Bell Pepper and Non-Bell Pepper Pest Management Strategic Plan

The Ohio State University
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About the Pest Management Strategic Plan Session
A meeting was convened at the Fawcett Center in Columbus, Ohio on April 8th and 9th, 2002 to discuss critical pesticide and pest management issues facing the Ohio pepper industry. Representative pepper growers, regulatory members of EPA and ODA, the executive director from Ohio Vegetable and Potato Growers Association, and Ohio State University researchers and Extension specialists were brought together for this meeting. The groups' tasks were to assess the state of current pesticides and pest management recommendations, as well as identify the top regulatory, educational, and research issues facing future production and expansion.

The entire group was actively engaged in discussions as the topics rotated from insects to nematodes to diseases and then weed management. Input was especially interesting as it related to replacement or alternative strategies.

Background Information
The following information has been excerpted from the 2002 National Agricultural Statistics Service in the report "Agricultural Chemical Usage 2002 Vegetables Summary" (http://jan.mannlib.cornell.edu/reports/nassr/other/pcu-bb/agcv0703.pdf). The focus of this NASS report is to assess fertilizer and pesticide usage in Ohio bell pepper production.

Fertilizer use on the 1,700 bell pepper acres was quite extensive, with 97% of acres receiving 286,000 lbs. of nitrogen, 97% of acres receiving 188,000 lbs. of phosphate, and 96% of acres receiving 286,000 lbs. of potassium. The rate per crop year (lbs. / A) for nitrogen was 174, for phosphorus was 115, and for potassium was 174.

Pesticide use on bell peppers was provided in detail for 5 of the 9 herbicides identified, 4 of the 21 insecticides identified, and only 2 of the 11 fungicides identified in the survey (Table 1). Missing data may be due to the inability of NASS to release all data because it could be used to compromise the identity and confidentiality of certain growers or farm operations.

The most widely used herbicide according to the study was glyphosate, followed distantly by trifluralin. Acephate was the highest use insecticide, followed by endosulfan and permethrin. Copper hydroxide was the dominant fungicide used in bell pepper production.

According to the survey data, soil fumigants are not used in Ohio for pepper production.

General Production Information
Number of growers taken from 1997 Census on Agriculture, remaining data taken from NASS Vegetable 2002 Summary.
(Solanaceae, *Capsicum annum*)
Percent of US Acreage/Rank: 3%/7th
Acres in Ohio: 1700
Number of Growers: 469
Per Acre Value: $4,704
Value of Production: $7,997,000

Location Of Production

Sweet (bell) peppers are primarily produced in the northern (Stark, Henry, Wood and Huron counties) and the southeastern (Washington and Meigs counties) parts of the state. Production of bell peppers has been steady over the years but acreage of specialty peppers such as banana, habernero, jalapeno, and cherry peppers, have slowly increased in their acreage over the past few years.

Production Methods

Peppers are a warm season crop which produce best during a long growing season. They are very sensitive to temperature extremes, preferring an average daytime temperature of 75F and an average nighttime temperature of 62F. Peppers grow well in a loam or sandy loam soil, with a pH between 6.0 and 6.8. Acid soils can lead to calcium and magnesium deficiencies and fruit damaged with blossom end rot. Peppers are usually planted in Ohio as transplants. Before planting, transplants should be only slightly hardened. Over-hardened transplants are slow to develop once in the field. Transplants should be set with a starter fertilizer high in phosphorus. Transplants are placed in rows 4 feet apart with 12-18 inches between plants. Many growers in Ohio plant under black plastic mulch with trickle irrigation laid under the plastic. This provides uniform moisture and fertility during the growing season. A constant water supply is necessary for adequate production. Bell peppers can be harvested when immature and green but have reached full size and maximum wall thickness or harvest can be delayed until the fruit turn red at maturity. Sweet peppers in Ohio are produced for both the fresh (green peppers) and processing (red peppers) markets. A good yield should be 800-1000 bu/A.

Worker Activities

Workers can be employed in several aspects of pepper production, ranging from the greenhouse to field work, from field preparation to harvest (Table 10). Greenhouse activities are primarily in the spring, from early March through April. Transplanting occurs from this point through mid June.

Bed preparation for transplants begins in March, and continues through early June. Cultivation for weed control will begin in late April and continue through mid July. Application of herbicides and fertilizers begin in the spring and continue through the end of July, while insecticides and fungicides for pest management begin to be applied in late May or early June. Tasks such as scouting and irrigation continue throughout the season, from planting to just prior to harvest. Harvest usually begins in July and can continue through October. After harvest, the fields are prepared for winter, usually via plowing. Some plowing activity may carry over into the following spring.

Primary Challenges to Pepper Production in Ohio

The myriad challenges to pepper production can be distilled into key pest categories. In terms of disease management, bacterial leaf spot, *Phytophthora* blight, anthracnose, and S*clerotinia* blight are areas of constant concern. There are sufficient fungicides to manage these diseases currently, but resistance issues are a concern. Recently *Alterneria* (internal mold) has become more of an issue in production. Some research attention needs to be given to understand the factors involved in the disease cycle. There are several biological fungicide products on the market but they have not shown great promise or have not been evaluated on a wide spectrum of diseases.

Weed control has generally been acceptable in pepper fields but key weed species such as yellow nutsedge, galinsoga, nightshade, redroot pigweed, and purslane continues to challenge growers. There are currently two herbicide materials registered under section 24C special local needs, Command and Dual Magnum, which are essential for growers to control key weed species. The re-introduction of tillage into pepper production systems for weed control is difficult because of increases in the use of plastic mulches (for weed control). Research on the use of cover crops in this system has not been addressed yet.

Insect pests have been a perennial struggle for pepper producers, particularly those growing red bell peppers which are exposed to season long pest pressure with a near zero tolerance for insect damage. European corn borer is the key pest that growers battle every year. With reduced Orthene limits, control of this insect is very difficult, especially if a warm season allows a third generation to develop. Aphids and two-spotted spider mite can also bother this crop, but usually can be controlled with biological agents or are confined to field edges. Stink bugs seem to be a pest on the increase in pepper production and might need to be the focus of future research.

Nematodes are currently not a major hurdle in the production of peppers. Correct diagnoses of the problem, proper rotation and variety selection are the best management tactics. Pesticide options for nematodes are limited.

One of the more subtle challenges discovered by the group were the differences in pesticide registrations between bell and non-bell pepper types, which could result in dramatically different management approaches. In particular there significant differences in the pest complex that attack bell and non-bell peppers and also significant differences in the pesticides labeled for each crop. Bell peppers usually sustain higher European corn borer damage than specialty peppers. Dual Magnum and Command herbicides cannot be used in non-bell production for weed control. Diseases seem indifferent to the bell or non-bell pepper division; they attack both with equal vigor.

Outline of Plan
The remainder of the document is a pest-by-pest analysis of the current role and efficacy of organophosphates, carbamates, B2 class pesticides (probable carcinogens), and other pesticides currently used in pepper production. In addition to the pesticide review, the use of other cultural or biological pest management aids that offer some control and other pipeline pest management tools (those identified as effective but not yet available) will also be examined as potential replacements to conventional controls. A list will be generated through discussions among the attendees to develop prioritized research, regulatory, and educational issues that need to be addressed.

Top Priorities Identified by the Ohio Pepper Pest Management Strategic Plan Committee

Research:
1. Develop alternatives to Orthene (acephate) such as neonicotinoids, IGR's, etc. and test the best ways to rotate Orthene with other insecticides for European corn borer control.

2. Thoroughly evaluate Dual (s-metolachlor) and Command (clomazone) for non-bell pepper weed control.

3. Develop spray application technology for better canopy penetration and coverage; intensify work with reduced rate applications.

4. Begin research on the parasitoid *Trichogramma ostriniae* for European corn borer egg control, the primary insect pest of peppers.

5. Develop variety trials that evaluate incidence of insect damage, disease management, fruit color, fruit marketability, and yield.

6. Evaluate biological and chemical alternatives to current synthetic fungicides.

Regulatory:
1. Remove or modify current Orthene (acephate) restrictions on number of applications per season. Use is currently capped at 2.66 lbs. / A (2.0 lbs. ai / A) for bell and 1.33 lbs. / A (1 lb. ai / A) for non-bell peppers. This translates into 1or 2 sprays per season to protect the crop when there may be as many as 3 generations of European corn borer to control. At a minimum, we would request 4 sprays per season, 2 sprays each for the second and third generations.

2. Retain Maneb (maneb) uses as a broad spectrum fungicide material.

3. Determine registration status of Topsin-M (thiophanate-methyl) for use in disease management.

4. Retain Thiram (thiram) uses for disease management.

5. Find an alternative for Ridomil (metalaxyl) fungicide, possibly Acrobat (dimethomorph).

6. Retain Thiodan (endosulfan) uses for aphid and stinkbug management.

Education:

1. Conduct workshops on proper seed treatment techniques at the annual Fruit and Vegetable Growers Congress.

2. Update the Ohio Vegetable Production Guide annually with information about new products, synthetic and biological, available for use in bell and non-bell pepper production.

3. Conduct a tour of bell and non-bell pepper fields to help educate growers, members of industry, and University personnel about proper insect, weed, and disease management.

4. Develop fact sheets for emerging diseases such as anthracnose and *Phytophthora*.

5. Create a list of educational materials currently available for growers, including material from other states if relevant.

Insects

1. European corn borer (*Ostrinia nubilalis*) Key pest – This is the key pest of peppers, having at least two and sometimes three generations per year in Ohio. The larvae must be controlled before they enter the fruit. A near zero tolerance exists for peppers found with an ECB larva. Discovery of larvae infested fruit could result in a rejected shipment at the processor.

Organophosphates currently registered

- Acephate (Orthene)
- REI – 24 hours
- PHI – 7 days

- noxious odor, product use limitations per season (two applications), best product on the market, translaminar material, works best on 7 day schedule, long residual.

Carbamates currently registered

- Methomyl (Lannate)
- REI – 48 hours
- PHI – 3 days

- not labeled for corn borer but known to be effective, not used much.

- Carbaryl (Sevin)
- REI – 12 hours
- PHI – 3 days

- short PHI, could cause increase in aphid populations, not used much, short residual.

B2 Carcinogens currently registered

None

Other insecticides currently registered

- Zeta-cypermethrin (Mustang)
- REI – 12 hours
- PHI – 1 day

- short PHI, good after peak season where Orthene is used, not systemic, could become less effective in heat, registered recently so not yet used much.

- Permethrin (Ambush, Pounce)
- REI – 12 hours
- PHI – 3 days

- non-systemic, short PHI, could become less effective in the heat.

- Esfenvalerate (Asana)
- REI – 12 hours
- PHI – 7 days

- least expensive pyrethroid, could become less effective in the heat, weaker on ECB than other pyrethroids.

- Cyfluthrin (Baythroid)

- REI – 12 hours
- PHI – 7 days
  - very expensive pyrethroid, could become less effective in the heat.

- Bifenthrin (Capture)
- REI – 7 days
- PHI – 7 days
  - recently registered thus not used much yet by growers, could become less effective in the heat.

- Pyrethrins (Pyronyl)
- REI – 12 hours
- PHI – 0 days
  - a product for organic growers, short PHI.

- Spinosad (SpinTor)
- REI – 4 hours
- PHI – 1 day
  - short PHI , have to spray on a 5 day schedule, very expensive.

- Tebufenozide (Confirm)
- REI – 4 hours
- PHI – 7 days
  - not used much, long PHI, expensive, good when used in rotation with other modes of action, product is an IGR.

- *Bacillus thuringiensis* (B.t.)
- REI – 4 hours
- PHI – 0 days
  - good for organic growers, lower PHI, target coverage is essential, effective if applied twice a week

- Pyrethrins & Rotenone (Pyrellin)
- REI - 12 hours
- PHI - 12 hours
  - residual short, not used much by growers, may be an organic product.

Other pest management aids

- Pheromone and blacklight traps are available for monitoring this pest. It is crucial to know when to start spray schedule. Guidelines for trap based spray protocol are available in Vegetable Production Guide. Other scouting protocols for egg masses exist though not heavily used because of difficulty and unreliability.

Pipeline pest management tools

- Use of *Trichogramma* parasitoid wasps to control the eggs of European corn borer.

- Use of lepidopteran active neonicotinoids, such as Assail or Proclaim.

Research needs:

- Sprayer technology issues such as target placement, improved application, plant spacing, cultivar selection, plant architecture as it relates to disease and insect management, and use of air assist "air tech" sprayers.
- Attempt to isolate the cause of internal mold in peppers, which may be correlated with incidence of European corn borer or corn earworm larvae in fruit or with cultivar selection.
- Pest status can differ between bell and hotter (non-bell) peppers.

Regulatory needs:

- Try to change regulations on Orthene to at least four applications per season or two sprays per generation for the second and third generations. This is the most important pesticide used in Ohio for raising peppers because the tolerance for larval infested fruit is near zero and Orthene is by far the most effective insecticide.

Educational needs:

- Continued education of growers on the proper use of pheromone and blacklight traps, update fact sheets concerning this pest and develop a new fact sheet specifically for peppers with current products and thresholds.

2. Aphid, Green peach (*Myzus persicae*) Key pest: occurs all season, most common in late July and August. Ideal conditions are hot and dry.

Organophospates currently registered

Some processors restrict or prohibit the use of OP's

- Dibrom (Naled)
- REI – 48 hours
- PHI – 1 day

- rarely used by growers

- Dimethoate (Cygon)
- REI – 48 hours
- PHI –0 days

- most commonly used product for aphids, limited systemic (translaminar), mixed with other products, key product for growers.

- Disulfoton (Di-Syston)
- REI – 48 hours
- PHI – 90 days

- toxic material, rarely used by growers, works well on aphids.

- Malathion (Cythion)
- REI – 12 hours

- PHI – 3 days
- rarely or slightly used, used in rotation, not translaminar, not as effective as other products.

- Oxydemetonmethyl (Metasystox-R)
- REI – 48 hours
- PHI – 3 days
- very toxic, reformulated into water soluble bag to be safer for workers to handle, can control mites, fairly effective.

- Acephate (Orthene)
- REI – 24 hours
- PHI – 7 days
- used only if European corn borer larvae need to be controlled at the same time. Limited to 2.0 lbs ai per A per season, translates into 2 applications per season, translaminar mobility, no longer used alone for aphid control.

Carbamate insecticides currently registered
Some processors restrict or prohibit the use of carbamates
- Methomyl (Lannate)
- REI – 48 hours
- PHI – 3 days
- moderately used, good in rotation, fairly expensive, very toxic, no residual, good for European corn borer too.

B2 Carcinogens currently registered
- Oxamyl (Vydate)
- REI – 48 hours
- PHI – 7 days
- used very rarely, efficacy unknown, also used for nematode control, very toxic.

Other insecticides currently registered
- Endosulfan (Thiodan)
- REI – 24 hours
- PHI – 1 or 4 days depending on rate
- used often, one of the top 3 products used, good residual, not as expensive as others, wide crop label, and good control on other pests.

- Thiamethoxam (Actara)
- REI – 12 hours
- PHI – 0 days
- very expensive, newer product, excellent at controlling sucking pests. Not widely used with growers yet.

- Imidacloprid (Admire)
- REI – 12 hours

- PHI – 0 days
- can not be used if Provado is used, soil applied, can use in drip irrigation, used as a preventative.

- Pymetrozine (Fulfill)
- REI – 12 hours
- PHI – 14 days
- newer product, good to use early, very specific for aphids, affects feeding behaviour, not effective for virus control.

- Thiamethoxam (Platinum)
- REI – 12 hours
- PHI – 0 days
- very expensive, soil treatment, not the best product.

- Imidacloprid (Provado)
- REI – 12 hours
- PHI – 0 days
- foliar applied, mostly curative in nature, can't be used if Admire has been applied, preferred product over Admire, expensive.

- Pyrethrins (Pyronyl)
- REI – 12 hours
- PHI – 0 days
- only option for organic growers, subject to review.

- Acetamiprid (Assail)
- REI – 12 hours
- PHI – 7 days
- new product, cannot rotate this product with Provado.

Other pest management aids

- Easily scouted for, prolific under hot and dry conditions
- Low numbers can be tolerated, aphids have a lot of natural enemies, try to use pesticides that won't disrupt natural enemies.

Pipeline pest management tools

- Mycotrol may have potential but efficacy unknown and expensive.
- No models have been established.

Research needs

- Investigate the use of reflective and white mulch to deter aphids from colonizing plants, may or may not have effect. Virus is not a big concern currently in peppers.
- Develop and test Lepidopteran active neonicotinoids.

Regulatory needs

- Orthene and Thiodan are key products not to lose.

Educational needs

- Pros and cons of long-term use of mulches.

3. Mite, Two-spotted spider (*Tetranychus urticae*) Key pest-thrives under hot, dry conditions, usually a problem only at the field edges.

Organophosphates currently registered

- Dibrom (Naled)
- REI – 48 hours
- PHI – 1 day

- rarely used by growers.

Carbamates currently registered

None

B2 Carcinogens currently registered

None

Other insecticides currently registered

- Dicofol (Kelthane)
- REI – 12 hours
- PHI – 2 days

- average control for this pest.

- Bifenthrin (Capture)
- REI – 7 days
- PHI – 7 days

- broad spectrum, kills more insects (beneficials) than mites.

- Abamectin (Agri-Mek)
- REI – 12 hours
- PHI – 7 days, bell peppers only

- best product to use, but also most expensive.

- Soap (M-Pede)
- REI – 12 hours
- PHI – 0 days

- not used for mite control.

Other pest management aids

Low numbers can be tolerated, damage is usually restricted to field edges, there are several natural predators of this pest.

Pipeline pest management tools

- None

Research needs:

- None.

Regulatory needs:

- None.

Educational needs:

- Remind growers that mites tend to concentrate on field edges and are usually controlled by natural predators.

4. Corn earworm (*Helicoverpa zea*) Serious yet sporadic pest that tunnels inside fruit, not a problem every year, should be monitored mainly in August and September along with European corn borer.

Organophosphates currently registered
None

Carbamates currently registered
None

B2 Carcinogens currently registered
None

Other insecticides currently registered

- Permethrin (Ambush, Pounce)
- REI – 12 hours
- PHI – 3 days

- use could flare aphids, average control, economical.

- Esfenvalerate (Asana)
- REI – 12 hours
- PHI – 7 days

- use could flare aphids, average control, economical.

- Cyfluthrin (Baythroid)
- REI – 12 hours
- PHI – 7 days

- use could flare aphids, average control, economical.

- Bifenthrin (Capture)
- REI – 7 days
- PHI – 7 days

- use could flare aphids, average control, economical.

- Indoxicarb (Avaunt)
- REI – 12 hours
- PHI – 3 days
  - harvest interval short, good with caterpillar pests on other crops, newer product, expensive.

- Pyrethrins (Pyronyl)
- REI – 12 hours
- PHI – 0 days
  - may be certified for organic use, short residual.

- Spinosad (SpinTor)
- REI – 4 hours
- PHI – 1 day
  - very expensive, short PHI and REI, also used for European corn borer.

- *Bacillus thuringiensis* (B.t.)
- REI – 4 hours
- PHI – 0 days
  - corn earworm and European corn borer too protected in fruit, not very effective, low environmental impact.

Other pest management aids

- Pheromone traps are excellent management tools, helpful in September and October, once corn borer is settled down.
- Degree day models exist but are not frequently used.

Pipeline pest management tools

- Gemstar product is a virus for corn earworm, efficacy unknown

Research needs:

- Check on Gemstar, see if it could be also be considered organic.

Regulatory needs:

- None

Educational needs:

- Increase growers understanding of pheromone trapping an option, advertise location of web site which houses seasonal flight data.

5. Cutworm, Black (*Agrotis ipsilon*) minor pest: can be a sporadic pest attacking seedlings, adults migratory, arrive from southern regions in the spring.

Organophosphates currently registered

None

Carbamates currently registered

- Methomyl (Lannate)
- REI – 48 hours
- PHI – 3 days

- cutworms are sporadic pests, this product is rarely used by growers.

- Carbaryl (Sevin)
- REI – 12 hours
- PHI – 3 days

- cutworms are sporadic pests, this product is rarely used by growers.

B2 Carcinogens currently registered

None

Other insecticides currently registered

- Zeta-cypermethrin (Mustang)
- REI – 12 hours
- PHI – 1 day

- cutworms are sporadic pests, this material has average efficacy.

- Permethrin (Ambush, Pounce)
- REI – 12 hours
- PHI – 3 days

- cutworms are sporadic pests, this material has average efficacy.

- Bifenthrin (Capture)
- REI – 7 days
- PHI – 7 days

- cutworms are sporadic pests, this material has average efficacy.

- Pyrethrins (Pyronyl)
- REI – 12 hours
- PHI – 0 days

- cutworms are sporadic pests, this material may be used by organic growers.

- Tebufenozide (Confirm)
- REI – 4 hours
- PHI – 7 days

- cutworms are sporadic pests, this material has average efficacy.

- Azadirachtin (Azatin, Neem)
- REI – 4 hours
- PHI – 0 days

- cutworms are sporadic pests, this material has average efficacy.

- *Bacillus thuringiensis* (B.t.)
- REI – 4 hours
- PHI – 0 days

- cutworms are sporadic pests, a product used by organic growers, efficacy below average.

Other pest management aids

- Scouting thresholds have been established, pheromone traps can be used to track flights in spring.

Pipeline pest management tools

- None, this pest is very sporadic.

Research needs

- None

Regulatory needs

- None

Educational needs

- Be sure growers know what thresholds exist for this pest and the correct scouting procedures.

6. Fall armyworm (*Spodoptera frugiperda*) serious but sporadic pest - similar to corn earworm, a migratory insect that is a pest sporadically during the late season, tunnels into fruit. When it occurs it is equal in importance to European corn borer.

Organophosphates currently registered

None

Carbamates currently registered

- Methomyl (Lannate)
- REI – 48 hours
- PHI – 3 days

- not used

- Carbaryl (Sevin)
- REI – 12 hours
- PHI – 3 days

- short PHI, could cause increase in aphid populations, not used much except after European corn borer flights are over.

B2 Carcinogens currently registered

None

Other insecticides currently registered

- Spinosad (SpinTor)

- REI – 4 hours
- PHI –1 day
  - not used extensively, short PHI.

- Tebufenozide (Confirm)
- REI – 4 hours
- PHI – 7 days
  - not used extensively.

- *Bacillus thuringiensis* (B.t.)
- REI – 4 hours
- PHI – 0 days
  - not used extensively, short PHI, can be used by organic growers.

Other pest management aids

- There is a pheromone trap available for this pest to determine if it is active or not, but thresholds have not been established on trap catches.

Pipeline pest management tools

- None at this time.

Research needs:

- Establish pheromone trap thresholds**.**

Regulatory needs:

- None at this time.

Educational needs:

- If this pest makes an appearance during the end of the season, it will be broadcast along with management tips in the weekly VegNet newsletter.

7. Potato flea beetle (*Epitrix cucumeris*) minor pest-can cause feeding injury at a non-economic level, can occasionally cause problems on seedling peppers.

Organophosphates currently registered

- Dibrom (Naled)
- REI – 48 hours
- PHI – 1 day
  - no additional comments.

Carbamates currently registered

- Carbaryl (Sevin)
- REI – 12 hours
- PHI – 3 days
  - no additional comments.

B2 Carcinogens currently registered
None

Other insecticides currently registered

- Endosulfan (Thiodan)
- REI – 24 hours
- PHI – 1 or 4 days, depending on rate

- no additional comments.

- Permethrin (Ambush, Pounce)
- REI – 12 hours
- PHI – 3 days

- no additional comments.

- Esfenvalerate (Asana)
- REI – 12 hours
- PHI – 7 days

- no additional comments.

- Bifenthrin (Capture)
- REI – 7 days
- PHI – 7 days

- no additional comments.

- Thiamethoxam (Actara)
- REI – 12 hours
- PHI – 0 days

- effective for potato flea beetle.

- Imidacloprid (Admire)
- REI – 12 hours
- PHI – 0 days

- no additional comments.

- Thiamethoxam (Platinum)
- REI – 12 hours
- PHI – 0 days

- effective for potato flea beetle.

- Pyrethrins (Pyronyl)
- REI – 12 hours
- PHI – 0 days

- no additional comments.

- Cryolite (Kryocide)

- REI – 12 hours
- PHI – 14 days

- no additional comments.

- *Beauveria sp*. (Mycotrol)
- REI – 12 hours
- PHI – 0 days

- no additional comments.

- Zeta-cypermethrin (Mustang)
- REI – 12 hours
- PHI – 1 day

- no additional comments.

Other pest management aids

- No scouting protocol is outlined for flea beetles in peppers.

Pipeline pest management tools

- None at this time given the rare status of this pest.

Research needs:

- None at this time given the rare status of this pest.

Regulatory needs:

- None at this time given the rare status of this pest.

Educational needs:

- Flea beetle damage to the seedlings will be seen occasionally, the plants will outgrow this damage in most cases, there is no threat of disease transmission associated with the feeding.

8. Hornworm (*Manduca sp.)* minor pest - This pest is very sporadic and rare in pepper fields. The larvae are very large and tend to feed at the top of the plant canopy. Their presence is easy to detect due to the large amounts of foliage and fruit they can consume. Relatively easy to control when necessary.

Organophosphates currently registered

- Acephate (Orthene)
- REI – 24 hours
- PHI – 7 days

- probably not going to be used for this insect due to application restrictions, efficacy should be quite good.

Carbamates currently registered

- Methomyl (Lannate)

- REI – 48 hours
- PHI – 3 days

- pest is very sporadic and rare, very few growers will treat for this insect.

- Carbaryl (Sevin)
- REI – 12 hours
- PHI – 3 days

- pest is very sporadic and rare, very few growers will treat for this insect.

B2 Carcinogens currently registered
None

Other insecticides currently registered
- Endosulfan (Thiodan)
- REI – 24 hours
- PHI – 1 or 4 days, depending on rate

- pest is very sporadic and rare, very few growers will treat for this insect.

- Spinosad (SpinTor)
- REI – 4 hours
- PHI – 1 day

- pest is very sporadic and rare, very few growers will treat for this insect.

- Pyrethrins (Pyronyl)
- REI – 12 hours
- PHI – 0 days

- pest is very sporadic and rare, very few growers will treat for this insect, could be considered an organic treatment.

- Tebufenozide (Confirm)
- REI – 4 hours
- PHI – 7 days

- pest is very sporadic and rare, very few growers will treat for this insect.

- Azadirachtin (Azatin, Neem)
- REI – 4 hours
- PHI –0 days

- pest is very sporadic and rare, very few growers will treat for this insect.

- Cryolite (Kryocide)
- REI – 12 hours
- PHI – 14 days

- pest is very sporadic and rare, very few growers will treat for this insect.

- *Bacillus thuringiensis* (B.t.)

- REI – 4 hours
- PHI – 0 days
  - pest is very sporadic and rare, very few growers will treat for this insect, this would be an excellent treatment if larvae are small, some Bt products may be allowed for organic production.

- Endosulfan & Pyrethrins (Thirethrin)
- REI – 24 hours
- PHI – 4 days
  - pest is very sporadic and rare, very few growers will treat for this insect.

Other pest management aids

- No commercial pheromone trap is available but blacklight traps can be used. Catches from two sites in Ohio have been posted at Vegnet.osu.edu for the past few years.

Pipeline pest management tools

- None identified for this pest given its rare status and sporadic nature.

Research needs:

- None

Regulatory needs:

- None

Educational needs:

- Promote use of Bt if treatment is needed.

9. Pepper maggot (*Zonosemata electa*) minor pest- A larval pest that infests the fruit of bell and non-bell peppers, very rare in Ohio and strongly associated with Horsenettle.

Organophosphates currently registered

- Malathion (Cythion)
- REI – 12 hours
- PHI – 3 days
  - rarely used by growers.

Carbamates currently registered

None

B2 Carcinogens currently registered

None

Other insecticides currently registered

- Endosulfan (Thiodan)
- REI – 24 hours

- PHI – 1 or 4 days, depending on rate
  - rarely used by growers.

- Endosulfan & Pyrethrins (Thirethrin)
- REI – 24 hours
- PHI – 4 days
  - rarely used by growers.

Other pest management aids

- There are yellow ammonium baited sticky traps available for monitoring this pest.

Pipeline pest management tools

- None currently being investigated in Ohio, although there is work being done in trap cropping in CT.

Research needs:

- None at this time.

Regulatory needs:

- None at this time.

Educational needs:

Make sure growers can identify this pest if it infests pods and that they remove all sources of Horse nettle near their production areas.

10. Western Flower Thrips (*Frankliniella occidentalis*) minor pest - mostly a pest in the greenhouse, can vector Tomato spotted wilt virus to pepper seedlings.

Organophosphates currently registered

None

Carbamates currently registered

None

B2 Carcinogens currently registered

None

Other insecticides currently registered

- Imidacloprid (Admire)
- REI – 12 hours
- PHI – 0 days
  - treatment in the field is not recommended for this pest.

- Cyfluthrin (Baythroid)
- REI – 12 hours
- PHI – 7 days
  - treatment in the field is not recommended for this pest.

- Spinosad (SpinTor)
- REI – 4 hours
- PHI – 1 day
  - treatment in the field is not recommended for this pest.

- Imidacloprid (Marathon II)
- REI – 12 hours
- PHI – 0 days
  - can be used in the greenhouse where treatment is acceptable.

Other pest management aids

- None

Pipeline pest management tools

- None

Research needs:

- None at this time.

Regulatory needs:

- None at this time.

Educational needs:

- Marathon II, new for vegetables that need to be treated in the greenhouse, same active ingredient as Admire. Not for use in treating fields infestations.
- Remind growers to separate ornamental plants and vegetable seedlings in greenhouse to reduce TSWV.

11. Greenhouse whitefly, Banded wing whitefly (*Trialeurodes vaporariorum, Trialeurodes abutilonea*) minor pest - both species can be a sporadic pest of peppers, mostly in greenhouse situations.

Organophosphates currently registered

None

Carbamates currently registered

None

B2 Carcinogens currently registered

None

Other insecticides currently registered

- Imidacloprid (Admire)
- REI – 12 hours
- PHI – 21 days
  - at planting soil treatment.

- Imidacloprid (Provado)
- REI – 12 hours
- PHI – 0 days
  - an essential foliar treatment when necessary.

- Thiamethoxam (Actara)
- REI – 12 hours
- PHI – 0 days
  - an essential foliar treatment when necessary.

- Endosulfan (Thiodan)
- REI – 24 hours
- PHI – 1 or 4 days, rate determined
  - limited to 2 applications per year.

Other pest management aids
- None

Pipeline pest management tools
- None

Research needs:
- None identified at this time.

Regulatory needs:
- None at this time.

Educational needs:
- Identification of species may be important for management purposes, several species of. whitefly are known to vector viruses.

12. Stink bugs – minor pest, adults and nymphs can feed on fruit, causing a white cloudy spot to appear. This pest may be on the increase in Ohio.

Organophosphates currently registered
None

Carbamates currently registered
None

B2 Carcinogens currently registered
None

Other insecticides currently registered

- Thiamethoxam (Actara)
- REI – 12 hours
- PHI – 0 days

- good foliar treatment.

Other pest management aids

- None

Pipeline pest management tools

- None

Research needs:

- Separate stinkbug injury from a condition called ghost spot (*Botrytis*).

Regulatory needs:

- None at this time.

Educational needs:

- Teach growers how to identify damage, usually find a large increase in damage if near wheat fields that are being harvested. This pest may not be readily seen during the day, active at night.

12. Beet armyworm – new migratory pest, presence sporadic but severe where it appears – larvae feed on foliage and fruit.

Organophosphates currently registered

None

Carbamates currently registered

None

B2 Carcinogens currently registered

None

Other insecticides currently registered

- Tebufenozide (Confirm)
- REI – 4 hours
- PHI – 7 days

- excellent material to use on all larval stages.

- Spinosad (SpinTor)
- REI – 4 hours
- PHI – 1 days

- excellent material to use on small larvae, good material on larger larvae.

- B.t. aizawai (Agree)
- REI – 4 hours
- PHI – 1 days
  - fair material to use on larvae.

- B.t. aizawai (XenTari)
- REI – 4 hours
- PHI – 0 days
  - fair material to use on larvae.

- B.t. aizawai (Ketch)
- REI – 4 hours
- PHI – 0 days
  - fair material to use on larvae.

- Acephate (Orthene)
- REI – 24 hours
- PHI – 7 days
  - poor material to use for larval control.

- Cyclopropanecarboxylate (Baythroid 2)
- REI – 12 hours
- PHI – 7 days
  - poor material to use for larval control.

- Lambda-cyhalothrin (Warrior)
- REI – 24 hours
- PHI – 5 days
  - poor material to use for larval control.

- Esfenvalerate (Asana)
- REI – 12 hours
- PHI – 7 days
  - poor material to use for larval control.

- Methomyl (Lannate)
- REI – 48 hours
- PHI – 3 days
  - poor material to use for larval control.

Other pest management aids

- Monitor adults with bucket type (‘Unitrap’) or sticky type (‘Pherocon 1C’) pheromone trap.

Pipeline pest management tools

- None

Research needs:

- Gather efficacy data, validate pheromone trap thresholds.

Regulatory needs:

- None at this time.

Educational needs:

- Teach growers how to identify damage and caterpillars, commonly used caterpillar insecticides have poor efficacy on this pest.

Nematodes

1. Root knot nematode (*Meloidogyne* spp.) minor pest – a minor pest of peppers, can be dealt with most effectively through rotation and variety resistance.

Organophosphates currently registered
None

Carbamates currently registered
None

B2 Carcinogens currently registered
- Oxamyl (Vydate)
- REI – 48 hours
- PHI – 7 days

- available but rarely if ever used in the field.

Other pest management aids
- Soil samples can be sent to the Plant and Pest Diagnostic Clinic.

Pipeline pest management tools
- None

Research needs
- None

Regulatory needs
- None at this time.

Educational needs
- Focus on rotation away from solanaceous crops.

2. Root lesion nematode (*Pratylenchus* spp.) minor pest – a minor pest of peppers, can be dealt with most effectively through rotation and variety resistance.

Organophosphates currently registered
None

Carbamates currently registered
None

B2 Carcinogens currently registered
- Oxamyl (Vydate)
- REI – 48 hours
- PHI – 7 days

- available but rarely if ever used in the field.

Other pest management aids

- Soil samples can be sent to the Plant and Pest Diagnostic Clinic.

Pipeline pest management tools

- None

Research needs:

- None

Regulatory needs:

- None at this time.

Educational needs:

- Focus on rotation away from solanaceous crops.

Fungal, Viral, and Bacterial Pathogens

1. Bacterial leaf spot (*Xanthomonas campestris pv. vesicatoria*) Key pathogen – attacks seedling and mature plants, may be seed born, can spread rapidly in greenhouse

B2 Carcinogens currently registered

- Manganese Ethylene(bis)dithiocarbamate (Maneb)
- REI – 24 hours
- PHI – 5 days
- should be tank mixed with copper for best results, apply no more than 14.4 lbs. active ingredient per acre per season.

Other pesticides currently registered

- Fixed Copper solutions (Copper sulfate, Copper oxychloride, & Cuprous oxide)
- REI – 24 hours
- PHI – 0 days
- continued use can lead to resistance issues.

- Basic Copper Sulfate (Cuprofix)
- REI – 24 hours
- PHI - 0 days
- continued use can lead to resistance issues, flowable formulation has short shelf life, add Champ or Kocide to increase efficacy.

Other pathogen management aids

- Use disease-free seeds, transplants, and resistant and improved varieties
- Use Clorox and hot water to treat seeds against bacterial spot, may need to return seed for commercial pelletizing and seed treatment.

Pipeline pest management tools

- Try to develop a comprehensive disease management plan for this pathogen.

Research needs:

- Develop resistant cultivars, alternatives to copper sprays, determine if plant architecture or spacing influences disease development, work with Serenade to see how it fits in with an overall disease management plan.

Regulatory needs:

- None at this time

Educational needs:

- Make sure growers understand benefits of seed treatment, know how to perform Clorox and hot water seed treatments; greenhouses should be closed in summer to allow heat build up and pathogen destruction, make sure growers have access to the most resistant varieties on the market.

2. Phytophthora blight (*Phytophthora capsici, Phytophthora parasitica*) Key disease – both a stem and fruit rot disease, cannot be controlled by a single tactic.

B2 Carcinogens currently registered
None.

Other pesticides currently registered

- Fixed Copper solutions (Copper sulfate, Copper oxychloride, & Cuprous oxide)
- REI – 24 hours
- PHI – 0 days
- continued use can lead to resistance issues.

- Mefenoxam (Ridomil Gold)
- REI – 12 hours
- PHI – 0 days
- very expensive, standard use in production, pockets of resistance showing up.
- Copper Hydroxide, Mefenoxam (Ridomil/Copper)
- REI – 24 hours
- PHI – 0 days
- very expensive, crop rotation difficult to manage due to length of residual.

Other pathogen management aids

- Water management essential, good drainage may reduce incidence.

Pipeline pest management tools

- None currently available.

Research needs

- Search for better acting or different mode of action fungicides, develop resistant varieties trying to keep the horticultural traits intact, provide more alternatives, consider how spacing affects yield and disease incidence, investigate raised beds combined with sand, eliminate depressions around seedlings and plants.

Regulatory needs

- Look at alternatives such as Acrobat.

Educational needs

- Farmers need to use good cultural practices, water management, have good drainage, use domed or raised beds, resistant varieties where possible, and rotate with non-solanaceous plants.

3. Anthracnose – key disease, attacks and destroys fruit.

B2 Carcinogens currently registered

- Manganese Ethylene(bis)dithiocarbamate (Maneb, Manex)

- REI – 24 hours
- PHI – 5 days
- good control of disease, may not perform as well on newer strains of disease, limited to 14.4 lbs. active ingredient per acre per season.

Other pesticides currently registered

- Fixed Copper solutions (Copper sulfate, Copper oxychloride, & Cuprous oxide)
- REI – 24 hours
- PHI – 0 days
- alternate with azoxystrobin.

- Copper sulfate (TopCop)
- REI – 24 hours
- PHI – 0 days
- alternate with azoxystrobin.

- Azoxystrobin (Quadris)
- REI – 4 hours
- PHI – 0 days
- mix with Maneb, must be alternated with coppers due to resistance management, may control newer strains of pathogen, product use limits per season, expensive product.

Other pathogen management aids

Use resistant and improved varieties.

Pipeline pest management tools

None currently available.

Research needs

- Increase screening for resistant varieties, fungicides with different modes of action, reduced risk products and alternatives to fungicides, work out timing of Quadris to reduce fruit infections.

Regulatory needs

- Seek products to alternate with Quadris.

Educational needs

- Educate growers that more aggressive strains are being selected for under current fungicide programs, disease may be seed borne, list resistant varieties in current issue of Vegetable Production guide.

4. *Sclerotinia* blight (*Sclerotinia sclerotiorum*)- Key pathogen - This pathogen has a wide host range, can't be rotated with soybeans or cole crops, very few products labeled for control.

B2 Carcinogens currently registered

None.

Other pesticides currently registered
- *Coniothyrium minitans* 2 (Contans)
- REI – 4 hours
- PHI – 0 days
- a biological control product.

Other pathogen management aids
None

Pipeline pest management tools
None at this time.

Research needs
- None

Regulatory needs
- None

Educational needs
- Remind growers that rotation and variety selection are key in preventing this disease.

5. Tobacco Mosaic Virus – can be managed in the greenhouse, sanitation is critical, eliminate introductions into greenhouse, eliminate physical brushing of seedlings to keep them short, virus can be transmitted mechanically as well as by aphids. See Insect section above, managing Aphids.

Other pathogen management aids
- Use resistant or improved varieties, dip hands in milk to eliminate virus particles.

Pipeline pest management tools
- None.

Research needs
- None at this time.

Regulatory needs
- None at this time.

Educational needs
- Remind growers that virus is transmitted mechanically, eliminate brushing, excellent sanitation practices, eliminate introduction in greenhouse, use milk as disinfectant.

6. Tomato Spotted Wilt Virus
See Insect section above, managing Western Flower Thrips

Other pathogen management aids

- Don't raise pepper seedlings near ornamental plants. Scout for thrips.

Pipeline pest management tools

- None**.**

Research needs:

- None at this time.

Regulatory needs:

- None at this time.

Educational needs:

- Essential to inspect plants at greenhouse, isolate peppers, tomatoes and ornamental plants, purchase seedlings from local greenhouses to avoid importing virus.

7. Early blight (*Alternaria solani*) minor disease - not usually a problem

B2 Carcinogens currently registered

None.

Other pesticides currently registered

- Fixed Copper solutions (Copper sulfate, Copper oxychloride, & Cuprous oxide)
- REI – 24 hours
- PHI – 0 days

- rarely used just for early blight control.

- Copper sulfate (TopCop)
- REI – 24 hours
- PHI – 0 days

- rarely used just for early blight control.

Other pathogen management aids

- Use disease resistant or improved varieties

Pipeline pest management tools

- None.

Research needs:

- None at this time.

Regulatory needs:

- None at this time.

Educational needs:

- Make sure growers can identify this disease if it should happen to occur in their fields.

8. Phomopsis blight (*Phomopsis vexans*) minor disease - very rarely seen in Ohio

B2 Carcinogens currently registered
None.

Other pesticides currently registered
- Fixed Copper solutions (Copper sulfate, Copper oxychloride, & Cuprous oxide)
- REI – 24 hours
- PHI – 0 days
- rarely used to control this disease.

- Copper sulfate (TopCop)
- REI – 24 hours
- PHI – 0 days
- rarely used to control this disease.

Other pathogen management aids
- Use resistant or improved varieties when possible.

Pipeline pest management tools
- None currently being worked on.

Research needs
- None at this time.

Regulatory needs
- None at this time.

Educational needs
- Make sure growers can identify this disease if it should happen to occur in their fields.

9. Fusarium crown rot (*Fusarium oxysporum radicis-lycopersici*) minor disease, however, all strains are resistant to current fungicides

B2 Carcinogens currently registered
None.

Other pesticides currently registered
None.

Other pathogen management aids
- Use resistant and improved varieties

Pipeline pest management tools
- None.

Research needs
- None.

Regulatory needs
- None

Educational needs
- Remind growers that rotation and use of resistant varieties is the only strategy available to manage this disease.

10. Damping Off (*Pythium sp*.) minor disease - Thrives in wet soils or excessively hot or cold soils, in most years it is not a problem.

B2 Carcinogens currently registered
None.

Other pesticides currently registered
- Tetramethylthiuram disulfide (Thiram)
- REI – 24 hours
- PHI – 7 days
- seed treatment is important for greenhouses

- Mefenoxam (Ridomil Gold)
- REI – 12 hours
- PHI – 0 days
- can't use in greenhouse, use for field treatment, possible phytotoxicity concerns in dry soil, can use with drip irrigation.

Other pathogen management aids
- Disease free seeds, transplants; use resistant or improved varieties

Pipeline pest management tools
- None at this time.

Research needs
- Alternate seed treatment

Regulatory needs
- Important to keep seed treatment Thiram.

Educational needs
- Teach growers when to use Ridomil Gold, important they understand the environmental conditions necessary for development of *Pythium*.

Weeds

1. Annual grasses and broadleaf weeds

Herbicides currently registered

Pre-plant

- Trifluralin (Treflan)
- REI – 12 hours
- PHI – 30 days

- incorporate material is essential, cold and wet soils can lead to root pruning, soil type is important as is good coverage.

Clomazone (Command)

- REI – 12 hours
- PHI – 65 days

- carry over concerns, especially beneath plastic, depth of planting critical, currently under a 24C in Ohio, applicator needs label, cannot be used on banana peppers, rotational concerns.

Pre-emerge

- S-Metalachlor (Dual Magnum)
- REI – 24 hours
- PHI – 90 days

- can't use on specialty or banana peppers, currently a 24C label in Ohio, applicator needs label.

Post-emerge

- DCPA (Dacthal)
- REI – 12 hours
- PHI – 0 days

- not used much by growers, possible human carcinogen (group C),

- Napropamide (Devrinol)
- REI – 12 hours
- PHI – 0 days

- used sparingly by growers.

- Sethoxydim (Poast)
- REI – 12 hours
- PHI – 20 days

- good control if conditions are wet and not suitabale for planting, used if preplant incorporated herbicide did not control grasses.

- Clethodim (Select)
- REI – 24 hours
- PHI – 20 days

- good control if conditions are wet and not suitable for planting, used if preplant incorporated herbicide did not control grasses.

- Paraquat (Gramoxone Extra)
- REI – 12 hours
- PHI - 30 days

- used often by growers, needs to be applied as a shielded spray.

Other weed management aids

- Cultivation ca be a key for weed control
- Incorporation of cover crops for weed control
- Fall tillage w/ herbicides

Pipeline pest management tools

- None currently available.

Research needs

- Command and Dual effects on specialty peppers (Habanera, Cherry, Banana, Pimento).

Regulatory needs

- Can Command be used on specialty peppers, expand Dual Magnum label to include all peppers.

Educational needs

- Have field day late June or July to identify problem weeds, habituate growers to importance of scouting fields.
- Rotation of herbicide classes to avoid resistance

Explanation of tables

The following nine tables reflect a combination of pesticide efficacy as rated by the members of the pest management strategic plan committee with extensive comments by individual Extension specialists. The rating system for IPM practices and strategies have been formerly established in Ohio as the Elements for pepper production (http://ipm.osu.edu/element/index.htm, 2002). The Elements of pepper production represent IPM tactics that have similarly been developed by a group of specialists and growers, and have been grouped with regard to timing of certain practices, from pre-season to post harvest. The pest management strategic plan committee also felt it necessary to include information about greenhouse production of seedlings where many insect and disease challenges begin. By listing tables with both straight pesticide efficacy of labeled and experimental compounds along with established IPM techniques for weeds, diseases, and other pests, provides an excellent summation of Ohio's bell and non-bell pepper strategic plan.

Table 1. Summary of all pesticide active ingredients reported in NASS Agricultural Chemical Usage 2002 Vegetables Report for Ohio.

Active Ingredient	Area Applied	Applications	Rate per Application	Rate per Crop Year	Total Applied
	Percent	Number	Lbs. / Acre	Lbs. / Acre	1,000 Lbs.
Herbicides					
Clomazone	14	1.0	0.34	0.35	0.1
Glyphosate	45	1.0	0.75	0.76	0.6
Napropamide	3	1.0	1.41	1.41	0.1
S-Metolachlor	12	1.0	0.85	0.85	0.2
Trifluralin	26	1.0	0.71	0.71	0.3
Bensulide	*	*	*	*	*
EPTC	*	*	*	*	*
Ethalfluralin	*	*	*	*	*
MCPB	*	*	*	*	*
Insecticides					
Acephate	77	2.6	0.80	2.09	2.8
Carbaryl	5	1.8	1.01	1.86	0.2
Endosulfan	54	1.4	0.61	0.86	0.8
Permethrin	44	7.7	0.20	1.53	1.2
Azinophos-methyl	*	*	*	*	*
Bifenthrin	*	*	*	*	*
Bt	*	*	*	*	*
Carbofuran	*	*	*	*	*
Chlorpyrifos	*	*	*	*	*
Cyfluthrin	*	*	*	*	*
Diazinon	*	*	*	*	*
Dimethoate	*	*	*	*	*
Esfenvalerate	*	*	*	*	*
Ethyl parathion	*	*	*	*	*
Imidacloprid	*	*	*	*	*
Malathion	*	*	*	*	*
Methomyl	*	*	*	*	*
Piperonyl butoxide	*	*	*	*	*
Pyrethrins	*	*	*	*	*
Spinosad	*	*	*	*	*
Tebufenozide	*	*	*	*	*
Fungicides					
Chlorothalonil	**	3.1	1.22	3.87	0.1
Copper hydroxide	69	17.9	0.48	8.64	10.2
Azoxystrobin	*	*	*	*	*
Benomyl	*	*	*	*	*
Copper amm. complex	*	*	*	*	*
Copper oxide	*	*	*	*	*
Copper sulfate	*	*	*	*	*
Mancozeb	*	*	*	*	*
Maneb	*	*	*	*	*
Mefenoxam	*	*	*	*	*
Thiophanate-methyl	*	*	*	*	*

* Usage data not published for this active ingredient

** Area applied less than one percent

Table 2. Efficacy of fungicides used on peppers in Ohio.

Pathogen	DO	CMV	TMV	TSWV	BLS	PhB	An	Alt	FuCR	ScB	*Impact on beneficial organisms*
Manageable (Y / N / Partially)	*P*	*P*	*P*	*P*	*P*	*P*	*M*	*N*	*N*	*N*	
Importance of pathogens	*M*	*O*	*O*	*O*	*V*	*V*	*P*	*M*	*P*	*M*	
Historical fungicide use on Ohio farms	*O*	-	-	-	*MSY*	*MSY*	*MSY*	-	-	*O*	
Protectant fungicides / bacteriocides											
Fixed Copper solutions (Copper sulfate)	P	-	-	-	F	P	P	U	-	-	U
Fixed Copper solutions (Copper oxychloride)	-	-	-	-	F	P	P	U	-	-	U
Fixed Copper solutions (Cuprous oxide)	-	-	-	-	F	P	P	U	-	-	U
Copper Sulfate (Cuprofix)	-	-	-	-	F	P	P	U	-	-	U
Copper sulfate (TopCop)	-	-	-	-	F	P	P	U	-	-	U
Manganese Ethylene(bis)dithiocarbamate (Maneb, Manex)	-	-	-	-	F*	P	F	U	-	-	U
Mefenoxam (Ridomil Gold)	G	-	-	-	-	F	-	U	-	-	U
Mefenoxam, Copper Hydroxide (Ridomil/Copper)	-	-	-	-	-	F	-	U	-	-	U
Tetramethylthiuram disulfide (Thiram)	G	-	-	-	-	-	-	U	-	-	U
Azoxystrobin (Quadris)	-	-	-	-	-	F	-	U	-	-	U
Trifloxistrobin (Flint)	-	-	-	-	-	-	-	U	-	-	U
Thiophanate methyl (Topsin M)*Section 18 Exemption	-	-	-	-	-	-	-	U	-	G	U
Potassium (eKsPunge)	U	-	-	-	U	U	U	U	U	U	U
Bacillus subtilus 1(Serenade)	U	-	-	-	U	P	P	U	U	U	U
Coniothyrium minitans 2 (Contans)	-	-	-	-	-	-	-	-	-	√	U
Unregistered Products											
None at this time											

Pathogens: **DO**=damping off (*Rhizoctonia* & *Pythium*), **CMV**=Cucumber mosaic virus, **TMV**= Tobacco mosaic virus, **TSWV**=tomato spotted wilt virus, **BLS**=bacterial leaf spot, **PhB**=*Phytophthora* blight, **An**=anthracnose, **Alt**=*Alternaria* internal mold, **FuCR**=*Fusarium* crown rot, **ScB**=*Sclerotinia* blight

Importance of pathogens: **V=** very, **M=** moderate, **O=** occasional

Historical Use: **R**=rare, **O**=occasional, **MSY**=multiple sprays every year, - = Not known

Efficacy: **E** = excellent, **G** = good, **F** = fair, **P** = poor, √ = pathogen listed on label but efficacy uncertain, **-** = pathogen **not** on label, **U** = unknown

Beneficial insect impact: **VL**=very low, **L**=low, **M**=moderate, **D**=disruptive
* = must be mixed with copper

Table 3. IPM tactics for disease management on peppers in Ohio.

Tactics	Importance	Pathogens: BLS, Anth, Phy, TSWV, SCL, IM, DO, PB	How often tactic is used	Comments
Pre-Plant				
Select well-drained site or improve drainage (raised beds, surface drains).	1	BLS, PB, SCL	A	Don't plant in low spots; Peppers very sensitive to wet roots.
Use fungicide-treated seed.	1	DO	A	Thiram use is critical.
Use hot-water and chlorine treated seed	1	BLS, AN, IM	S	Pre-pelleted seed difficult or impossible to treat; special equipment and skills needed for hot-water treatment.
Select hybrids with good resistance or tolerance.	1	BLS, Phy	S	Not enough varieties have good resistance combined with horticultural trait; use resistance varieties whenever possible.
Select transplants grown in isolation from other vegetables crops or ornamentals.	1	TSWV, BLS	unknown	Should be followed at all times.
Select properly rotated site 4-5 years away from vines and solanaceous crops.	2	Phy	S/U	Land availability may prevent use of this tactic.
Use drip tape and plastic mulch foe weed control, disease control and irrigation.	2	Phy, BLS, Anth, IM, white mold	U	Reduces moisture in plant canopy and splashing soil onto plant, compared to overhead sprinklers and bare ground.
At-Plant				
Apply Ridomil Gold if Phytophthora or Pythium is a concern.	2	Phy, P*ythium*	S	Ridomil Gold very expensive.
In-Season				
Apply copper and maneb.	3	BLS	U	Not highly effective for BLS under high disease pressure.
Apply Ridomil Gold 30 days post-planting.	2	Phy	S	Expensive.
Alternate Quadris with Maneb.	1	Anth	N	Anthracnose recently added to Quadris label, growers not yet familiar with it
At-Harvest				
Stay out of field when plants are wet.	2	BLS,Anth	S	Bacterial and fungal disease easily spread where plants are wet.
Remove diseased plants from field to reduce inoculums.	2	BLS,Phy,Anth,	S	Inoculum survives over winter in plants.

Importance: **1**= very important, **2** = important, **3** = somewhat important, **4** = not important

Pathogens: BLS= bacterial leaf spot, **Anth** = anthracnose**, Phy** = *phytophthora* blight**, TSWV** = tomato spotted wilt virus, **SCL**= *sclerotinia***, IM** = internal mold**, DO**= damping off

Tactic Use: A = Always, **U** = usually, **S** = sometimes, **N** = rarely/never

Table 4. Efficacy of herbicides used on peppers in Ohio.

Weeds	Barnyardgrass	Crabgrass	Fall Panicum	Foxtails	Johnsongrass	Johnsongrass seedlings	Quackgrass	**Yellow nutsedge**	**Gallinsoga**	Jimsonweed	**Lambsquarters**	Morningglory	Mustards	**Pigweed**	**Purslane**	Ragweed –common	Ragweed – giant	Smartweed	Velvetleaf	**Nightshade**	*Impact on beneficial organisms*
Historical herbicide control pattern on Ohio farms	Pre-plant / Pre-emerge used primarily for grasses; Post used less often						1, 2	1, 2	1	3	1, 2	2	1	1, 2	1, 2	1	3	1	1	2	
Pre-Plant																					
Trifluralin (Treflan)	G	G	G	G	N	G	N	N	N	N	F-G	P	N	G	G	N	-	P-F	N	N	U
Clomazone (Command)	G	G	G	G	N	G	N	N	F	G	G	P	F	P	G	F	-	G	G	-	U
Pre-emerge																					
S-Metalachlor (Dual Magnum)	G	G	G	G	N	P	N	F-G	F	P	P-F	N	-	G	G	N	-	P	P	G	U
Postemerge																					
DCPA (Dacthal)*	F-G	G	F	G	N	-	N	N	N	N	G	N	P	G	G	N	-	N	N	G	U
Napropamide (Devrinol)*	F	F	-	-	-	-	-	-	-	-	F	N	N	F	F	-	-	-	-	N	U
Sethoxydim (Poast)	G	G	G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N	N	N	U
Clethodim (Select)	G	G	G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N	N	N	U
Paraquat [4] (Gramoxone Extra)	-	F-G	F	G	F-G	F-G	F-G	F-G	G	G	F-G	F-G	F-G	G	F-G	F-G	F-G	F-G	F-G	F-G	U
Unregistered Products																					
None at this time																					

[4] Variable control is mostly related to weed size. Smaller weeds are more readily controlled.

* Rarely used by growers.

Weed species that are **bolded** indicate **key weeds** to control in **pepper production**

Historical Control Pattern: **1 =** Pre-Emerge**, 2 =** Post Emerge, **3** = No consistent control pattern

Efficacy: G = good, **F** = fair, **P** = poor, **N** = none, **-** = insufficient data

Beneficial insect impact: VL=very low, **L**=low, **M**=moderate, **D**=disruptive, **U**=unknown

Table 5. IPM tactics for weed management on peppers in Ohio.

Weeds	Annual grasses	Perennial grasses	Annual broadleaf	Perennial broadleaf	*Specific Weeds*
IPM tactics for weed management					
Pre-plant					
Practice weed seed exclusion tactics such as high pressure washing machinery shared between farms for weeds not already on farm.	S	S	S	S	Yellow nutsedge, triazine resistant lambsquarters
Buy certified seed and weed free soil mixtures; determine weed seed content of all seed and do not plant seed contaminated with weed seed not known to occur on your farm.	H	H	H	H	Check weeds in growers greenhouse
Use site free of perennials if possible.	NA	NA	NA	H	Quackgrass, Johnsongrass, Yellow nutsedge, or Canada thistle
Use a combination of fall/spring tillage and fall/spring application of a broad spectrum herbicide to control established perennials or rotate with a herbicide resistant crop on which a broad spectrum herbicide was used.	H	H	H	H	Perennials
Apply pre-plant herbicides to control seedling broadleaf weeds and annual grasses if necessary.	H	H	H	H	Broadleaf weeds and grasses
Use stale seedbed technique.	M	M	M	M	None
Use plastic mulch for weed control.	H	H	H	H	None
At-plant					
Apply pre-emerge herbicide after planting for control of annual grasses and broadleaf weeds.	M	M	M	M	Broadleaf weeds and grasses

* May not be practiced by grower.

Tactic effectiveness: S=slightly effective, **M**=moderately effective, **H**=highly effective

Table 5 (continued). IPM tactics for weed management on peppers in Ohio.

Weeds	Annual grasses	Perennial grasses	Annual broadleaf	Perennial broadleaf	*Specific Weeds*
IPM tactics for weed management					
In-season					
Control nearby weeds such as pokeweed, diseased perennials, tomatoes, cucumbers, squash, and melons that may harbor virus potentially vectored to crop by either aphids or thrips.	M	M	M	M	Pokeweed
Control Horsenettle for pepper maggot.	M	M	M	M	Horsenettle
Cultivate weeds if not using plastic.	S	S	S	S	None
Apply post emerge products, using directed or shielded sprays to control remaining weeds.	H	H	H	H	None
Update field weed maps, use to make treatment decisions next season.	H	H	H	H	None
Herbicide and crop history	H	H	H	H	None
Watch for weeds that are not common or are new to the field, consider adopting a zero threshold for these weeds and physically remove them in order to prevent seed production.*	H	H	H	H	None
Harvest					
None					None
Post-harvest					
Update field weed maps, use to make treatment decisions next season.	H	H	H	H	None
Know herbicide and crop history	H	H	H	H	None
Spot spray persistent perennial weeds.	H	H	H	H	Perennial weeds
Use a combination of tillage and cover crops to reduce weed populations in the following season.	H	H	H	H	None

* May not be practiced by grower.

Tactic effectiveness: S=slightly effective, **M**=moderately effective, **H**=highly effective

Table 6. Efficacy of insecticides used on peppers in Ohio.

Pest	CW	FB	Ap	ECB	FAW	CEW	HW	PM	Mi	SB	WF	BA	N	*Impact on beneficial organisms*
Importance of pest	P	O	M	V	M	M	O	P	P	M	M	P	O	
Currently manageable (Y / N / Partially)	Y	Y	Y	P	P	P	Y	Y	Y	Y	Y	Y	Y	
Historical insecticide use on Ohio farms	R	R	O	MS	O	O	O	R	R	O	O	R	R	
Organophospates														
Dibrom (naled)	-	√	√	-	-	-	-	-	F	-	-	-	-	M / D
dimethoate (Cygon)	-	-	G	-	-	-	-	√	(F)	-	-	-	-	D
Di-Syston (disulfoton)	-	-	G	-	-	-	-	-	-	-	-	-	-	M
malathion (Cythion)	-	-	F	-	-	-	-	√	-	-	-	-	-	L / M
Metasystox-R (oxydemetonmethyl)	-	-	G	-	-	-	-	-	(F)	-	-	-	-	M
Orthene (acephate)*	-	-	G	E	-	-	G	-	-	-	-	P	-	M / D
Carbamates														
Lannate (methomyl)	G	-	G	F	√	-	√	-	-	-	-	√	-	D
Sevin (carbaryl)	√	G	-	F	√	-	G	-	-	F	-	-	-	D
Vydate (oxamyl)	-	-	√	-	-	-	-	-	(G)	-	-	-	F	D
Organochlorines														
Kelthane (dicofol)	-	-	-	-	-	-	-	-	G	-	-	-	-	L / M
Thiodan (endosulfan)	-	G	G	-	-	-	G	√	-	-	√	-	-	M
Pyrethroids														
Ambush, Pounce (permethrin)	G	G	-	G	-	F	-	-	-	-	-	-	-	D
Asana (esfenvalerate)	-	G	-	F	-	G	-	-	-	-	-	P	-	D
Baythroid (cyfluthrin)	-	-	-	G	-	G	-	-	-	-	-	P	-	D
Capture (Bifenthrin)	G	G	-	G	(G)	G	(G)	-	F	-	√	-	-	D
Mustang (Zeta-cypermethrin)	G	G	-	G	-	F	-	-	-	√	-	-	-	D
Neonicitinoids														
Actara (Thiamethoxam)	-	G	G	-	-	-	-	-	-	G	G	-	-	L
Admire (imidacloprid)	-	F	G	-	-	-	-	-	-	-	G	-	-	L
Assail (Acetamiprid)	-	-	G	-	-	-	-	-	-	-	√	-	-	L
Platinum (Thiamethoxam)	-	G	G	-	-	-	-	-	-	-	√	-	-	L
Provado (imidacloprid)	-	-	G	-	-	-	-	-	-	-	√	-	-	L

***** Used exclusively for European corn borer.

Pests: **CW**=cutworms, **FB**=flea beetles, **Ap**=aphids, **ECB**=European corn borer, **FAW**=Fall armyworm, **CEW**=corn earworm, **HW** = hornworms, **PM**=pepper maggot, **Mi**=mites, **SB**=stink bugs, **WF**=whitefly, **BA**=beet armyworm, **N**=Nematodes
Historical Use: R=rare, **O**=occasional, **MS**=multiple sprays every year
Importance of pest: V= very, **M=**moderate, **O=** occasional, **P=** potential
Currently manageable: Y=yes, **N=**no, **P=**partially
Efficacy: The efficacy of these products can vary based on insect pressure: **E** = excellent, **G** = good, **F** = fair, **P** = poor, √ = pest listed on label but efficacy uncertain, **-** = pest **not** on label, **(rating)** = pest **not** on label but product known to provide some control
Beneficial insect impact: VL=very low, **L**=low, **M**=moderate, **D**=disruptive

Table 6 (continued). Efficacy of insecticides used on peppers in Ohio.

Pest	CW	FB	Ap	ECB	FAW	CEW	HW	PM	Mi	SB	WF	BA	N	*Impact on beneficial organisms*
Importance of pest	P	O	M	V	M	M	O	P	P	M	M	O	P	
Currently manageable (Y / N / Partially)	Y	Y	Y	P	P	P	Y	Y	Y	Y	Y	Y	P	
Historical insecticide use on Ohio farms	R	R	O	MS	O	O	R	R	R	O	O	R	R	
Miscellaneous Nerve Poisons														
Agri-Mek (abamectin)	-	-	-	-	-	-	-	-	G	-	-	-	-	L
Avaunt (Indoxacarb)	-	-	-	-	-	G	-	-	-	-	-	√	-	L
Fulfill (Pymetrozine)	-	-	G	-	-	-	-	-	-	-	√	-	-	L
pyrethrins (Pyronyl)	√	G	√	√	-	√	G	-	-	√	√	-	-	M
SpinTor (spinosad)	-	-	-	G	√	√	G	-	-	-	-	E	-	L
Insect Growth Regulators														
Confirm (tebufenozide)	√	-	-	G	√	-	G	-	-	-	-	E	-	L
neem (azadirachtin; Azatin)	√	-	-	-	-	-	G	-	-	√	√	-	-	M
Trigard (cyromazine)	-	-	-	-	-	-	-	-	-	-	-		-	L / M
Miscellaneous Insecticides														
Bacillus thuringiensis (B.t.)	F	-	-	F	F	F	G	-	-	-	-	F	-	VL
cryolite (Kryocide)	-	√	-	-	-	-	G	-	-	-	-	-	-	L
Mycotrol (*Beauveria*)	-	√	√	-	-	-	-	-	-	-	√	-	-	L
soap (M-Pede)	-	-	F	-	-	-	-	-	F	-	F	-	-	L
Pyrellin (pyrethrins + rotenone)	-	G	√	√	-	-	-	-	-	√	√	-	-	M / D
Thirethrin (endosulfan + pyrethrins)	-	√	G	-	-	-	G	√	-	-	√	-	-	M
Unregistered Products														
Warrior (Lambda cyhalothrin)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	P	NA	D

Pests: **CW**=cutworms, **FB**=flea beetles, **Ap**=aphids, **ECB**=European corn borer, **FAW**=Fall armyworm, **CEW**=corn earworm, **HW** = hornworms, **PM**=pepper maggot, **Mi**=spider mites, **SB**=stink bugs, **WF**=whitefly, **BA**=beet armyworm, **N** = nematodes

Historical Use: R=rare, **O**=occasional, **MS**=multiple sprays every year

Importance of pest: V= very, **M=**moderate, **O=** occasional, **P=** potential

Currently manageable: Y=yes, **N=**no, **P=**partially

Efficacy: The efficacy of these products can vary based on insect pressure: **E** = excellent, **G** = good, **F** = fair, **P** = poor, √ = pest listed on label but efficacy uncertain, **-** = pest **not** on label, **(rating)** = pest **not** on label but product known to provide some control, **NA**=unknown

Beneficial insect impact: VL=very low, **L**=low, **M**=moderate, **D**=disruptive

Table 7. IPM tactics for insects on peppers in Ohio.

Pests	CW	FB	Ap	ECB	FAW	CEW	HW	PM	Mi	Thr	SB	BA	WF
IPM tactics available													
Pre-plant													
Select hybrids well adapted for your growing area with good tolerance or resistance to viruses, such as CMV, TMV, TSWV.	NA	NA	H	NA	NA	NA	NA	NA	NA	H	NA	NA	NA
Select transplants grown in isolation from ornamental crops to avoid TSWV	NA	NA	NA	NA	NA	NA	NA	NA	NA	H	NA	NA	NA
Control of thrips in greenhouse essential to preventing TSWV	NA	NA	NA	NA	NA	NA	NA	NA	NA	H	NA	NA	NA
Target coverage on plant may be critical, systemic or contact insecticide	M	M	M	H	H	H	M	M	M	H	H	M	H
At-planting													
Apply soil insecticide to control various soil borne pests only if known to be a problem.	M	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
In-season													
Set up pheromone traps and check once or twice per week; if fruit are present begin protective sprays when trap catches begin to increase or until trap activity reaches the respective pest (ECB, FAW, CEW, BA) threshold.	NA	NA	NA	H	H	H	NA	NA	NA	NA	NA	M	NA
Scout for aphids and other misc. pests particularly in first half of season where ECB not a problem.	H	H	H	NA	NA	NA	H	H	H	S	H	NA	H
Use selective insecticides to conserve natural enemies.	S	S	H	S	S	S	H	S	H	S	S	S	S
Control Horsenettle for pepper maggot.	NA	NA	NA	NA	NA	NA	NA	NA	H	NA	NA	NA	NA
Have access to local trap network	NA	NA	NA	H	H	H	S	NA	NA	NA	NA	H	NA
Harvest													
None													
Post-harvest													
Plow down residue as soon as possible after harvest to reduce insect over wintering locations.	NA	M	NA	H	NA	NA	NA	NA	NA	NA	NA	NA	NA

Pests: **CW**=cutworms, **FB**=flea beetles, **Ap**=aphids, **ECB**=European corn borer, **FAW**=Fall armyworm, **CEW**=corn earworm, **HW**=hornworms, **PM**=pepper maggot, **Mi**=mites, **Thr**=thrips, **SB** = stink bugs, **WF** = whitefly

Tactic effectiveness: **S**=slightly effective, **M**=moderately effective, **H**=highly effective, **NA**=Not Applicable

Table 8. Pesticides available for greenhouse production of pepper seedlings.

Pests	FG	SF	Ap	LM	Mi	Thr	WF	Virus	DO	PM	BLS	Bo
Insecticides available												
Insects												
Azadirachtin	M	M	M	M	NA	M	M	S	NA	NA	NA	NA
Bacillus thuringiensis kurstaki	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bacillus thuringiensis aizawai	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bacillus thuringiensis israelensis	M	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beauveria bassiana	NA	NA	S	NA	NA	M	M	S	NA	NA	NA	NA
Cinnamaldehyde	NA	NA	M	NA	M	NA	NA	NA	NA	NA	NA	NA
Spray oil	NA	NA	S	S	M	S	M	S	NA	NA	NA	NA
Insecticidal soap	NA	NA	M	S	M	S	M	NA	NA	NA	NA	NA
Malathion	NA	NA	M	NA	M	M	NA	S	NA	NA	NA	NA
Neem oil	S	NA	M	NA	U	S	M	S	NA	NA	NA	NA
Pyrethrums & piperonyl butoxide	M	NA	M	NA	NA	M	M	S	NA	NA	NA	NA
Pyrethrum & rotenone	M	NA	M	NA	NA	M	M	S	NA	NA	NA	NA
Imidacloprid	M	U	H	H	NA	H	H	M	NA	NA	NA	NA
Diseases												
Microthiol Disperss	NA	NA	NA	NA	NA	NA	NA	NA	NL	M	NL	NL
Serenade	NA	NA	NA	NA	NA	NA	NA	NA	NL	U	P	U
Kaligreen	NA	NA	NA	NA	NA	NA	NA	NA	NL	M	NL	NL
SoilGard	NA	NA	NA	NA	NA	NA	NA	NA	M	NL	NL	NL
RootShield	NA	NA	NA	NA	NA	NA	NA	NA	M	NL	NL	NL
Mycostop	NA	NA	NA	NA	NA	NA	NA	NA	U	NL	NL	U
AQ10	NA	NA	NA	NA	NA	NA	NA	NA	NL	U	NL	NL

Pests: **FG**=fungus gnats, **SF**=shore flies, **Ap**=aphids, **LM**=leaf miners, **Mi**=mites, **Thr**=thrips, **WF** = whitefly, **Virus**=any of several plant viruses, **DO**=damping off, **PM**=Powdery mildew, **BLS**=Bacterial leaf spot, **Bo**=Botrytis.

Pesticide efficacy: P = Poor**, S**=slightly effective, **M**=moderately effective, **H**=highly effective, **NA**=Not Applicable, **NL**=Not Labeled, **U**=Unknown

Table 9. IPM tactics used in the greenhouse for pepper seedling production.

Pests	FG	SF	Ap	LM	Mi	Thr	WF	Virus	DO	PM	BLS	Bo
IPM tactics available												
Insects												
Use yellow sticky cards to monitor insects	H	H	H	H	NA	M	H	NA	NA	NA	NA	NA
Use blue sticky cards to monitor thrips	S	S	S	S	NA	H	S	NA	NA	NA	NA	NA
Use of indicator plants for insect presence	S	S	S	S	S	H	S	H	NA	NA	NA	NA
Plant inspection for insects	H	H	H	H	H	H	M	NA	NA	NA	NA	NA
Screen fans or intake areas	H	H	H	H	NA	S	H	NA	NA	NA	NA	NA
Destroy and remove unwanted or extra plants far from greenhouse	NA	NA	NA	NA	NA	H	NA	H	NA	NA	NA	NA
Biological control of pests	H	NA	H	H	H	H	H	NA	NA	NA	NA	NA
Weeds												
Remove and destroy unwanted plants or weeds from greenhouse	NA	NA	NA	NA	NA	M	NA	H	M	NA	NA	NA
Diseases												
Use indicator plants	NA	NA	NA	NA	NA	M	NA	H	S	NA	NA	NA
Plant inspection for diseases	NA	NA	NA	NA	NA	NA	NA	H	H	H	H	H
Remove and destroy unwanted plants or weeds from greenhouse	NA	NA	NA	NA	NA	M	NA	H	M	H	H	H
Do not grow seedlings near ornamental plants	NA	NA	NA	NA	NA	M	NA	H	S	NA	NA	H
Proper ventilation to maintain temperature and reduce free moisture	NA	NA	NA	NA	NA	NA	NA	NA	H	M	M	H
Use certified disease free seed	NA	NA	NA	NA	NA	NA	NA	M	H	NA	H	NA
Use fungicide treated seed	NA	NA	NA	NA	NA	NA	NA	NA	H	NA	NA	NA
Use hot water seed treatment	NA	NA	NA	NA	NA	NA	NA	M	H	NA	H	NA
Use clorox seed treatment	NA	NA	NA	NA	NA	NA	NA	M	H	NA	H	NA
Disinfect all flats, tools, benches, pots	NA	NA	NA	NA	NA	NA	NA	M	H	M	M	M
Do not irrigate with pond or surface water	NA	NA	NA	NA	NA	NA	NA	NA	H	NA	M	M

Pests: **FG**=fungus gnats, **SF**=shore flies, **Ap**=aphids, **LM**=leafminers, **Mi**=mites, **Thr**=thrips, **WF** = whitefly, **Virus**=any of several plant viruses, **DO**=damping off, **PM**=powdery mildew, **BLS**=bacterial leaf spot, **Bo**=Botrytis.

Tactic effectiveness: **S**=slightly effective, **M**=moderately effective, **H**=highly effective, **NA**=Not Applicable

Table 10. General time line for crop phenology and major worker activities for bell peppers in Ohio.