting
- Relatively expensive
- Keeps disease from entering field and spreading
**Herbicides**

**bensulide (Prefar) - Pre**
- Good activity against annual grasses only
- Safe on new growth
- Needs to be watered in to move to root zone
- Residual effects only good for 12 weeks
- Some important weeds not affected
- Rarely used

**clethodim (Select) - Post**
- Better activity against perennial grasses than Poast
- Best selective material for quackgrass
- New material

**clomazone (Command) - Pre**
- Some efficacy against galinsoga

**glyphosate (Roundup) – Post**
- Activity against annuals and perennial weeds
- Easy to use
- Inexpensive
- Safe for applicator
- Crop injury potential
- No residual activity
- Timing is critical to efficacy
- Critical for spot treatment
- Very widely used
- *Not labeled for use when crop present

**halosulfuron (Sandea, Permit) - Pre**
- Poor efficacy against galinsoga

**metolachlor (Dual) - Pre**
- Very effective against galinsoga
- Special local needs use only in some states

**napropamide (Devrinol) - Pre**
- Good activity against annual grasses and small seeded broadleaf weeds
- Safe on new growth
- Needs to be watered in or incorporated to prevent photodegradation
- Residual effects only good for 12 weeks
- Some important weeds not affected
- Root growth inhibitor but used on new plantings
- Widely used
paraquat (Gramoxone) – Pre, Post*
- Effective burn-down
- Fast acting
- More effective against tree seedlings than other materials
- Applicator safety is an issue
- Crop injury potential
- Expensive
- Not effective against perennials
- Offensive odor
- Restricted use is an issue
- Important niche material for management of tree seedlings
- Must be used prior to crop emergence
- Nonionic surfactant recommended
- *Not labeled for use when crop present

pelargonic acid (Scythe) - Post
- Effective burn-down
- Fast acting
- No PHI
- Expensive
- Not effective against perennials
- Not very effective at killing growth point
- Very odorous

pendimethalin (Prowl) - Pre
- Good activity against annual grasses and many broadleaf weeds
- Effective with a surface application under plastic mulch
- Safe on new growth
- Poor efficacy against galinsoga
- Needs to be watered in or incorporated to move to root zone
- Residual effects only good for 6-8 weeks
- Recent registration
- Not commonly used

sethoxydim (Poast) - Post
- Good activity against annual grasses
- Safe on crop
- Crop injury potential due to required mix with crop oil
- Fair activity against perennial grasses with multiple applications
- Very long PHI (30 days)
- Generally used
**trifluralin (Treflan, Trilin) - Pre**

- Good activity against annual grasses and many broadleaf weeds
- Safe on new growth
- Poor efficacy against galinsoga, nightshade, and velvetleaf
- Must be incorporated so not effective with plastic mulch
- Can stunt crop if incorporated too deeply under plastic, especially in cold soils
- Residual effects only good for 8-10 weeks
- Commonly used for bare ground plantings or before laying plastic
Research priorities

New chemistries and options
- More organic management chemistries are needed that are safe to beneficial organisms. (PM)
- Develop more disease resistant varieties, particularly BLS resistant hot peppers and ‘frying’ peppers. (BLS, Phyt)
- Explore use of noncompetitive, fast-growing, permanent ground covers to reduce erosion during growing season. (Phyt)
- Explore the effects of groundcovers on soil drainage. (Phyt)
- Explore grass herbicide options (for between rows) that have shorter days to harvest and/or have a residual effect. (Weeds)

Specific materials and equipment
- More materials are needed that work against melon aphids. (Aphids)
- Determine the effects of fungicides, such as azadirachtin, on Beauvaria bassiana (BotaniGard, Mycotrol) applications, particularly for any counterproductive activity. (Aphids)
- More information is needed on the use of harpin protein ‘yield promoters’ as relates to an increase of early blight in tomato in northern climates. (BLS)
- Alternatives to copper chemistries are needed to improve soil health and toxicity issues. (BLS)
- Explore the activity and application of other soil fungus to out-compete or consume Phytophthora. (Phyt)
- Explore the uses of grafting in achieving disease resistance. (Phyt)
- More materials are needed that work against galinsoga. (Weeds)
- Quantify the effect of flame weeding in galinsoga management. (Weeds)

Models
- Explore methods of notifying and alerting growers of new information.
- Develop monitoring models for coastal regions where seasonal development ranges ahead of other New England regions and insect population is heavier. (ECB)
- Clarify chemical families of materials to avoid confusion when combining and to discourage development of resistance. (ECB)
- Explore monitoring, mapping and trapping to determine current geographical ranges of pests. (PM, Phyt)
- Determine thresholds for nematode damage.
- A firm threshold model for Armyworms and Corn Earworms would be useful to growers, especially if developed for southern New England areas where the pest population is more consistent.
- Research is needed into effects of Sclerotinia infection on yield.
Regulatory priorities

Packaging and labels
- Loss of carbamate pesticides (carbaryl, methomyl, etc.) would impact management of many other crops found on a diversified farm.
- Create incentives for pesticide packaging that is practical for small-acreage growers. Smaller quantities are needed for small-acreage application. (ECB)

Specific materials
- Fast-track registration of new materials, especially organic materials. (PM)
- Standardize and limit the frequency at which the OMRI Products List and local organic certifying agency product lists change. The current rate of change is too frequent to maintain inventory of acceptable materials and is a hindrance to timely application of acceptable materials. (BLS)
- Expand Dual registration to other New England states. (Weeds)

Desired revisions
- Direct funds towards development and continuation of models, forecasts, newsletters that are useful to growers.
- Provide incentives to increase the research and extension that is beneficial to commercial growers.
- Create grant funding opportunities for newer researchers who may not yet have the background to as effectively compete for other funding.
- Encourage the infrastructure (fertilizers, suppliers, consultants) to support small farms.
- Direct funds towards publications and guides that may be useful to growers. (ECB)
- Provide incentives to increase the number of applied weed specialists in practice. (Weeds)
- Foster and enforce consistency among the varied international, federal, state, and county regulations, interpretation and enforcement. (Deer)
- Streamline and speed local permitting processes for deer control action. (Deer)
**Education priorities**

**Scouting and identification**
- Provide information on pest lifecycles, pest movement and dispersal, and variations, such as race, that are critical to management.
- Provide information on proper timing and placement of pest-monitoring traps. (ECB)
- Promote the efficacy of pest predator populations in aphid management strategies. (Aphids)
- Clarify the identification features of pest predators. (Aphids)
- Encourage proper identification of ECB and PM injury in comparison to diseases. (PM)

**Timing**
- Proper timing of sprays and alternating between materials (ECB)
- Promote awareness of critical periods when crop must be kept weed-free. (Weeds)

**Methods**
- Promote the uses and benefits of trap crops. (PM)
- Demonstrate the use of hot water seed treatment to illustrate the worth of the practice. (BLS)
- Encourage the separation of resistant and non-resistant varieties in the field to ease management and to minimize management to only non-resistant varieties. (BLS)
- Promote the management uses of a three-year crop rotation and removal of all pepper plant residues. (BLS)
- Continue to promote the criticalness of water management practices and the minimal efficacy of chemicals in disease management. (Phyt)
- Encourage checking irrigation sources for disease inoculum. (Phyt)
- Promote proper formation of beds to ease cultivation. (Weeds)
- Promote the management uses of crop rotation to reduce galinsoga. (Weeds)
- Encourage the cleaning of equipment to prevent the spread of weeds. (Weeds)

**Awareness**
- Clarify the differences between systemic and topical material efficacy.
- Notify growers of models that are available for predicting and tracking pest activity.
- Spread awareness of pests that are likely to spread into and within New England due to climate change.
- Clarify chemical families of materials to avoid confusion when combining and to discourage development of resistance. (ECB)
- Raise awareness that use of insecticides in addition to fungicides exacerbates aphid populations and such pest problems are avoidable. (Aphids)
• Spread awareness of the likely spread of Pepper Maggot into areas of northern New England. (PM)
• Notify growers of the changes in disease populations that are becoming more virulent, pervasive and destructive. (Phyt)
• Foster and enforce consistency among the varied international, federal, state, and county regulations, interpretation and enforcement. (Deer)
• Raise awareness that federal government assistance for deer fence installation is available. (Deer)
III. Key Pests

Key Insect pests

European Corn Borer (*Ostrinia nubilalis* (Hubner))

% Acres Affected: 81%

- Year to year problem but impact can be variable.
- A late winter temperature drop below freezing can reduce pest population when it happens.
- Monitoring and management is timed with adult flight periods but targeted at larvae which cause the damage.
- Stem boring activity early in the season is not as common as fruit damage later in season.
- The critical period for monitoring and management is when fruit is present in July and August.
- Traps to monitor for pest can be used in both corn and pepper, saving time and money when both crops are present.
- Management materials for corn and pepper are generally the same, saving time and money when both crops are present.
- The primary consideration when choosing applied materials is the pre-harvest interval (PHI).

Currently Registered Pesticides

<table>
<thead>
<tr>
<th>Pesticide</th>
<th>Efficacy</th>
<th>Pros</th>
<th>Cons</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>acephate Orthene</td>
<td>60% excellent 40% good</td>
<td>• Inexpensive&lt;br&gt;• Less detrimental to beneficials (than synthetic pyrethroids)&lt;br&gt;• Longer residual effect</td>
<td>• Broad spectrum - harmful to beneficials&lt;br&gt;• Long PHI (7 days)&lt;br&gt;• Resistance developing</td>
<td>• More useful for late-harvest peppers that have longer time in field&lt;br&gt;• Only useful early in season for early-harvest peppers due to Long PHI&lt;br&gt;• Used to be standard use material</td>
</tr>
<tr>
<td>azadiracthin Aza-Direct</td>
<td>Immediate plus residual effects in combination with Pyganic&lt;br&gt;• OMRI listed</td>
<td>• Expensive</td>
<td>• Becoming common to combine with Pyganic</td>
<td></td>
</tr>
<tr>
<td><em>Bacillus thuringiensis kurstaki</em> Dipel</td>
<td>30% excellent 70% good</td>
<td>• Not detrimental to beneficials&lt;br&gt;• Not toxic to mammals&lt;br&gt;• OMRI listed</td>
<td>• Easily washed off by rain and photodegrades&lt;br&gt;• Narrow window of efficacy (only newly-hatched larvae susceptible)</td>
<td>• Can be effective if applied properly and repeatedly&lt;br&gt;• More effective when applied with certain “stickers”</td>
</tr>
<tr>
<td>Insecticide</td>
<td>% of Growers</td>
<td>Description</td>
<td>Strengths</td>
<td>Weaknesses</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------</td>
<td>-------------</td>
<td>-----------</td>
<td>------------</td>
</tr>
<tr>
<td>Carbaryl (Sevin)</td>
<td>7%</td>
<td>17% excellent, 83% good</td>
<td>Labeled for multiple crops, Low toxicity to mammals, Relatively inexpensive</td>
<td>Requires frequent application, Used in rotation with spinosad in organic program, Very important for organic growers</td>
</tr>
<tr>
<td>Chlorpyrifos (Warrior)</td>
<td>2%</td>
<td>50% excellent, 50% good</td>
<td>Labeled for multiple crops, Relatively inexpensive</td>
<td>Harmful to beneficials, Long PHI (5 days), Severe dermal reactions possible, The material against ECB in sweet corn</td>
</tr>
<tr>
<td>Cyflurin (Baythroid)</td>
<td>2%</td>
<td>100% good</td>
<td>Labeled for multiple crops, Relatively inexpensive</td>
<td>Harmful to beneficials, Long PHI (5 days), Part of rotational insecticide arsenal</td>
</tr>
<tr>
<td>Esfenvalerate (Asana)</td>
<td>9%</td>
<td>63% excellent, 38% good</td>
<td>Labeled for multiple crops, Relatively inexpensive</td>
<td>Harmful to beneficials, Long PHI (7 days), Severe dermal reactions possible, No advantage over other pyrethroids</td>
</tr>
<tr>
<td>Malathion (Malathion)</td>
<td>1%</td>
<td></td>
<td></td>
<td>Not labeled for ECB</td>
</tr>
<tr>
<td>Methomyl (Lannate)</td>
<td>15%</td>
<td>43% excellent, 57% good</td>
<td>Broad spectrum</td>
<td>Extreme protective equipment required (storage, loading, applying), Harmful to beneficials, Highly toxic to mammals, Phytotoxicity possible with certain varieties, Requires frequent application, Resistance developing, Old material, One of only a few materials available for aphids in corn, Restricted use</td>
</tr>
<tr>
<td>Methoxyfenozide (Intrepid)</td>
<td>2%</td>
<td>100% good</td>
<td>Labeled for multiple crops, Longer residual effect, Low toxicity to mammals, Not detrimental to beneficials, Short PHI (1 day)</td>
<td>Difficult to validate effect - no immediate kill, Only effective against Lepidoptera, Relatively expensive, Insect growth regulator, Used in rotation with spinosad</td>
</tr>
<tr>
<td>Permethrin (Ambush, Pounce)</td>
<td>66%</td>
<td>66% excellent, 33% good</td>
<td>Labeled for multiple crops, Relatively inexpensive</td>
<td>Harmful to beneficials, Long PHI (5 days),</td>
</tr>
<tr>
<td>(20% growers)</td>
<td>• No PHI</td>
<td>• Expensive</td>
<td>• Requires frequent application</td>
<td></td>
</tr>
<tr>
<td>---------------</td>
<td>------------</td>
<td>-------------</td>
<td>--------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>pyrethrins</strong></td>
<td>• OMRI listed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pyganic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>spinosad</strong></td>
<td>• Not detrimental to predators</td>
<td>• Harmful to beneficial parasitic wasps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entrust,</td>
<td>• OMRI listed (Entrust only)</td>
<td>• Large volume packaging sometimes problematic for small acreage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SpinTor</td>
<td>• Short PHI (1 day)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(22% growers)</td>
<td></td>
<td></td>
<td>• Used in rotation with Intrepid and B.t. materials</td>
<td></td>
</tr>
<tr>
<td><strong>zeta-cypermethrin</strong></td>
<td>75% excellent 25% good</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mustang</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1% growers)</td>
<td>• Labeled for multiple crops</td>
<td>• Harmful to beneficials</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Relatively inexpensive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Short PHI (1 day)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Cultural and Biological Alternatives

<table>
<thead>
<tr>
<th>Practices Reported</th>
<th>Efficacy</th>
<th>Pros</th>
<th>Cons</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Row covers</strong></td>
<td>• Effective barrier</td>
<td>• May cause blossom loss</td>
<td>• May cause blossom loss</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Expensive</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Must remove and cultivate (for weed control) after rain if organic</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Remove nearby corn stubble</strong></td>
<td>• Can affect pest population if done regionally</td>
<td>•</td>
<td>•</td>
<td></td>
</tr>
<tr>
<td><strong>Eliminate alternative hosts (weeds, etc.)</strong></td>
<td>•</td>
<td>• Difficult to remove all of the many alternative host plants</td>
<td>•</td>
<td></td>
</tr>
<tr>
<td><strong>Traps to monitor</strong></td>
<td>• Best way to time insecticide applications</td>
<td>• Cloth traps don’t last long</td>
<td>• Trap opening must be at weed height</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• No need to place specifically in pepper field</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Release predators /parasites</strong></td>
<td>•</td>
<td>•</td>
<td>• Not common practice</td>
<td></td>
</tr>
<tr>
<td><strong>Nitrogen application</strong></td>
<td>•</td>
<td>•</td>
<td>• Balance between fruit production needs and vigorous growth</td>
<td></td>
</tr>
<tr>
<td><strong>Perimeter trap crop</strong></td>
<td>•</td>
<td>• Not effective</td>
<td>•</td>
<td></td>
</tr>
</tbody>
</table>
Research Needs:
- Develop monitoring models for coastal regions where seasonal development ranges ahead of other New England regions and insect population is heavier.
- Clarify chemical families of materials to avoid confusion when combining and to discourage development of resistance.

Regulatory Needs:
- Create incentives for pesticide packaging that is practical for small-acreage growers. Smaller quantities are needed for small-acreage application.
- Direct funds towards publications and guides that may be useful to growers.

Education Needs:
- Provide information on proper timing and placement of pest-monitoring traps.
- Proper timing of sprays and alternating between materials
- Clarify chemical families of materials to avoid confusion when combining and to discourage development of resistance.
Aphids (Numerous species including: Green Peach Aphid *Myzus persicae*, Melon Aphid *Aphis gossypii*, Potato Aphid *Macrosiphum euphorbiae*)

% Acres Affected: 64%

- Usually not a problem or not specifically managed.
- Growers may preserve aphid parasites and predators by using selective insecticides against other pests, limiting applications to perimeter trap crops when possible, and by eliminating the use of broad-spectrum materials on resistant plants.
- Predators will usually control aphid populations, especially on small farms with multiple crops, provided there is no disruption of the predator population.
- Incidence increases with use of broad-spectrum, weakly effective insecticides targeted at other insects because they affect the predator population.
- Use of fungicides targeted at other pests can destroy the entomopathogenic fungi that would kill aphids.
- Incidence more likely on plants that have come out of infested greenhouses, from under row covers in the early season, and during hot and dry weather.
- Green peach aphid is the predominant species. Melon aphid outbreaks are rare and very difficult to manage when they occur. Other species are minor pests.
- Aphid ‘honey dew’ waste can make fruit sticky.

Currently Registered Pesticides

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<th>Pesticide</th>
<th>Efficacy</th>
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<th>Cons</th>
<th>Comments</th>
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</thead>
</table>
| **acephate** Orthene (8% growers) | 29% excellent 71% good | • Inexpensive  
• Less detrimental to beneficials (than synthetic pyrethroids)  
• Longer residual effect  
• Systemic | • Broad spectrum - harmful to beneficials  
• Long PHI (7 days)  
• Resistance developing | • More useful for late-harvest peppers that have longer time in field  
• Only useful early in season for early-harvest peppers due to Long PHI  
• Used to be standard use material |
| **Beauvaria bassiana** BotaniGard, Mycotrol (1% growers) | 100% good | • OMRI listed (Mycotrol only) | • Efficacy drops with age of material  
• Foliage damage (phytotoxicity) possible with liquid formulation | |
| **borax** Prev-Am | | • | • Only registered for use in CT  
• Should not apply during mid-day sun | • New material |
<p>| <strong>chlorpyrifos</strong> | | • Labeled for multiple | • Harmful to beneficials | • <em>The</em> material against |</p>
<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Crops</th>
<th>PHI Duration</th>
<th>Other Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Warrior</strong></td>
<td>Relatively inexpensive</td>
<td>Long PHI (5 days)</td>
<td>ECB in sweet corn</td>
</tr>
<tr>
<td><strong>cyflurin</strong></td>
<td>Labeled for multiple crops</td>
<td>Harmful to beneficials</td>
<td>Part of rotational insecticide arsenal</td>
</tr>
<tr>
<td>Baythroid</td>
<td>Relatively inexpensive</td>
<td>Long PHI (5 days)</td>
<td></td>
</tr>
<tr>
<td><strong>dimethoate</strong></td>
<td>Systemic</td>
<td>Harmful to beneficials - leads to increased aphid population</td>
<td></td>
</tr>
<tr>
<td>Dimethoate</td>
<td>100% good</td>
<td>Very toxic to mammals when compared to other materials</td>
<td>Effective older material</td>
</tr>
<tr>
<td>(1% growers)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>dimethyl</strong></td>
<td>Systemic</td>
<td>Highly toxic to mammals</td>
<td>Other neonicotinoids: Safari – Greenhouse use only, Venom – Fiel use</td>
</tr>
<tr>
<td>phosphorothioate</td>
<td>29% excellent 57% good 14% poor</td>
<td>Unpleasant to use</td>
<td></td>
</tr>
<tr>
<td>MSR</td>
<td>OMRI listed</td>
<td>Phytotoxicity possible</td>
<td></td>
</tr>
<tr>
<td></td>
<td>80% excellent 20% good</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>imidacloprid</strong></td>
<td>Systemic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Admire, Provado</td>
<td>100% good</td>
<td></td>
<td>Other neonicotinoids: Safari – Greenhouse use only, Venom – Fiel use</td>
</tr>
<tr>
<td>(11% growers)</td>
<td>OMRI listed</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>insecticidal</strong></td>
<td>Relatively inexpensive</td>
<td>Not particularly effective against multiple insect pests</td>
<td>May be harmful to beneficials (no data)</td>
</tr>
<tr>
<td>soap</td>
<td>Short PHI (1 day)</td>
<td>Offensive odor</td>
<td></td>
</tr>
<tr>
<td>M-Pede</td>
<td>OMRI listed</td>
<td>Requires frequent application</td>
<td></td>
</tr>
<tr>
<td>(1% growers)</td>
<td>100% excellent</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>malathion</strong></td>
<td>Broad spectrum</td>
<td>Extreme protective equipment required (storage, loading, applying)</td>
<td>Old material</td>
</tr>
<tr>
<td>Malathion</td>
<td>Usually effective against melon aphid</td>
<td>Harmful to beneficials</td>
<td>Identification of pest important prior to use</td>
</tr>
<tr>
<td>(3% growers)</td>
<td>57% excellent 43% good</td>
<td>Highly toxic to mammals</td>
<td>One of only a few materials available for aphids in corn</td>
</tr>
<tr>
<td><strong>methomyl</strong></td>
<td></td>
<td>Phytotoxicity possible with certain varieties</td>
<td>Restricted use</td>
</tr>
<tr>
<td>Lannate</td>
<td></td>
<td>Resistance developing (Green Peach Aphid)</td>
<td></td>
</tr>
<tr>
<td>(8% growers)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>oxamyl</strong></td>
<td></td>
<td>May cause blossom drop</td>
<td>Not recommended</td>
</tr>
<tr>
<td>Vydate</td>
<td></td>
<td>Harmful to beneficials</td>
<td></td>
</tr>
</tbody>
</table>
pyrimethane
Fulfil
(2% growers)
50% excellent
50% good
• Best material available
• Labeled for multiple crops
• Not detrimental to beneficials
• Not systemic
• Only labeled for aphids
• EPA designated reduced risk material
• Unique chemistry

pyriproxyfen
Knack
(1% growers)
100% good
• Systemic
• Not effective against adult stages
• Insect growth regulator
• New material

zeta-cypermethrin
Mustang
• Labeled for multiple crops
• Relatively inexpensive
• Short PHI (1 day)
• Harmful to beneficials

<table>
<thead>
<tr>
<th>Practices Reported*</th>
<th>Efficacy</th>
<th>Pros</th>
<th>Cons</th>
<th>Comments</th>
</tr>
</thead>
</table>
| Plastic mulches     | • Reflective silver mulch repels insects  
|                     | • Black mulch reduces aphids and warms soil | • Reflective mulches do not allow soil to warm, stunts growth  
|                     |                     | • Reflective mulches can oxidize and lose reflectivity later in season | • May be more effective further south due to season/temp differences |
| Eliminate alternative hosts (weeds, etc) | • | • Difficult to remove all alternative hosts, particularly black cherry | • Especially critical in greenhouses |
| Scouting            | • Identification of species present  
|                     | • Allows tracking of population growth  
|                     | • Can reduce frequency of management material application | • |
| Preserve/attract beneficials | • Cut flowers attract beneficials | • Seed is expensive for crops attractive to beneficials | • Not common practice in fields |
| Manage nitrogen     | • | • | • High nitrogen levels encourage aphid populations |

Cultural and Biological Alternatives
Research Needs:
- More materials are needed that work against melon aphids.
- Determine the effects of fungicides, such as azadirachtin, on *Beauvaria bassiana* (Botanigard, Mycotrol) applications, particularly for any counterproductive activity.

Regulatory Needs:
- None specified.

Education Needs:
- Promote the efficacy of pest predator populations in aphid management strategies.
- Clarify the identification features of pest predators.
- Raise awareness that use of insecticides in addition to fungicides exacerbates aphid populations and such pest problems are avoidable.
Pepper Maggot (*Zonosemata electa* (Say))

% Acres Affected: 63%

- This pest is currently present in Rhode Island and coastal New Hampshire but has not yet been identified as a pest in northern New Hampshire, Maine, or Vermont.
- Movement of population is likely to spread north along river valleys or through accidental transportation.
- Once present, the pest is endemic.
- Treatment is most effective when adults emerge in July although the maggots do not emerge until later in the summer.
- Systemic materials will be effective against maggots.
- Not all 'sting' damage done by adults result in eggs and/or maggots.
- There are no practical trapping methods but trap crops are very good to scout for first indication of pest presence.
- A perimeter trap crop of hot cherry peppers is very useful to attract pests away from other crops. Materials can sometimes be applied only to the trap crop to manage the pest population.

### Currently Registered Pesticides

<table>
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<tr>
<th>Pesticide</th>
<th>Efficacy</th>
<th>Pros</th>
<th>Cons</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>acephate Orthene</td>
<td>71% good</td>
<td></td>
<td>•</td>
<td>• Not labeled for PM</td>
</tr>
<tr>
<td>dimethoate Dimethoate</td>
<td>75% good</td>
<td>•Systemic</td>
<td>•Broad spectrum - harmful to beneficials</td>
<td></td>
</tr>
<tr>
<td>endosulfan Thiodan, Thionex</td>
<td>70% good</td>
<td>•Highly toxic to mammals</td>
<td>•Unpleasant to use</td>
<td>Labeled for use on eggplant</td>
</tr>
<tr>
<td>esfenvalerate Asana</td>
<td>50% good</td>
<td></td>
<td>•</td>
<td>• Not labeled for PM</td>
</tr>
<tr>
<td>malathion Malathion</td>
<td>33% good</td>
<td>•Relatively inexpensive</td>
<td>•Not particularly effective against multiple insect pests</td>
<td>May be harmful to beneficials (no data)</td>
</tr>
<tr>
<td>zeta-cypermethrin Mustang</td>
<td></td>
<td>•Labeled for multiple crops</td>
<td>•Harmful to beneficials</td>
<td></td>
</tr>
</tbody>
</table>
### Cultural and Biological Alternatives

<table>
<thead>
<tr>
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</tr>
</thead>
</table>
| Trap crop (1% growers) |          | • Increases ease of detecting damage  
• May only need to apply management material to trap crop | • | • |

**Research Needs:**
- More organic management chemistries are needed that are safe to beneficial organisms.
- Explore monitoring, mapping and trapping to determine current geographical ranges of pests.

**Regulatory Needs:**
- Fast-track registration of new materials, especially organic materials.

**Education Needs:**
- Encourage proper identification of ECB and PM injury in comparison to diseases.
- Promote the uses and benefits of trap crops.
- Spread awareness of the likely spread of Pepper Maggot into areas of northern New England.
Comments on Other Insects and Slugs
These insects are not considered Key Pests but do warrant special note as emerging issues in New England.

Armyworms (Fall, Beet)
- Will infrequently affect peppers.
- Presence can be monitored.
- Spinosad (Entrust) is a better choice for management than acephate (Orthene) which will not affect armyworms.
- A firm threshold model would be useful to growers, especially if developed for southern New England areas where the pest population is more consistent.

Black Cutworms
- Migrate from the borders into every field in every year.
- The usual leaf damage is generally not a problem but sometimes stem damage occurs.
- Scout for leaf feeding.
- Can hand-dig out of soil.

Colorado Potato Beetle
- Can be a problem when eggplants are planted nearby or in rotation.
- Effective materials are available.

Corn Earworms
- Large populations occur along coastal New England.
- Spinosad (Entrust) is a better choice for management than acephate (Orthene) which will not affect armyworms.
- A firm threshold model would be useful to growers, especially if developed for southern New England areas where the pest population is more consistent.

Mites
- Broad mite outbreaks have been seen in New Hampshire and originating in greenhouses in Vermont.
- Relatively easy to manage.

Pepper Weevil
- Not present in New England.
- Could be imported on transplants grown outside New England.
- Avoid accidental introduction by growing or purchasing transplants locally.
Tarnished Plant Bugs
- Severe infestations can cause blossom drop.

Thrips
- Incidence more likely on plants that have come out of infested greenhouses
- Predators will usually control pest populations.
- Fruit damage is possible.

Slugs
- Usually not a significant problem on pepper.

Other Insects not considered Key Pests
- Common stalk borer
- Caterpillars (general), Hornworms
- Flea beetles
- Grasshoppers
- Japanese/Asiatic Beetles
- Leafminers
- Stinkbugs
- Whiteflies
- Wireworms
Key Diseases

Bacterial Leaf Spot (*Xanthomonas campestris pv. Vesicatoria*)

% Acres Affected: 61%

- Incidence is higher during periods of high humidity and warm nighttime temperatures. These conditions are less likely to be found in more northern areas of New England.
- Incidence is more likely where higher acreage of the crop is grown.
- Water management and crop rotation are critical to management.
- A three year crop rotation allows time for any infected pepper residue to decompose, reducing inoculum.
- Many resistant varieties are available to different races of disease.
- Seed may be infected prior purchase.
- Tomato plants are also susceptible.

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</tr>
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<tr>
<td>basic copper sulfate (Basicop)</td>
<td>100% excellent</td>
<td>Relatively inexpensive (compared to other copper materials)</td>
<td>Probably not as effective as newer materials</td>
<td>Older material, The copper is the effective component</td>
</tr>
<tr>
<td>copper hydroxide (Champ, Kocide)</td>
<td>43% excellent, 38% good, 5% poor</td>
<td>•</td>
<td>•</td>
<td>New formulation (Kocide 3000) promising greater ease of use</td>
</tr>
<tr>
<td>hydrogen dioxide (Oxidate)</td>
<td>OMRI listed</td>
<td>•</td>
<td>Expensive, Requires frequent application</td>
<td>Copper materials are more convenient to use, Not widely used</td>
</tr>
<tr>
<td>maneb (Manex)</td>
<td>57% excellent, 29% good, 14% poor</td>
<td>•</td>
<td>•</td>
<td>Not labeled for BLS, Old recommendation was to mix with copper – new copper materials work better alone</td>
</tr>
<tr>
<td>streptomycin (Streptomycin)</td>
<td>Must apply to transplants before planting</td>
<td>•</td>
<td>Relatively expensive</td>
<td>Keeps disease from entering field and spreading</td>
</tr>
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<td>Relatively expensive</td>
<td>Keeps disease from entering field and spreading</td>
</tr>
<tr>
<td>Practices Reported*</td>
<td>Efficacy</td>
<td>Pros</td>
<td>Cons</td>
<td>Comments</td>
</tr>
<tr>
<td>---------------------</td>
<td>----------</td>
<td>------</td>
<td>------</td>
<td>----------</td>
</tr>
</tbody>
</table>
| Resistant varieties (19% growers) | 29% excellent 65% good | • Common practice | • Not completely effective  
• No variety is resistant to every strain of pathogen  
• Not every strain of pathogen has a resistant variety available | • Infection still occurs in resistant varieties but is prevented from spreading within the plant. Initial infection can look alarming. |
| Hot water treat seeds (2% growers) | 100% good | • Effective  
• Some seed companies will treat prior to sale | • Can overheat/boil and destroy seed  
• Equipment necessary | • Seed companies discourage it –can destroy seed  
• Follow with fungicide to prevent damping off (normal procedure) |
| Bleach treat seeds | | • | • Only removes pathogens on seed surface | • |
| Rotate crops/Remove all plant residue | | • | • Takes time to execute | • A three year rotation is preferred |
| Eliminate alternate hosts | | • | • | • Solonaceous weeds such as nightshade, horsenettle, and jimsonweed |
| Inspect transplants and scout | | • | • | • No comments |
| Maintain fertility, pH | | • | • | • Drop in fertility or pH, especially nitrogen, encourages disease  
• High magnesium predisposes to bacterial diseases |
| Avoid planting in foggy areas | | • | • | • Do not work field when plants wet |
**Research Needs:**
- Develop more disease resistant varieties, particularly BLS resistant hot peppers and ‘frying’ peppers.
- More information is needed on the use of harpin protein ‘yield promoters’ as relates to an increase of early blight in tomato in northern climates.
- Alternatives to copper chemistries are needed to improve soil health and toxicity issues.

**Regulatory Needs:**
- Standardize and limit the frequency with which the OMRI Products List and local organic certifying agency product lists change. The current rate of change is too frequent to maintain inventory of acceptable materials and is a hindrance to timely application of acceptable materials.

**Education Needs:**
- Demonstrate the use of hot water seed treatment to illustrate the worth of the practice.
- Encourage the separation of resistant and non-resistant varieties in the field to ease management and to minimize management to only non-resistant varieties.
- Promote the management uses of a three-year crop rotation and removal of all pepper plant residues.
Phytophthora (Numerous species including: P. capsici and P. parasitica)
% Acres Affected: 50%

- Sudden and dramatic losses are possible, particularly post-harvest, when conditions favor disease development.
- Inoculum can never be eliminated from soils and will accumulate in the soil if crop is not rotated.
- Causal organism is an aggressive colonizer of soil, especially following fumigation.
- Water management, proper drainage, and crop rotation are absolutely critical to management.
- Cultural methods that avoid standing water and prevent movement of water between beds are advantageous.
- Washing soil from equipment between fields will reduce the spread of inoculum.
- A three year crop rotation allows time for any infected pepper residue to decompose, reducing inoculum.
- Rotation is difficult on small acreage farms because many crops (Solanaceous, cucurbits, beans) are susceptible to the same species of Phytophthora.
- Mapping of field locations where and when there is disease present is a valuable tool for planning management.

Currently Registered Pesticides

<table>
<thead>
<tr>
<th>Pesticide</th>
<th>Efficacy</th>
<th>Pros</th>
<th>Cons</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>cymoxanil + fumoxidone</td>
<td>50% good</td>
<td>One of the better materials available</td>
<td>Poor efficacy</td>
<td>Foliar spray effective against secondary spread</td>
</tr>
<tr>
<td>Tanos (2% growers)</td>
<td>50% poor</td>
<td></td>
<td>Resistance development possible</td>
<td>Must apply before symptoms appear</td>
</tr>
<tr>
<td>dimethomorph</td>
<td>100% good</td>
<td>Some efficacy</td>
<td>Resistance development possible</td>
<td>Different chemical family</td>
</tr>
<tr>
<td>Acrobat, Forum (1% growers)</td>
<td></td>
<td>Systemic</td>
<td>Not as effective as Tanos</td>
<td>Foliar spray effective against secondary spread</td>
</tr>
<tr>
<td>fosetyl aluminum</td>
<td></td>
<td>Inexpensive</td>
<td></td>
<td>Not widely used</td>
</tr>
<tr>
<td>Aliette and others (Phostrol,</td>
<td></td>
<td>Moderately effective</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PhosPhyte, ProPhyte) (1% growers)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>hydrogen dioxide</td>
<td>100% good</td>
<td>OMRI listed</td>
<td>Expensive</td>
<td>Not widely used</td>
</tr>
<tr>
<td>Oxidate (1% growers)</td>
<td></td>
<td></td>
<td>Requires frequent application</td>
<td></td>
</tr>
<tr>
<td>stance</td>
<td>Efficacy</td>
<td>Pros</td>
<td>Cons</td>
<td>Comments</td>
</tr>
<tr>
<td>--------</td>
<td>----------</td>
<td>------</td>
<td>------</td>
<td>----------</td>
</tr>
<tr>
<td>Maneb</td>
<td>17% excellent 33% good 50% poor</td>
<td>• Some efficacy</td>
<td>• Not as effective as Tanos</td>
<td>• Not recommended • Useful against downy mildew on cucurbits</td>
</tr>
<tr>
<td>Mefenoxam</td>
<td>22% excellent 67% good 11% poor</td>
<td>•</td>
<td>• Almost useless on newer mating types • Expensive</td>
<td>• Apply prior to planting</td>
</tr>
<tr>
<td>Sodium methyldithiocarbamate</td>
<td>100% good</td>
<td>•</td>
<td>•</td>
<td>• Soil fumigant</td>
</tr>
</tbody>
</table>

**Cultural and Biological Alternatives**

<table>
<thead>
<tr>
<th>Practices Reported*</th>
<th>Efficacy</th>
<th>Pros</th>
<th>Cons</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistant varieties (4% growers)</td>
<td>50% excellent 25% good 25% poor</td>
<td>• The resistant variety ‘Palidin’ provides good yield and fruit is marketable</td>
<td>• Only one variety available with strong resistance • Others varieties less resistant but have more marketable fruit</td>
<td></td>
</tr>
<tr>
<td>Raised Bed (1% growers)</td>
<td>100% good</td>
<td>•</td>
<td>•</td>
<td>• Shaping beds into domes to prevent runoff into planting holes</td>
</tr>
<tr>
<td>Rotate crops</td>
<td>•</td>
<td>• Takes time to execute</td>
<td>• A three year rotation is preferred</td>
<td></td>
</tr>
</tbody>
</table>

**Research Needs:**
- Develop more disease resistant varieties.
- Explore use of noncompetitive, fast-growing, permanent ground covers to reduce erosion during growing season.
- Explore the effects of groundcovers on soil drainage.
- Explore the activity and application of other soil fungus to out-compete or consume Phytophthora.
- Explore the uses of grafting in achieving disease resistance.
- Explore monitoring, mapping and trapping to determine current geographical ranges of pests.
Regulatory Needs:
- None specified.

Education Needs:
- Continue to promote the criticalness of water management practices and the minimal efficacy of chemicals in disease management.
- Encourage testing irrigation sources for disease inoculum.
- Notify growers of the changes in disease populations that are becoming more virulent, pervasive and destructive.
Comments on Other Diseases and Nematodes

These diseases are not considered Key Pests but do warrant special note as emerging issues in New England.

**Anthracnose**
- Incidence is increasing in New England.

**Bacterial Soft Rot** (*Erwinia carotovora*)
- Secondary infection to ECB or Pepper Maggot damage.

**Blossom End Rot**
- This physiological damage can be mistaken for a disease.
- Low pH exacerbates the condition.
- Regular watering allows a constant flow of calcium to reduce the manifestation of the condition.

**Pythium**
- Pepper seedlings are particularly susceptible.
- Cold, wet soil during germination favors infection.
- Infection in a greenhouse can affect large numbers of seedlings.
- Older plants are a bit more resistant to effects of infection.
- Presence in all soils is managed through sanitation practices and moisture management.
- Fungicidal root and soil treatments can protect from infection.

**Sclerotinia**
- Inoculum presence is random in fields.
- Knowing presence is important to rotation with other crops because peppers tolerate presence better than other crops.
- Research is needed into effects of infection on yield.

**Sun Scald**
- This physiological damage can increase risk of *Alternaria* infection.
- Some varieties are more susceptible.
**Viruses** (Alfalfa, Cucumber, Potato, Tobacco, Tomato)
- Not usually persistent in the field from year to year.
- Some strains of virus are less damaging than others.
- Applied sprays are **not** a direct management option.
- Insecticides that induce increased aphid activity exacerbate the spread of virus.
- Resistant varieties are available.
- Avoid accidental introduction by growing or purchasing transplants locally.
- Avoid contact with thrips on ornamentals that may transmit the tomato spotted wilt virus.

**Nematodes** (Northern Root-knot, Lesion, Stubby Root)
- Growers tend to ignore this pest in New England.
- Research would be useful to determine and map presence to determine thresholds for damage.

**Other Diseases not considered Key Pests**

*Alternaria*
*Cercospora* leaf spot
*Rhizoctonia*
Weeds

- Galinsoga and nightshade are the most problematic weeds.
- Presence between rows, under plants, and in holes in plastic can be problematic.
- Critical periods for weed control are different for mulched and bare ground.
- Days to harvest of applied materials are a limiting consideration during late season.

Currently Registered Pesticides for Pre-emergent Weeds

<table>
<thead>
<tr>
<th>Pesticide</th>
<th>Efficacy</th>
<th>Pros</th>
<th>Cons</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>bensulide</td>
<td>50% good</td>
<td>Good activity against annual grasses only</td>
<td>Needs to be watered in to move to root zone</td>
<td>Rarely used</td>
</tr>
<tr>
<td>Prefar</td>
<td>50% poor</td>
<td>Safety on new growth</td>
<td>Residual effects only good for 12 weeks</td>
<td></td>
</tr>
<tr>
<td>(2% growers)</td>
<td></td>
<td></td>
<td>Some important weeds not affected</td>
<td></td>
</tr>
<tr>
<td>clomazone</td>
<td>100% good</td>
<td>Some efficacy against galinsoga</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Command</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3% growers)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>halosulfuron</td>
<td>67% excellent</td>
<td>Good activity against annual grasses and small seeded broadleaf weeds</td>
<td>Poor efficacy against galinsoga</td>
<td></td>
</tr>
<tr>
<td>Sandea, Permit</td>
<td>33% good</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3% growers)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>metolachlor</td>
<td>100% excellent</td>
<td>Very effective against galinsoga</td>
<td></td>
<td>Special local needs use only in some states</td>
</tr>
<tr>
<td>Dual</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1% growers)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>napropamide:</td>
<td>29% excellent</td>
<td>Good activity against annual grasses and small seeded broadleaf weeds</td>
<td>Needs to be watered in or incorporated to prevent photodegradation</td>
<td>Root growth inhibitor but used on new plantings</td>
</tr>
<tr>
<td>Devrinol</td>
<td>65% good</td>
<td></td>
<td></td>
<td>Widely used</td>
</tr>
<tr>
<td>(18% growers)</td>
<td>6% poor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>paraquat</td>
<td>50% excellent</td>
<td>Good activity against annual grasses and many broadleaf weeds</td>
<td>Poor efficacy against galinsoga</td>
<td>Not labeled for pre-emergent use</td>
</tr>
<tr>
<td>Gramoxone</td>
<td>50% good</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2% growers)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pendimethalin</td>
<td></td>
<td>Good activity against annual grasses and many broadleaf weeds</td>
<td>Poor efficacy against galinsoga</td>
<td>Recent registration</td>
</tr>
<tr>
<td>Prowl</td>
<td></td>
<td></td>
<td></td>
<td>Not commonly used</td>
</tr>
<tr>
<td>trifluralin</td>
<td>10% excellent</td>
<td>Good activity against annual grasses and many broadleaf weeds</td>
<td>Poor efficacy against galinsoga, nightshade, and velvetleaf</td>
<td>Commonly used for bare ground plantings or before laying plastic</td>
</tr>
<tr>
<td>Trellan, Trilin</td>
<td>80% good</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(11% growers)</td>
<td>10% poor</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Currently Registered Pesticides for Post-emergent Weeds

<table>
<thead>
<tr>
<th>Pesticide</th>
<th>Efficacy</th>
<th>Pros</th>
<th>Cons</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>clethodim (1% growers)</td>
<td>100% good</td>
<td>• Better activity against perennial grasses than Poast</td>
<td>•</td>
<td>• Best selective material for quackgrass • New material</td>
</tr>
<tr>
<td>glyphosate (4% growers)</td>
<td>75% excellent 25% good</td>
<td>• Activity against annuals and perennial weeds • Easy to use • Inexpensive • Safe for applicator</td>
<td>• Crop injury potential • No residual activity • Timing is critical to efficacy</td>
<td>• Critical for spot treatment • Not labeled for use when crop present • Very widely used</td>
</tr>
<tr>
<td>metolachlor (5% growers)</td>
<td>100% good</td>
<td>•</td>
<td>•</td>
<td>• Not labeled for post-emergent use</td>
</tr>
<tr>
<td>napropamide (1% growers)</td>
<td>100% good</td>
<td>•</td>
<td>•</td>
<td>• Not labeled for post-emergent use</td>
</tr>
<tr>
<td>paraquat (1% growers)</td>
<td>100% excellent</td>
<td>• Effective burn-down • Fast acting • More effective against tree seedlings than other materials</td>
<td>• Applicator safety is an issue • Crop injury potential • Expensive • Not effective against perennials • Offensive odor • Restricted use is an issue</td>
<td>• Important niche material for management of tree seedlings • Must be used prior to crop emergence • Nonionic surfactant recommended • Not labeled for use when crop present</td>
</tr>
<tr>
<td>pelargonic acid (1% growers)</td>
<td>100% excellent</td>
<td>• Effective burn-down • Fast acting • No PHI</td>
<td>• Expensive • Not effective against perennials • Not very effective at killing growth point • Very odorous</td>
<td>•</td>
</tr>
<tr>
<td>sethoxydim (1% growers)</td>
<td>100% excellent</td>
<td>• Good activity against annual grasses • Safe on crop</td>
<td>• Crop injury potential due to required mix with crop oil • Fair activity against perennial grasses with multiple applications • Very long PHI (30 days)</td>
<td>• Generally used</td>
</tr>
</tbody>
</table>
## Cultural and Biological Alternatives

<table>
<thead>
<tr>
<th>Practices Reported</th>
<th>Efficacy</th>
<th>Pros</th>
<th>Cons</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic mulching</td>
<td>79% excellent</td>
<td>• The most effective option around plants</td>
<td>• Holes can allow weed growth</td>
<td>• A standard practice</td>
</tr>
<tr>
<td></td>
<td>20% good</td>
<td>• The first step in weed management</td>
<td>• Application costs can be high</td>
<td>• Provides other benefits (soil moisture retention, etc)</td>
</tr>
<tr>
<td></td>
<td>2% poor</td>
<td>• Can be supplemented with chemical options</td>
<td>• Can provide pine vole habitat when plastic left on ground over winter</td>
<td>• Use in combination with bed shaping into domes to prevent runoff into planting holes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Very effective</td>
<td></td>
<td>• Must fertilize through drip irrigation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Organically acceptable if plastic not left on ground over winter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other mulching</td>
<td>56% excellent</td>
<td>• The most effective option around plants</td>
<td>• Can provide slug habitat</td>
<td>Provides other benefits (soil moisture retention, etc)</td>
</tr>
<tr>
<td></td>
<td>33% good</td>
<td>• The first step in weed management</td>
<td>• Can prevent warming of soil</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11% poor</td>
<td>• Can be supplemented with chemical options</td>
<td>• Application costs can be high</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Very effective</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Organically acceptable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical cultivation</td>
<td>44% excellent</td>
<td>• Fairly effective on emerged annual weeds</td>
<td>• Can be challenging when mulch present</td>
<td>Galinsoga is resistant to cultivation</td>
</tr>
<tr>
<td>(79% growers)</td>
<td>52% good</td>
<td></td>
<td>• Perennial weed growth quick to recover</td>
<td>Cultivation generally occurs between crop rows</td>
</tr>
<tr>
<td></td>
<td>3% poor</td>
<td></td>
<td>• Not effective on wet soil</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Can damage crop roots</td>
<td></td>
</tr>
<tr>
<td>Hoeing</td>
<td>61% excellent</td>
<td>• The best mechanical option for persistent and noxious weeds</td>
<td>• Very labor intensive</td>
<td></td>
</tr>
<tr>
<td>&amp; Hand pulling</td>
<td>38% good</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(78% growers)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No-till or zone-</td>
<td>33% excellent</td>
<td>• Provides benefits towards improving soils</td>
<td>• Lowers overall soil temp</td>
<td></td>
</tr>
<tr>
<td>till (3% growers)</td>
<td>67% poor</td>
<td>• Zone-till allows soil to warm in narrow bands</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mowing between</td>
<td>100% good</td>
<td>• The most effective option for between crop rows</td>
<td>• Requires multiple treatments</td>
<td>Standard practice</td>
</tr>
<tr>
<td>rows (1% growers)</td>
<td></td>
<td></td>
<td>• Can encourage weed seed dispersal</td>
<td></td>
</tr>
</tbody>
</table>

- Plastic mulching
  - 72% growers
  - Efficacy: 79% excellent, 20% good, 2% poor
  - Pros:
    - The most effective option around plants
    - The first step in weed management
    - Can be supplemented with chemical options
    - Very effective
    - Organically acceptable if plastic not left on ground over winter
  - Cons:
    - Holes can allow weed growth
    - Application costs can be high
    - Can provide pine vole habitat when plastic left on ground over winter
  - Comments:
    - A standard practice
    - Provides other benefits (soil moisture retention, etc)
    - Use in combination with bed shaping into domes to prevent runoff into planting holes
    - Must fertilize through drip irrigation

- Other mulching
  - Straw, hay, or other organic material
  - 10% growers
  - Efficacy: 56% excellent, 33% good, 11% poor
  - Pros:
    - The most effective option around plants
    - The first step in weed management
    - Can be supplemented with chemical options
    - Very effective
    - Organically acceptable
  - Cons:
    - Can provide slug habitat
    - Can prevent warming of soil
    - Application costs can be high
  - Comments:
    - Provides other benefits (soil moisture retention, etc)

- Mechanical cultivation
  - 79% growers
  - Efficacy: 44% excellent, 52% good, 3% poor
  - Pros:
    - Fairly effective on emerged annual weeds
  - Cons:
    - Can be challenging when mulch present
    - Perennial weed growth quick to recover
    - Not effective on wet soil
    - Can damage crop roots
  - Comments:
    - Galinsoga is resistant to cultivation
    - Cultivation generally occurs between crop rows
    - More effective in sandier soils

- Hoeing
  - 66% growers
  - Efficacy: 61% excellent, 38% good
  - Pros:
    - The best mechanical option for persistent and noxious weeds
  - Cons:
    - Very labor intensive

- No-till or zone-till
  - 3% growers
  - Efficacy: 33% excellent, 67% poor
  - Pros:
    - Provides benefits towards improving soils
    - Zone-till allows soil to warm in narrow bands
  - Cons:
    - Lowers overall soil temp

- Mowing between rows
  - 1% growers
  - Efficacy: 100% good
  - Pros:
    - The most effective option for between crop rows
  - Cons:
    - Requires multiple treatments
    - Can encourage weed seed dispersal
  - Comments:
    - Standard practice
Late season cover crop overseeding (1% growers) | 100% good | • Useful for between crop rows | • Living mulches can compete with crop for nutrients and resources | • Dutch white clover and rye are commonly used
Crop rotation (1% growers) | 100% good | • | • | • Standard practice

**Research Needs:**
- Explore grass herbicide options (for between rows) that have fewer days to harvest and/or have a residual effect.
- More materials that work against galinsoga are needed.
- Quantify the effect of flame weeding in galinsoga management.

**Regulatory Needs:**
- Expand Dual registration to other New England states.
- Provide incentives to increase the number of applied weed specialists in practice.

**Education Needs:**
- Promote awareness of critical periods when crop must be kept weed-free.
- Promote proper formation of beds to ease cultivation.
- Promote the management uses of crop rotation to reduce galinsoga.
- Encourage the cleaning of equipment to prevent the spread of weeds.
**Key Vertebrates**

**Whitetail Deer** (*Odocoileus virginianus*)

- Damage can be variable but dramatic
- There are wide variations in international, federal, state, and county regulations, interpretation and enforcement.
- Fencing is the most effective management tool when pest populations are high.

**Currently Registered Pesticides** – None specified

**Cultural and Biological Alternatives**

<table>
<thead>
<tr>
<th>Practices Reported</th>
<th>Efficacy</th>
<th>Pros</th>
<th>Cons</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fence</td>
<td>50% excellent 50% good</td>
<td>• The most effective barrier</td>
<td>• Expensive to install</td>
<td>• Deer like to go under fences as well as over</td>
</tr>
<tr>
<td>Electric fence</td>
<td>17% excellent 83% good</td>
<td>• Effective temporarily</td>
<td>• Must be on all the time</td>
<td>• May need to bait fence to educate deer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Double layer more confusing to deer</td>
<td>• No longer effective once deer learn to go over</td>
<td></td>
</tr>
<tr>
<td>Shooting</td>
<td>50% excellent 50% good</td>
<td>• Very effective on individuals</td>
<td>• Not as effective when pest pressure is high</td>
<td>• Bow hunting is less disruptive to neighbors</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>• Can be unsafe if neighbors are nearby</td>
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<td></td>
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<td></td>
<td>• Noise can be irritating to neighbors</td>
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<td></td>
<td></td>
<td></td>
<td>• Deer are active at night</td>
<td></td>
</tr>
<tr>
<td>Dogs</td>
<td>50% good</td>
<td>•</td>
<td>• Temporary effectiveness</td>
<td>•</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>• Require upkeep</td>
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<td></td>
<td></td>
<td></td>
<td>• Fencing necessary to contain dogs</td>
<td></td>
</tr>
<tr>
<td>Reflectors</td>
<td>100% good</td>
<td>•</td>
<td>• Must move or change regularly</td>
<td>•</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>• Limited range</td>
<td></td>
</tr>
<tr>
<td>Odors, etc</td>
<td></td>
<td>• Temporary effectiveness</td>
<td>• Cannot spray directly on crops</td>
<td>•</td>
</tr>
</tbody>
</table>

**Research Needs:**
- None specified.

**Regulatory Needs:**
- Foster and enforce consistency among the varied international, federal, state, and county regulations, interpretation and enforcement.
- Streamline and speed local permitting processes for deer control action.
Education Needs:
- Foster and enforce consistency among the varied international, federal, state, and county regulations, interpretation and enforcement.
- Raise awareness that federal government assistance for deer fence installation is available.

Comments on Other Vertebrates
These vertebrates are not considered Key Pests but do warrant special note as emerging issues in New England.

Woodchuck/Groundhog
- Not widespread
- Scattered occurrence is easy to manage

Turkeys
- Pull fruit off plants, peck fruit
- Pull transplants
- Eat beneficials
- Remove straw mulch

Other Vertebrates not considered Key Pests

Birds
Coyote
Porcupine
Rabbit
Raccoons
Skunks
Voles, Chipmunks, Squirrels, Mice
IV. Appendices
# Pepper Crop, Worker, Pest and Pesticide Timing

<table>
<thead>
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<td><strong>Crop Stage</strong></td>
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<td>Pre-Harvest</td>
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<td>Green fruit Harvest</td>
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<tr>
<td>Green &amp; Mature fruit Harvest</td>
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<tr>
<td><strong>Worker activities</strong></td>
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<td>Land preparation and cultivation</td>
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<td>Field Scouting for Integrated Pest Management (IPM)</td>
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<td>X</td>
<td>X</td>
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<tr>
<td>Aph</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td>PM</td>
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<td>X</td>
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<td>X</td>
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<td>Phyt</td>
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**Insect & Disease Pest Key Activity & Monitoring Periods**

**Insecticide & Disease Application Timing**

**Nonchemical Insect & Disease Pest Control Timing**

ECB = European Corn Borer  
BLS = Bacterial Leaf Spot  
Aph = Aphids  
Phyt = Phytophthora  
PM = Pepper Maggot
### Weed Key Activity & Monitoring Periods

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<td>Preplant</td>
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<td>X X X X</td>
<td>X X X X</td>
<td>X X X X</td>
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<tr>
<td>Pre-emergent weeds</td>
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<td>X X X X X X X X X</td>
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<tr>
<td>Post-emergent weeds</td>
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### Herbicide Application Timing

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<tr>
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<td>X X X</td>
<td>X X X</td>
<td>X X X</td>
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<tr>
<td>Pre-emergent weeds</td>
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<td>X X X X</td>
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<td>X X X</td>
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<tr>
<td>Post-emergent weeds</td>
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<td>X X X X</td>
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### Nonchemical Weed Control Timing

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<tr>
<td>Preplant</td>
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<td>X X X</td>
<td>X X X</td>
<td>X X X</td>
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<tr>
<td>Pre-emergent weeds</td>
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<td>X X X</td>
<td>X X X</td>
<td>X X X</td>
<td>X X X</td>
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<tr>
<td>Post-emergent weeds</td>
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<td>X X X X</td>
<td>X X X</td>
<td>X X X</td>
<td>X X X</td>
<td>X X X</td>
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</tbody>
</table>

### Vertebrate Pest Control Timing

<table>
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</thead>
<tbody>
<tr>
<td>Deer*</td>
<td></td>
<td></td>
<td>X X X</td>
<td>X X X</td>
<td>X X X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Deer browsing can happen anytime, but may be more prevalent and damaging in the spring.
# New Pest Management Technologies for Insect and Mite Pests of Pepper

Tables adapted from [http://www.pestmanagement.info/NPMT/](http://www.pestmanagement.info/NPMT/)

<table>
<thead>
<tr>
<th>Method</th>
<th>Source</th>
<th>Status</th>
<th>Pests Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abamectin</td>
<td>Pipeline</td>
<td>Registration Approved (Insecticide) (Miticide) Tolerance Accepted (Insecticide) (Miticide)</td>
<td>MITES, LEAFMINERS, THRIPS</td>
</tr>
<tr>
<td>Abamectin</td>
<td>IR4</td>
<td>Registered (Insecticide)</td>
<td>Broad spectrum acaricide with activity on leafminers, Colorado potato beetle, and pear psylla. Weak against sucking insects and thrips. Good IPM tool with short re-entry interval. Translaminar activity providing long residual activity.</td>
</tr>
<tr>
<td>Acetamiprid</td>
<td>IR4</td>
<td>Registered (Insecticide)</td>
<td>Broad spectrum control with contact and systemic activity via foliar applications. Excellent on sucking pests like aphids and whitefly.</td>
</tr>
<tr>
<td>Azadirachtin</td>
<td>IR4</td>
<td>Registered (Insecticide)</td>
<td>Disrupts insect molting. Target pests include whitefly, leafminer, and Lepidoptera.</td>
</tr>
<tr>
<td>Bacillus thuringensis</td>
<td>IR4</td>
<td>Registered (Insecticide)</td>
<td>New strains of Bt are being discovered that have activity against numerous pests.</td>
</tr>
<tr>
<td>Beauvaria bassiana</td>
<td>Pipeline</td>
<td>Biopesticide (Insecticide) (Miticide) Registration Approved (Miticide) (Insecticide) Tolerance Accepted (Miticide) (Insecticide)</td>
<td>SOWBUGS, MILIPEDES, MITES, LEAFROLLERS, THRIPS, BEETLES, WEEVILS, BILLBUGS, WHITE GRUBS, FLEAHOPPERS, WHITEFLIES, APHIDS, LEAFHOPPERS, MEALYBUGS, PEAR PSYLLA, ANTS, CORN BORERS, LOOPERS</td>
</tr>
<tr>
<td>Bifenazate</td>
<td>IR4</td>
<td>Pending (Insecticide)</td>
<td>Controls spider and European red mites, including eggs and motiles. Provides quick knockdown. Safe on predator mites.</td>
</tr>
<tr>
<td>Bifenthrin</td>
<td>IR4</td>
<td>Registered (Insecticide)</td>
<td>Broad spectrum activity on aphids, armyworms, cutworms, flea beetles, mites, and corn borers.</td>
</tr>
<tr>
<td>Bistrifluron</td>
<td>IR4</td>
<td>Potential (Insecticide)</td>
<td>Active against lepidopteran pests, whitefly. It acts by inhibiting chitin synthesis (Insect Growth Regulator).</td>
</tr>
<tr>
<td>Canola oil</td>
<td>Pipeline</td>
<td>Biopesticide (Insecticide) Registration Approved (Insecticide) Tolerance Accepted (Insecticide)</td>
<td>MITES, LEAFROLLERS, LEAFMINERS, BEETLES, PLANT BUGS, WHITEFLIES, APHIDS, LEAFHOPPERS, SOFT SCALES, ARMORED SCALES, MEALYBUGS, PSYLLIDS, ADELGIDS, CATERPILLARS, WEBWORMS, CANKERWORMS</td>
</tr>
<tr>
<td>Chromafenozide</td>
<td>IR4</td>
<td>Potential (Insecticide)</td>
<td>Specific to lepidopteran pests, novel ecodysosone agonist.</td>
</tr>
<tr>
<td>Chrysoperla</td>
<td>IR4</td>
<td>Potential (Insecticide)</td>
<td>Controls aphids.</td>
</tr>
<tr>
<td>Active Ingredient</td>
<td>Status</td>
<td>Classification</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------</td>
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</tr>
<tr>
<td>Cinnamaldehyde</td>
<td>IR4</td>
<td>Registered (Insecticide) (Fungicide)</td>
<td>Aphids, mites and the diseases downy mildew, powdery mildew, botrytis, and brown rots.</td>
</tr>
<tr>
<td>Clothianidin</td>
<td>IR4</td>
<td>Potential (Insecticide)</td>
<td>Contact and stomach activity. It controls plum curculio, aphids, leathoppers, apple maggot, leafminers, leafrollers, codling moth, and pear psylla.</td>
</tr>
<tr>
<td>Cyfluthrin</td>
<td>IR4</td>
<td>Registered (Insecticide)</td>
<td>Manages cabbage looper, potato leathopper, Colorado potato beetle, European corn borer, flea beetle, potato tuberworm, citrus thrips.</td>
</tr>
<tr>
<td>Cyromazine</td>
<td>IR4</td>
<td>Registered (Insecticide)</td>
<td>Leaf miners, maggots, fungal gnats.</td>
</tr>
<tr>
<td>Deltamethrin</td>
<td>IR4</td>
<td>Pending (Insecticide)</td>
<td>Beetles, bugs, Lepidoptera.</td>
</tr>
<tr>
<td>Diflubenzuron</td>
<td>IR4</td>
<td>Pending (Insecticide)</td>
<td>Wide range of leaf feeding insects.</td>
</tr>
<tr>
<td>Emamectin Benzoate</td>
<td>IR4</td>
<td>Pending (Insecticide)</td>
<td>Effective on larval Lepidoptera. (Beet/fall armyworms, cabbage webworms, corn earworms, imported cabbage worm, cabbage looper.) and leafminers</td>
</tr>
<tr>
<td>Esfenvalerate</td>
<td>IR4</td>
<td>Registered (Insecticide)</td>
<td>Broad-spectrum control on numerous insect pests.</td>
</tr>
<tr>
<td>Fenpropathrin</td>
<td>IR4</td>
<td>Pending (Insecticide)</td>
<td>Aphids, whitefly, various worms, mites, glassy winged sharpshooter, and stinkbugs.</td>
</tr>
<tr>
<td>Ferric phosphate</td>
<td>Pipeline</td>
<td>Registration Approved (mullusicide) Tolerance Accepted (mullusicide)</td>
<td>SLUGS AND SNAILS</td>
</tr>
<tr>
<td>Flonicamid</td>
<td>IR4</td>
<td>Pending (Insecticide)</td>
<td>Effective against aphids, thrips, leathoppers, plant bug and other sucking pests. Provides rapid antifeeding activity. Non-toxic to beneficials.</td>
</tr>
<tr>
<td>Flufenzin</td>
<td>IR4</td>
<td>Potential (Insecticide)</td>
<td>Acaricide.</td>
</tr>
<tr>
<td>Imidacloprid</td>
<td>IR4</td>
<td>Registered (Insecticide)</td>
<td>Primarily effective against sucking insects (aphid, whitefly, scale, etc.) as well as beetles and grubs. Controls numerous pests which are resistant to insecticides.</td>
</tr>
<tr>
<td>Indoxacarb</td>
<td>Pipeline</td>
<td>Organophosphate (OP) Alternative (Insecticide) Reduced-Risk Pesticide (Insecticide) Registration Approved (Insecticide) Tolerance Accepted (Insecticide)</td>
<td>loopers, armyworms, fruitworms, pinworms</td>
</tr>
<tr>
<td>Indoxacarb</td>
<td>IR4</td>
<td>Registered (Insecticide)</td>
<td>Controls most major Lepidopteran pest species. Possibly controls plant bugs. Soft on beneficials so it is a good fit with IPM.</td>
</tr>
<tr>
<td>Product Name</td>
<td>Formulation</td>
<td>Registration Approval</td>
<td>Tolerance</td>
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<tr>
<td>Iron phosphate</td>
<td>Pipeline</td>
<td>Biopesticide (mullusicide) Registration Approved (mullusicide) Tolerance Accepted (mullusicide)</td>
<td>SLUGS, SNAILS</td>
</tr>
<tr>
<td>Isomate BTW</td>
<td>IR4</td>
<td>Registered (Insecticide)</td>
<td></td>
</tr>
<tr>
<td>Kaolin</td>
<td>Pipeline</td>
<td>Biopesticide (plant growth regulator) (Insecticide) (Miticide) Registration Approved (Miticide) (Insecticide) Tolerance Accepted (Miticide) (plant growth regulator) (Insecticide)</td>
<td>mites, flea beetles, tarnished plant bugs, leafhoppers, Colorado potato beetle, lace bugs, stink bugs, tomato fruit worm, tomato pinworm</td>
</tr>
<tr>
<td>Kaolin</td>
<td>IR4</td>
<td>Registered (Insecticide)</td>
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</tr>
<tr>
<td>Lambda-Cyhalothrin</td>
<td>IR4</td>
<td>Pending (Insecticide)</td>
<td></td>
</tr>
<tr>
<td>Lufenuron</td>
<td>IR4</td>
<td>Potential (Insecticide)</td>
<td></td>
</tr>
<tr>
<td>Metarhizium anisopliae</td>
<td>IR4</td>
<td>Potential (Insecticide)</td>
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<tr>
<td>Methoxyfenozide</td>
<td>IR4</td>
<td>Pending (Insecticide)</td>
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<tr>
<td>Pymetrozine</td>
<td>IR4</td>
<td>Registered (Insecticide)</td>
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<tr>
<td>Pyridanil</td>
<td>IR4</td>
<td>Pending (Insecticide)</td>
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</tr>
<tr>
<td>Pyriproxyfen</td>
<td>Pipeline</td>
<td>Reduced-Risk Pesticide (Insecticide) Registration Approved (Insecticide) Tolerance Accepted (Insecticide)</td>
<td>WHITEFLIES, APHIDS, CABBAGE LOOPER, TOBACCO HORNWORM</td>
</tr>
<tr>
<td>Pyriproxyfen</td>
<td>IR4</td>
<td>Registered (Insecticide)</td>
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<td>Spinosad</td>
<td>Pipeline</td>
<td>Reduced-Risk Pesticide (Insecticide) Registration Approved (Insecticide) Tolerance Accepted (Insecticide)</td>
<td>LEAFMINERS, THRIPS, ARMYWORMS, LOOPERS, EUROPEAN CORN BORER, HORNWORMS</td>
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<tr>
<td>Tebufenozide Section 18 issued</td>
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<tr>
<td>Tetradecadienyl acetate + tetradecenol</td>
<td>Pipeline</td>
<td>Biopesticide (Insecticide) Registration Approved (Insecticide)</td>
<td>BEET ARMYWORM</td>
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<tr>
<td>Thiacloprid</td>
<td>IR4</td>
<td>Potential (Insecticide)</td>
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<tr>
<td>Insecticide</td>
<td>Registration</td>
<td>Status</td>
<td>Description</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>--------------</td>
<td>-----------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Thiamethoxam</td>
<td>IR4</td>
<td>Registered</td>
<td>Broad-spectrum activity against soil dwelling pests, sucking pests, and some chewing pests. Effective against aphids, whitefly, thrips, leafhopper and certain beetles. Being marketed for seed, soil, and foliar treatments.</td>
</tr>
<tr>
<td>Thiamethoxam Section 18</td>
<td></td>
<td>withdrawn</td>
<td></td>
</tr>
<tr>
<td>Thiocyclam</td>
<td>IR4</td>
<td>Potential</td>
<td></td>
</tr>
<tr>
<td>Verticillium lecanii</td>
<td>IR4</td>
<td>Potential</td>
<td>Effective against whitefly.</td>
</tr>
<tr>
<td>Zeta-cypermethrin</td>
<td>IR4</td>
<td>Registered</td>
<td>Controls cutworms, thrips, armyworms, etc.</td>
</tr>
</tbody>
</table>
# New Pest Management Technologies for Diseases of Pepper

Tables adapted from [http://www.pestmanagement.info/NPMT/](http://www.pestmanagement.info/NPMT/)

<table>
<thead>
<tr>
<th>Method</th>
<th>Source</th>
<th>Status</th>
<th>Pests Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acibenzolar</td>
<td>IR4</td>
<td>Registered (Fungicide)</td>
<td>Induces resistance to Blue mold, bacterial diseases, Downy Mildew, and Sclerotinia.</td>
</tr>
<tr>
<td>AE C638206</td>
<td>IR4</td>
<td>Pending (Fungicide)</td>
<td>Active against Phytophthora, Pythium, Plasmopora, Peronospora, Bremia and Pseudoperonospora.</td>
</tr>
<tr>
<td>AKD-3088</td>
<td>IR4</td>
<td>Potential (Nematicide)</td>
<td></td>
</tr>
<tr>
<td>Ampelomyces quisqualis isolate M-10</td>
<td>IR4</td>
<td>Pending (Fungicide)</td>
<td>Hyperparasite of Powdery mildew.</td>
</tr>
<tr>
<td>Azoxystrobin</td>
<td>Pipeline</td>
<td>Reduced-Risk Pesticide (Fungicide) Registration Approved (Fungicide) Tolerance Accepted (Fungicide) issued</td>
<td>powdery mildew, anthracnose</td>
</tr>
<tr>
<td>Azoxystrobin</td>
<td>IR4</td>
<td>Registered (Fungicide)</td>
<td>Broad spectrum of pathogens of fungi: Cladosporium, Venturia, Botryosphaeria, Mycosphaerella, Pyrenophora, Puccinia, Pyricularia, Plasmopara, Guignardis, Pseudopeziza, Alternaria, Sphaerotheca, Erysiphe, Leveillula, Septoria, Pythium, Uncinula, Didymella</td>
</tr>
<tr>
<td>Bacillus firmus</td>
<td>IR4</td>
<td>Potential (Bacterial Nematicide)</td>
<td>Controls root knot and other nematodes including Heterodera avenae.</td>
</tr>
<tr>
<td>Bacillus pumilus strain 2808</td>
<td>IR4</td>
<td>Pending (Fungicide)</td>
<td>Botrytis, downy and powdery mildews, rusts, Sclerotinia blight, and rots.</td>
</tr>
<tr>
<td>Bacillus subtilis</td>
<td>IR4</td>
<td>Potential (Fungicide)</td>
<td>Disease suppression.</td>
</tr>
<tr>
<td>Bacillus subtilis QST 713</td>
<td>Pipeline</td>
<td>Biopesticide (Fungicide) Registration Approved (Fungicide) Tolerance Accepted (Fungicide)</td>
<td>gray mold, powdery mildew</td>
</tr>
<tr>
<td>Bacillus subtilis strain QST 713</td>
<td>IR4</td>
<td>Registered (Fungicide)</td>
<td>Protectant fungicide/bactericide with SAR activity. Broad spectrum, controls Botrytis, powdery and downy mildews, early blight, and bacterial spot.</td>
</tr>
<tr>
<td>Bacteriophages</td>
<td>IR4</td>
<td>Pending (Fungicide)</td>
<td>Manages bacteria spot and bacteria speck.</td>
</tr>
<tr>
<td>Benthiavalicarb</td>
<td>IR4</td>
<td>Potential (Fungicide)</td>
<td>Controls downy mildew</td>
</tr>
<tr>
<td>Chitosan</td>
<td>IR4</td>
<td>Pending (Fungicide)</td>
<td>Downy and powdery mildew, gray mold and Botrytis.</td>
</tr>
<tr>
<td>Copper Octanoate</td>
<td>IR4</td>
<td>Registered (Fungicide)</td>
<td>Downy mildew, powdery mildew, blue mold, white rust, anthracnose.</td>
</tr>
<tr>
<td>Copper octanoate</td>
<td>Pipeline</td>
<td>Registration Approved (Bactericide) (Fungicide) Tolerance Accepted (Fungicide) (Bactericide)</td>
<td>ANTHRACNOSE, BACTERIAL BLIGHT, EARLY BLIGHT, LATE BLIGHT, GRAY MOLD, LEAF SPOTS, BACTERIAL SPOT</td>
</tr>
<tr>
<td>Cyazofamid</td>
<td>IR4</td>
<td>Pending (Fungicide)</td>
<td>Effective against Oomycete and</td>
</tr>
</tbody>
</table>
Plasmodiophoromycetes, fungi, especially late blight and downy mildew.

<table>
<thead>
<tr>
<th><strong>Dimethomorph</strong></th>
<th>IR4</th>
<th>Pending (Fungicide)</th>
<th>Downy mildew, late blight, Phytophthora, Plasmopara, Pseudoperonospora Bremia, and Peronospora. Should be mixed with other fungicides for resistance management.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ethaboxam</strong></td>
<td>IR4</td>
<td>Potential (Fungicide)</td>
<td>Useful for grape downy mildew, potato and tomato late blight, pepper blight and cucumber downy mildew. Preventive and curative activity.</td>
</tr>
<tr>
<td><strong>Famoxadone</strong></td>
<td>IR4</td>
<td>Pending (Fungicide)</td>
<td>Broad spectrum fungicide, including Early blight, downy mildews, and other ascomycetes. Can be combined with Cymoxanil (marketed as Tanos) to pick up Late blight.</td>
</tr>
<tr>
<td><strong>Fenamidone</strong></td>
<td>IR4</td>
<td>Potential (Fungicide)</td>
<td>Foliar protectant and curative activity against Oomycete fungi. Also effective against ascomycete and Alternaria. Inhibits electronic transport.</td>
</tr>
<tr>
<td><strong>Fenbuconazole</strong></td>
<td>IR4</td>
<td>Pending (Fungicide)</td>
<td>Powdery mildew, rusts, apple scab, brown rot, cotton ball, mummy berry (Monolinia spp.), smuts, bunts, Cladosporium, Mycosphaerella, Cercospora, Septoria, Rhizoctonia, Pyrenophora, Helminthosporium &amp; related genera, and a Colletotrichum sp. - in turf.</td>
</tr>
<tr>
<td><strong>Fenhexamid</strong></td>
<td>IR4</td>
<td>Pending (Fungicide)</td>
<td>Non-systemic protectant fungicide that is effective against Botrytis cinerea, Monolinia, Sclerotinia sclerotiorum of lettuce.</td>
</tr>
<tr>
<td><strong>Gliocladium catenulatum J1446</strong></td>
<td>Pipeline</td>
<td>Biopesticide (Fungicide) Registration Approved (Fungicide)</td>
<td>Damping-off, seed rot, root and stem rot, wilt diseases caused by Rhizoctonia, Pythium, Phytophthora, Fusarium,Didymella, Botrytis, Verticillium, etc. in greenhouse or indoors</td>
</tr>
<tr>
<td><strong>Gliocladium catenulatum Strain J1446</strong></td>
<td>IR4</td>
<td>Registered (Fungicide)</td>
<td>Recommended for control of Pythium and Rhizoctonia.</td>
</tr>
<tr>
<td><strong>Glutamic Acid</strong></td>
<td>IR4</td>
<td>Pending (Fungicide)</td>
<td>Controls brown rot and supresses shot hole.</td>
</tr>
<tr>
<td><strong>Harpin protein</strong></td>
<td>Pipeline</td>
<td>Biopesticide (Fungicide) (Bactericide) (virus resistance) (plant growth regulator) (Insecticide) Registration Approved (plant growth regulator) (Insecticide) (virus resistance) (Fungicide) (Bactericide) Tolerance Accepted (Fungicide)</td>
<td>PLANT DISEASES, IMPROVEMENT IN GROWTH AND YIELD, SUPPRESSION OF INSECTS AND OTHER PESTS</td>
</tr>
<tr>
<td>Product Name</td>
<td>Status</td>
<td>Mode of Action</td>
<td>Uses</td>
</tr>
<tr>
<td>------------------------------</td>
<td>-----------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Harpin Protein</td>
<td>IR4 Registered</td>
<td>(Bactericide) (Insecticide) (plant growth regulator) (virus resistance)</td>
<td>Bacterial leaf spot wilt, blight and fungal diseases such as botrytis, brunch rot, and powdery mildew.</td>
</tr>
<tr>
<td>Hydrogen peroxide</td>
<td>Pipeline Biopesticide</td>
<td>(Bactericide) (Fungicide) Registration Approved (Fungicide) (Bactericide) Tolerance Accepted (Bactericide) (Fungicide)</td>
<td>ANTHRACNOSE, POWDERY MILDEW, PHYTOPHTHORA BLIGHT</td>
</tr>
<tr>
<td>Hydrogen peroxide</td>
<td>IR4 Pending</td>
<td>Fungicide</td>
<td>Broad spectrum bactericide and fungicide.</td>
</tr>
<tr>
<td>Mefenoxam</td>
<td>IR4 Registered</td>
<td>Fungicide</td>
<td>Same spectrum as metalaxyl.</td>
</tr>
<tr>
<td>Milsana Bioprotectant</td>
<td>IR4 Pending</td>
<td>Fungicide</td>
<td>Induces phytoalexins which infer resistance to powdery mildew and other diseases such as Botrytis.</td>
</tr>
<tr>
<td>Muscodor albus</td>
<td>IR4 Potential</td>
<td>Fungicide</td>
<td>Fungus produces volatile compounds that are effective against plant pathogenic and bacteria.</td>
</tr>
<tr>
<td>Myclobutanil</td>
<td>Section 18 crisis issued</td>
<td>Fungicide</td>
<td>powdery mildew</td>
</tr>
<tr>
<td>Myclobutanil</td>
<td>IR4 Pending</td>
<td>Fungicide</td>
<td>Powdery mildews, rusts, apple scab, brown rot (Monilinia spp.), shothole (Stimina spp.), cherry leaf spot (Coccomyces spp.) grape black rot (Guignardia spp.).</td>
</tr>
<tr>
<td>Nocobifen-BAS 510</td>
<td>IR4 Pending</td>
<td>Fungicide</td>
<td>Manages powdery mildew, Alternaria, Botrytis, Sclerotinia and Monillia</td>
</tr>
<tr>
<td>Oxolinic Acid</td>
<td>IR4 Potential</td>
<td>Fungicide</td>
<td>Controls gram-negative bacteria including rice grain rot, potato black leg, soft rot, and fire blight.</td>
</tr>
<tr>
<td>Paecilomyces lilacinus</td>
<td>IR4 Potential</td>
<td>Nematicide</td>
<td>Controls root knot and cyst nematodes.</td>
</tr>
<tr>
<td>Peroxyacetic Acid</td>
<td>IR4 Registered</td>
<td>Fungicide</td>
<td>Post-harvest decay and rot.</td>
</tr>
<tr>
<td>Phosphorous acid and its sodium, potassium, and ammonium salts</td>
<td>Pipeline Biopesticide</td>
<td>(Fungicide) Tolerance Accepted (Fungicide)</td>
<td>Phytophthora and Pythium diseases, downy mildew</td>
</tr>
<tr>
<td>Potassium dihydrogen phosphate</td>
<td>Pipeline Biopesticide</td>
<td>Registration Approved (Fungicide)</td>
<td>POWDERY MILDEW</td>
</tr>
<tr>
<td>Potassium Dihydrogen Phosphate</td>
<td>IR4 Registered</td>
<td>Fungicide</td>
<td>Powdery mildew.</td>
</tr>
<tr>
<td>Prochloraz</td>
<td>IR4 Potential</td>
<td>Fungicide</td>
<td>Powdery mildew, Fusarium spp., leafblotch, Botrytis, Alternaria and others.</td>
</tr>
<tr>
<td>Propamocarb Hydrochloride</td>
<td>IR4 Potential</td>
<td>Fungicide</td>
<td>Downy mildew, late blight, damping-off, Pythium, Phytophthora, and Aphanomyces. Should be mixed with other fungicides for resistance management.</td>
</tr>
<tr>
<td>Pyraclostrobin</td>
<td>IR4 Pending</td>
<td>Fungicide</td>
<td>Broad spectrum activity on</td>
</tr>
<tr>
<td></td>
<td>IR4</td>
<td>Status</td>
<td>Activities</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
<td>--------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Anthracnose, Alternaria, downy mildew, Cercospora leaf spot, rust, powdery mildew, Septoria, Phytophthora, Pythium, Rhizoctonia.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pyrimethanil</td>
<td>IR4</td>
<td>Potential</td>
<td>Active against Botrytis spp., Venturia spp., Alternaria solani, Alternaria mali, Sphaerotheca macularis and Monilinia spp.</td>
</tr>
<tr>
<td>Quinoxyfen/DE795</td>
<td>IR4</td>
<td>Pending</td>
<td>Has shown activity against powdery mildew in a wide range of crops.</td>
</tr>
<tr>
<td>Streptomyces lydicus WYEC 108</td>
<td>IR4</td>
<td>Pending</td>
<td>Controls soil borne plant root rots and damping off fungi.</td>
</tr>
<tr>
<td>TM 416</td>
<td>IR4</td>
<td>Potential</td>
<td>Bacterial speck and spot.</td>
</tr>
<tr>
<td>Trifloxystrobin</td>
<td>IR4</td>
<td>Registered</td>
<td>Active against powdery mildew and leaf spot diseases. Also provides significant control of scab, rusts, downy mildew and other diseases.</td>
</tr>
<tr>
<td>Zoxamide</td>
<td>IR4</td>
<td>Registered</td>
<td>Control of foliar phycamycetes and albugo. Also protectant against Oomycete fungi. Will be mixed with mancozeb for broader activity.</td>
</tr>
</tbody>
</table>
Pesticide and Non-chemical Methods for Weeds

http://www.nevegetable.org/.

**Weed Group Name Abbreviations**

PER = Perennial
AG = Annual Grass
AB = Annual broadleaf

**Ratings:**

E = 90% control or better
G = 70-70% control
F = 50-70% control or better
P = 5-50% control
N = less than 5% control

<table>
<thead>
<tr>
<th>Active ingredient or Method</th>
<th>Brand name(s)</th>
<th>AG</th>
<th>AB</th>
<th>PER</th>
</tr>
</thead>
<tbody>
<tr>
<td>bensulide</td>
<td>Prefar</td>
<td>E</td>
<td>N-P</td>
<td>N-P</td>
</tr>
<tr>
<td>clethodim</td>
<td>Select</td>
<td>E</td>
<td>N</td>
<td>N-E</td>
</tr>
<tr>
<td>clomazone</td>
<td>Command</td>
<td>G</td>
<td>N-E</td>
<td>N-F</td>
</tr>
<tr>
<td>glyphosate</td>
<td>Roundup</td>
<td>E</td>
<td>E</td>
<td>G-E</td>
</tr>
<tr>
<td>halosulfuron</td>
<td>Sandea, Permit</td>
<td>P</td>
<td>F-E</td>
<td>P-G</td>
</tr>
<tr>
<td>metolachlor</td>
<td>Dual</td>
<td>G-E</td>
<td>P-E</td>
<td>P-G</td>
</tr>
<tr>
<td>napropamide</td>
<td>Devrinol</td>
<td>G-E</td>
<td>P-E</td>
<td>P</td>
</tr>
<tr>
<td>paraquat</td>
<td>Gramoxone</td>
<td>E</td>
<td>G-E</td>
<td>P-G</td>
</tr>
<tr>
<td>pelargonic acid</td>
<td>Scythe</td>
<td>E</td>
<td>G-E</td>
<td>P-G</td>
</tr>
<tr>
<td>sethoxydim</td>
<td>Poast</td>
<td>E</td>
<td>N</td>
<td>N-E</td>
</tr>
<tr>
<td>trifluralin</td>
<td>Treflan</td>
<td>G-E</td>
<td>P-E</td>
<td>P-G</td>
</tr>
</tbody>
</table>
New Pest Management Technologies for Weeds of Pepper
Tables adapted from http://www.pestmanagement.info/NPMT/

<table>
<thead>
<tr>
<th>Method</th>
<th>Source</th>
<th>Status</th>
<th>Pests Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternaria destruens</td>
<td>IR4</td>
<td>Potential (Herbicide)</td>
<td>Controls dodder (swamp, largeseed, field, and smallseed).</td>
</tr>
<tr>
<td>Carfentrazone-ethyl</td>
<td>IR4</td>
<td>Pending (Herbicide)</td>
<td>Numerous broadleaf weeds, including cocklebur and water hemp.</td>
</tr>
<tr>
<td>Clethodim</td>
<td>IR4</td>
<td>Registered (Herbicide)</td>
<td>Strictly a grass herbicide.</td>
</tr>
<tr>
<td>Clomazone</td>
<td>IR4</td>
<td>Registered (Herbicide)</td>
<td>Material controls a broad spectrum of grasses and broadleaf weeds.</td>
</tr>
<tr>
<td>Colletotrichum gloeosporioides f. sp malvae</td>
<td>IR4</td>
<td>Pending (Herbicide)</td>
<td>It is pathogenic to round-leaved mallow, small flowered mallow, common mallow, and velvetleaf.</td>
</tr>
<tr>
<td>Flufenacet</td>
<td>IR4</td>
<td>Potential (Herbicide)</td>
<td>Soil applied for annual grasses and some broadleaf weeds.</td>
</tr>
<tr>
<td>Flumioxazin</td>
<td>IR4</td>
<td>Potential (Herbicide)</td>
<td>Low use rate pre-emergence broadleaf herbicide with contact activity and residual soil activity.</td>
</tr>
<tr>
<td>Glyphosate</td>
<td>IR4</td>
<td>Registered (Herbicide)</td>
<td>Controls most weeds.</td>
</tr>
<tr>
<td>Halosulfuron</td>
<td>IR4</td>
<td>Pending (Herbicide)</td>
<td>Nutsedge, velvetleaf, cocklebur, other broadleaf weeds.</td>
</tr>
<tr>
<td>Oxadiargyl</td>
<td>IR4</td>
<td>Potential (Herbicide)</td>
<td>Broad spectrum weed control, similar to oxidiazion.</td>
</tr>
<tr>
<td>Pelargonic Acid</td>
<td>IR4</td>
<td>Registered (Herbicide)</td>
<td>Contact, non-selective broad spectrum foliar applied material</td>
</tr>
<tr>
<td>Pyrithiobac-sodium</td>
<td>IR4</td>
<td>Potential (Herbicide)</td>
<td>Controls a wide range of broadleaf weeds via pre- and post-emergence application.</td>
</tr>
<tr>
<td>S-metolachlor</td>
<td>IR4</td>
<td>Registered (Herbicide)</td>
<td>Same spectrum as metolachlor (Dual).</td>
</tr>
<tr>
<td>Sulfentrazone</td>
<td>IR4</td>
<td>Potential (Herbicide)</td>
<td>Controls broadleaf and grass species.</td>
</tr>
<tr>
<td>Trifloxysulfuron</td>
<td>IR4</td>
<td>Potential (Herbicide)</td>
<td>Broadleaf weeds.</td>
</tr>
</tbody>
</table>
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