Parsley
Pest Management Strategic Plan
For Ohio

The Ohio State University
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TABLE OF CONTENTS

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Executive Summary

A meeting was convened at the Fisher Auditorium in Wooster, Ohio on November 14th, 2007 to discuss current pesticide and pest management issues facing the Ohio parsley industry. This meeting was especially critical due to the scheduled cancellation in 2012 of Guthion (azinphos-methyl), the main insecticide used to control the carrot weevil, the key pest in parsley. One urgent priority of the meeting was to recommend a search for alternatives to Guthion in the next four years. Meeting participants included representative fresh market parsley growers, regulatory members of the Environmental Protection Agency and the Ohio Department of Agriculture, The Ohio State University researchers, extension specialists, and an IR-4 NCR representative. The only interested parties not in attendance included the only grower of processed parsley in Ohio and a representative of Campbell Soup Company, the primary industrial consumer of all processed parsley. Since the grower could not attend the meeting, a telephone interview was conducted with the grower prior to the meeting to allow the grower to discuss any current pesticide, pest management, or production issues. These comments were shared with the PMSP group at the appropriate times during the overall discussion.

Lynnae Jess of the North Central IPM Center at Michigan State University facilitated the parsley PMSP meeting. The main agenda items were to assess the efficacy of the currently labeled pesticides and pest management recommendations, as well as to identify potential pipeline products either in research or IR-4 trials. At the end of the meeting, the top regulatory, educational, and research issues facing future production were discussed and recorded.

Throughout the day-long process, growers, regulatory officials, and researchers were actively engaged in discussions as the topics rotated from insect to disease to weed management and finally seed quality.

Background Information

Ohio currently ranks third in the nation for overall parsley production. Annual fresh market production for Ohio as of 2002 is 254 acres (National Ag Statistics Service). Parsley grown for processing adds 110 acres to the Ohio total and comprises nearly all the processed acreage in the nation. Although parsley is only a minor specialty crop in the state, it has come under scrutiny because Guthion (azinphos-methyl) is the primary insecticide used to control the carrot weevil, the key pest of parsley. This insect can cause major stand losses due to petiole and root injury. The status of Guthion has recently changed from being a 24c label on parsley in Ohio to a national label restricted to Ohio and New Jersey. Regardless of current label status, US EPA has mandated no further registrations of this material past 2012 at the latest. Guthion is an organophosphate insecticide, and many of the products in this class are not being re-registered because of criteria outlined in the Food Quality Protection Act.

Because of the eventual loss of the Guthion, it is critical that fresh market and processing growers, along with industry, Ohio State University vegetable specialists, and state regulatory officials take a proactive approach to preserving parsley production in Ohio. It was deemed critical to the future of parsley industry in Ohio to convene a PMSP meeting to discuss the effectiveness of current pesticides and non-chemical techniques while identifying alternative treatments.

General Production Information
The production information listed below was taken mostly from National Ag Statistics Service (NASS) during their 2002 Census on Agriculture and a grower survey conducted by Casey Hoy and Margaret Huelsman in 1998.
http://www.nass.usda.gov/census/census02/volume1/us/st99_2_029_029.pdf

Umbelliferae (*Petroselinum crispum*)
Acres in Ohio: 364 total, 254 acres fresh market, 110 acres processing
Percent of US Acreage/Rank: 6.9%/3rd fresh market, 100%/1st processing
Number of Growers: Eight fresh market, One processing
Per Acre Value: $8,500 - $9,000
Value of Production in Ohio: $3,104,000 - $3,276,000

Location Of Production
Ohio produces fresh market parsley in primarily three northeastern counties, Huron, Portage, and Stark, with processing parsley grown only in northwestern Henry County to supply Campbell Soup Company. Both fresh market and processing parsley acreages have slowly increased over the past few years.

Production Methods
Fresh market parsley is grown primarily on muck soils on the northeastern side of Ohio, while processing parsley is grown on mineral soils on the northwestern side of the state. In either case, parsley is direct seeded at rates up to 15 lbs per acre in beds as early as the middle of March through the end of May. Soils can range from 5.5 to 6.5 in pH, and are fertilized with 100-120 lbs per acre for N, P_2O_5, and K_2O. Plantings are staggered to allow for a continuous harvest.

Fresh market parsley is grown exclusively for its green leaves, or tops. The curled-leaf and Italian flat-leaf types are the most popular. For the earlier plantings, it takes approximately 65 days from seeding to first harvest. This period is shorter for later plantings. Once harvest begins, it can be repeated approximately every 30 days, for a total of 3-4 harvests per season per field. Parsley is hand harvested and cut 1.5-2 inches from ground level to allow re-growth.

Processing parsley is grown in much the same manner except the plants will be harvested for their juice, not leaves. There are fewer harvests because top growth and plant size is maximized for each harvest. There is minimal labor required for harvest in contrast with fresh market as the harvest process is mechanized.

Worker Activities

Workers can be employed in several aspects of parsley production such as field preparation, direct seeding, pesticide application, irrigation tasks, and multiple hand harvests.

Field preparation for direct seeding begins in early March and continues through mid May. Fertilizer is broadcast and disked in just prior to seeding; some farm operations shape beds for direct seeding. Direct seeding occurs from mid March through late May. Preemergent herbicides are applied soon after planting. The crop is monitored for carrot weevil damage from mid May through late June; if weevil populations are found over threshold, then insecticides are applied. Field cultivation and hand hoeing for weed control begin as early as May and continue through mid October. Fungicides or bactericides for management of fungal or bacterial diseases on parsley foliage are applied on an “as needed” basis; there are no prophylactic applications. Irrigation is applied as needed to the crop, but usually only after the first harvest. The earliest harvest begins at the end of May or first part of June, and will continue on a roughly 30 day schedule throughout the growing season. Postemergent herbicides are usually applied immediately after a harvest due to long post harvest intervals and short re-growth periods. The last harvest can extend into the middle or end of October. At the end of the season, fields are prepared for winter by planting a cover crop to slow soil erosion or are left with field residue intact. Field preparation begins again the following spring.

Primary Challenges to Parsley Production in Ohio

Fresh market and processed parsley represent two geographically distinct growing regions in Ohio, each with their own pest management challenges. In the northwestern part of the state where processed parsley is grown, weed and disease issues dominate production challenges, but in the northeastern part of the state where fresh market parsley is grown, insect, weed, disease, and seed quality problems all cause major production challenges.

The key pest of parsley is the carrot weevil, *Listronotus oregonensis* (LeConte), which is also a pest of carrots and celery. This species is known as a serious pest in the Great Lakes Region (Ohio, Michigan, Illinois, Ontario, Quebec, New York), and New Jersey, but is not reported to be a major pest in other areas of significant parsley production such as Florida and California. It has a congener, *Listronotus texanas* (Stockton), that attacks carrots and dill in Texas and Louisiana.

The overwintering female weevil lays eggs in the petioles of young plants. The larvae feed in the roots and crown, which causes weak growth, wilting, and death of plants. Parsley growers have reported losses due to carrot weevil at up to 100% in certain field locations. To prevent damage, growers use a combination of cultural and chemical control. Crop rotation is widely adopted as a cultural control. Some growers have experimented with the cultural control method of leaving parsley fields to overwinter as a trap crop, but they think that this tactic is not effective. Insecticide use has been effective if applied at the appropriate time before larvae infest the plants, which is typically in early June. Previous recommendations were for insecticide to be applied as soon as weevil activity was detected by trapping in the spring (Stevenson 1985, Boivin 1985, Ghidiu & VanVranken 1995), but more recent recommendations are to scout for weevil oviposition scars in early summer, and treat with insecticide if the 1% threshold is exceeded (Torres & Hoy 2002, 2005, Torres et al. 2002).

There are 24 insecticides labeled on parsley, but until January 2008 only azinphos-methyl (Guthion), an organophosphate insecticide, listed carrot weevil on the label, with geographical restriction to Ohio and New Jersey. Azinphos-methyl has been used for carrot weevil control in Ohio since its efficacy was documented by Simonet (1981). However, all labeled uses of Guthion are scheduled to be cancelled by September, 2012. The EPA approved the addition of carrot weevil as a target pest on the malathion label on January 16th, 2008. Although other insecticides can be used on parsley, their efficacy on carrot weevil is poor or unknown. With the phaseout of Guthion, there is a need to find a replacement or to request the geographically restricted use of Guthion be maintained beyond 2012.

Weed management in parsley is an issue that needs to be addressed and is complicated by very slow crop growth and lack of canopy closure. Cool-season annuals including foxtail, lambsquarters, and Pennsylvania smartweed grow much faster than parsley seedlings and must be well controlled from seeding onward to prevent large reductions in both stand and vigor of the crop. Fast-growing warm-season species including common purslane and prostrate pigweed may over-whelm the crop during establishment or following harvest when mechanical weed control is no longer possible. The prostrate growth habit of these species makes hand-weeding difficult, and purslane seedlings generally reestablish if not removed from the field. As a first line of defense, crop rotation and stale seedbed techniques should be used to reduce the soil weed seed bank but are not always practical to implement. Cultivation, herbicides and hand-weeding are integrated to control emergent weeds after planting; however, growers in Ohio and other Great Lakes states are forced to abandon significant acreages of parsley every year because of weeds.

In addition to insects and weeds, new diseases are being reported in parsley. Bacterial leaf spot occurred for the first time on parsley in Ohio in 2007 and resulted in significant loss on muck soil (Bruce Buurma, Buurma Farms; Richard Danhoff, Weirs Farms, personal communication). A *Xanthomonas* sp. was isolated from infected tissue and Koch's postulates were completed on parsley (Xu and Miller, unpublished). Related pathovars of *Xanthomonas* are known to be seedborne in their host, including coriander and carrot. As with other bacterial diseases, management is very difficult once disease develops in the field. Copper-containing bactericides are the only tool currently available to manage the disease at this stage, and they are only marginally effective. Prevention of seed transmission of bacterial pathogens is the most effective means of controlling bacterial diseases, but seed sanitation treatments such as hot water, Clorox, and dry heat have not been attempted for parsley. *Septoria* blight, caused by *Septoria petroselini*, is also a constant threat to parsley production since its introduction to northern Ohio on infested seed in the mid-1990s. The disease is managed entirely by application of a strobilurin fungicide (Quadris). Development of resistance to strobilurin fungicides in the *S. petroselini* population now endemic in this area is of concern due to lack of an effective fungicide labeled for *Septoria* on parsley that can be used in alternation with Quadris. However, to date Quadris failure has not been observed in parsley in Ohio.

Parsley seed quality is also important because it affects the uniformity and speed of crop establishment, along with subsequent cut parsley yield and quality. Parsley seeds are small (~ 250,000 seeds per pound) and can exhibit erratic and low germination patterns even under optimal field conditions. Seedling emergence is especially slow and uneven in the cold, wet soils of early spring. Variable seed quality among commercial parsley seed lots is often observed, resulting in irregular stands. This is exemplified by the fact that official seed testing protocols for parsley (10d and 28d for first and last germination counts, respectively) are greatly extended compared to protocols (usually 4-7d and 10-14d) for many other vegetable species (Int'l. Seed Testing Association, 1985). Damping-off pathogens such as *Pythium* spp. and *Rhizoctonia solani* also contribute to poor seedling emergence. These pathogens also contribute to root rot resulting in non-productive plants and reduced yield.

There are several non-chemical management tactics and many pesticides currently registered for pests in parsley, however, the efficacy, PHI, and REI of these products quickly reduce the number of real treatment options to a handful. There are some pesticide re-registrations that will provide greater utility to growers, but new pipeline products are needed to offer additional control options. Likewise, seed sanitation techniques using hot water, Clorox, and hydrochloric acid are accepted in small seeded vegetable crops to reduce seedborne diseases and may need to be implemented to control seedborne diseases. The use of a new commercially available fungicide seed treatment alone and combined with biological seed treatments may increase germination, seedling establishment, and disease control.

Outline of Strategic Plan

The remainder of this document lists the major pests in the categories of insects, diseases, and weeds. The role and efficacy of labeled and pipeline (identified but not yet available) pesticides currently used in parsley production are then listed for every named pest. In addition to the pesticide review, the use of other cultural or biological pest management options that offer some control will also be examined as potential replacements to conventional controls.

Top Priorities Identified by the Parsley Pest Management Strategic Plan Committee

Research priorities

1. Improve broadleaf weed control by evaluating new and pipeline pre- and postemergent materials, especially for purslane control during mid to late season.
2. Develop chemical and non-chemical carrot weevil control strategies that will be evaluated in both lab and field settings. Specifically these points were mentioned:
   - -find insecticide replacements for Guthion
   - -evaluate the efficacy of biologicals or entomopathogenic nematodes
   - -evaluate insecticide seed treatments & soil treatments to control carrot weevil larvae in roots
   - -find insecticides with extended activity to control weevil adults and reduce egg laying
3. Develop bacterial spot and *Septoria* leaf spot management protocols, which may include:
   - -seed sanitation (hot water, Clorox, HCL, dry heat, etc.), general seed testing, new biological and fungicidal seed treatments (Farmore), and foliar field applications
   - - evaluating the utility of Kasumin (antibiotic)
4. Develop seed treatments to reduce seed and seedling damping-off caused by *Rhizoctonia solani* and *Pythium* spp.:
   - - new biological and fungicidal materials (Apron, FarMore, *Bacillus* spp., etc.)
   - - efficacy of Kasumin
5. Evaluate parsley seed quality and seedling vigor, especially if exposed to seed sanitation treatments or seed treatments (biologicals or fungicides) outlined above.
6. Validate that carrot weevil dispersal behavior relies primarily on walking and not flying to reinfest fields in the spring, and that they overwinter primarily in woods or hedgerows adjacent to parsley fields.

Regulatory priorities

1. Seek shorter Restricted Entry Interval (REI) & Post Harvest Interval (PHI) for Lorox (Linuron).
2. Seek shorter Restricted Entry Interval (REI) & Post Harvest Interval (PHI) for Guthion (azinphos-methyl).
3. Institute seed testing protocols for bacterial leaf spot and *Septoria* leaf spot.
4. Seek approval for Apron and Farmore seed treatments for *Pythium* and *Rhizoctonia* damping off management.
5. Work with registrant (Chemnova/Loveland) to reduce Malathion PHI from 21 days to 2 days. (accomplished 1/28/2008)
6. Work with registrant (Chemnova/Loveland) to reduce Malathion REI from 7 days to 12 hours. (accomplished, 1/15/2008)
7. Seek approval for a rotation partner (Switch or Tilt) with Quadris to treat *Septoria* leaf spot for resistance management.

Extension priorities

1. Create outreach programs for growers based on the research priorities listed above, particularly the use of the carrot weevil scouting protocol to determine spray applications.
2. Conduct field days for growers to demonstrate advances in research and understanding of pest complexes at the annual Muck Crops field day.
3. Develop OSU fact sheets based on advances in research and understanding of parsley pest complex.
4. Conduct a workshop or several presentations on parsley research topics at the Ohio Produce Growers and Marketing Association annual meeting.
5. Write articles for the VegNet newsletter and post this information to the VegNet website.
6. Help growers locate current supply of Guthion for parsley in Ohio.

Insect Pests of Parsley

Green Peach Aphid (*Myzus persicae*)

Biology & Life Cycle: In the northern United States, green peach aphids overwinter as eggs. Winged aphids eventually disperse from their overwintering locations in the spring to other plant hosts during the growing season to begin new colonies. The reproductive capacity of green peach aphids has been described as "fantastic." Up to 30 generations per year may take place in this pest's southernmost range. Ladybugs, lacewings, syrphid flies, damsel bugs, wasps, and parasitic fungi tend to regulate green peach aphid populations outdoors. Rain, wind, and mud also help check aphid populations outside.

Distribution: The green peach aphid was first described in Europe in 1776. It is a pest all over the world. Green peach aphids have been collected from over 100 plants, including a wide variety of vegetable and ornamental crops. Spinach, potatoes, and peaches (the host on which eggs are laid) seem to be especially favored hosts. It is an occasional pest of peppers, eggplant, lettuce, and greens such as turnips, kale, and collards.

Damage: Aphids suck plant sap and contaminate the host with honeydew and cast skins. They are also the vectors of a number of plant viruses including tobacco, tomato, lettuce, dahlia, canna, and bee mosaics as well as tuber spindle, rugose mosaic, and leaf roll diseases of potato.

Importance: minor to none.

Non-Chemical Control: biological control agents / natural enemies.

Chemical Control: Sprays usually not used for this insect, even if present.

Organochlorine
None

Organophosphates
Malathion (Malathion 57EC, Loveland)
Rate = 1-2 pints / A
PHI = 2 days
REI = 12 hours
Efficacy = unknown, probably good

Carbamates
None

Pyrethroids

Zeta-cypermethrin (Mustang Max 0.8EC)
Rate = 2.24-4.3 oz / A
PHI = 1 day
REI = 12 hours
Efficacy = unknown, probably fair, depends on species

Permethrin (Permethrin 3.2EC)
Rate = 4-8 fl oz/A
PHI = 1 day
REI = 12 hours
Efficacy = unknown, probably fair

Neonicotinoids
Acetamiprid (Assail 30SG)
Rate = 1.8 – 4 oz / A
PHI = 7 days
REI = 12 hours
Efficacy = unknown, probably excellent

Dinotefuran (Venom 70SG)
Rate = 1-3 oz / A, limit 6 oz / A per season
PHI = 7 days
REI = 12 hours
Efficacy = unknown, probably excellent

Imidacloprid (Provado 1.6F)
Rate = 3.75 fl. oz / A
PHI = 7 days
REI = 12 hours
Efficacy = Excellent

Thiamethoxam (Actara 25WDG)
Rate = 1.5-3 oz/A
PHI = 0 days
REI = 12 hours
Efficacy = unknown, probably excellent

Insect Growth Regulators
None

Other Products
Flonicamid (Beleaf 50SG)
Rate = 1.2 – 2.8 oz/A.
PHI = 0 days
REI = 12 hours
Efficacy = unknown, probably excellent

Pymetrozine (Fulfill 50WDG)
Rate = 2.75 oz / A

PHI = 7 days
REI = 12 hours
Efficacy = unknown, probably excellent

Pipeline Products:
None

To Do List:
Research
None

Regulatory
None

Extension
Advise growers of new material for aphid control, Beleaf (flonicamid).

Aster leafhopper (*Macrosteles quadrilineatus*) and Potato leafhopper (*Empoasca fabae)*

Biology & Life Cycle: Leafhopper adults arrive on air currents from Southern states in the late spring. After eggs are deposited on hosts, nymphal stages are completed in about 2-3 weeks. This cycle continues until the first frost.

To acquire and transmit the aster yellow phytoplasma, aster leafhoppers (ALH) must feed for a prolonged period on an infected host (either locally or in a southern state). Next, the pathogen must incubate within the leafhopper for about 3 weeks before it can be transmitted to another plant. Because of the extensive incubation period, the disease is rarely spread from plant to plant within a commercial field. Thus, the primary method for transmission of aster yellows to a host is by the migrant adults already carrying the pathogen. Potato leafhopper (PLH) is not known to vector the phytoplasma.

Distribution: Aster leafhopper is a consistent problem for carrot growers in the upper Midwest and for lettuce growers in Ohio because the leafhoppers serve as a vector for the phytoplasma-like pathogen, however, it is not a major concern among Ohio parsley growers. The major source of ALH is the spring migration from the southern United States. Migration of ALH and PLH occurs via transport on northern jet streams created by high pressure systems developing east of the Mississippi, converging with low pressure systems from the western states.

Damage: Aster yellows symptoms include yellowing of younger leaves, progressing to red or purple discoloration, dwarfed and twisted petioles, and a dense growth of shoots. Primary susceptible vegetables that serve as hosts include: lettuce, celery, carrots, endive, and parsnip. Common weed hosts for aster yellows include: thistle, fleabane, wild lettuce, sow thistle, chicory, wild carrot, galinsoga, dandelion, plantain, cinquefoil and others. Overall, 150 species of plants in 40 different families have been recorded as hosts of aster yellows vectored by the ALH.

Importance: Minor to none on parsley, except parsley can act as reservoir of leafhoppers and aster yellows for lettuce; parsley is non symptomatic.

Non-Chemical Control: None.

Chemical Control: Several insecticides are registered for use in parsley on the leafhopper complex, but rarely are they used unless lettuce is nearby.

Organochlorine
None

Organophosphates
Malathion (Malathion 57EC, Loveland)
Rate = 1-2 pints / A
PHI = 2 days
REI = 12 hours
Efficacy = unknown, probably fair

Carbamates
Carbaryl (Sevin XLR)
Rate = 0.5-1 qts / A; limit 6 qts / A / season
PHI = 14 days
REI = 2 hours
Efficacy = unknown, probably good

Pyrethroids
Cyfluthrin (Baythroid 2EC)
Rate = 0.8-3.2 oz/A, limit 12.8 oz / A / season
PHI = 0 days
REI = 12 hrs
Efficacy = unknown, probably good

Permethrin (Permethrin 3.2EC, Pounce 3.2EC, Ambush 2EC)
Rate = 2.0-8.0 oz / A, cannot exceed 2.0 lbs ai/season (Permethrin 3.2EC)
Rate = 2.0-8.0 oz / A, cannot exceed 2.0 lbs ai/season (Pounce 3.2EC)
Rate = 6.4-12.8 oz/A, cannot exceed 2.0 lbs ai/season (Ambush 2EC)
PHI = 1 day
REI = 12 hours
Efficacy = unknown, probably good

Zeta-cypermethrin (Mustang Max 0.8EC)
Rate = 2.24-4.3 oz / A
PHI = 1 day
REI = 12 hours
Efficacy = unknown, probably good; used as an edge spray alone or in combination with Provado, especially if parsley is near lettuce field.

Neonicotinoids
Dinotefuran (Venom 70SG)
Rate = 1-3 oz / A, limit 6 oz / A per season
PHI = 7 days
REI = 12 hours
Efficacy = unknown, probably good

Thiamethoxam (Actara 25WDG)
Rate = 1.5-3 oz/A
PHI = 0 days
REI = 12 hours
Efficacy = unknown, probably good

Insect Growth Regulators
None

Other Products
None

Pipeline Products:
None

To Do List:
Research
None

Regulatory
None

Extension
None

Carrot Weevil, *Listronotus oregonensis* (LeConte)

Biology & Life Cycle:
Carrot weevil adults have functional wings but rarely fly. They walk from their overwintering sites to new parsley fields, or to any other host like carrot and celery. The adult weevils overwinter in or near parsley fields, particularly those with parsley left standing during the winter season. They spend the cold weather under plant residues, or about one inch below the soil surface around parsley plants. If the parsley field is plowed at the end of the crop season, and before the weevils have entered the resting or diapause stage, then the adults may be forced to walk away to overwinter in hedgerows or other sites nearby. They hide under plant debris, sod, or wood pieces.

In early spring, the surviving overwintering parsley plants resume vegetative growth at the same time that the overwintering adult weevils become active and seek host plants on which to feed and reproduce. If the overwintering parsley field can provide food and places to lay eggs in early spring, then the adult weevils do not need to walk away; if the overwintering parsley does not provide food, or if it is plowed in spring, then the weevils have to move away and any parsley field planted nearby can become infested.

Adult weevils are active in new parsley fields from approximately mid-May until the end of June, but the most activity occurs from late May until mid-June. At the end of August, a new population of adult weevils is present in the field, but the majority of this weevil population does not cause damage to the current year’s crop. These weevil adults overwinter and reproduce in the following crop season.

Adult weevils begin laying eggs when parsley plants have an average of four true leaves. Weevil females make punctures in the plant petioles and deposit an average of three eggs inside. They then cover the oviposition scars with a dark tar-like substance. The oviposition scar looks like a round dark spot, approximately 1 mm (1/25 inch) in diameter. The scar can be present anywhere in the petiole, but is most often in the concave side. The eggs are white or yellow during the first day, then they gradually darken to black when the larvae are ready to hatch, which is about five days after the eggs are laid. The oviposition period occurs from mid-May until the end of June, with the highest numbers of eggs per plant occurring in June.

The newly hatched larvae get to the crown and root to feed by moving down the petiole or dropping to the ground. Fully grown larvae stop feeding and leave the root to pupate in the surrounding soil. The larva makes an earthen cell in which to pupate. Once the pupal cell is made, the larva enters the prepupal stage and transforms to a pupa in two to seven days. During the pupal stage, the larva changes dramatically and transforms to an adult in about three to 14 days. Weevils remain inside the pupal cell for about one to five days before emerging from the soil surface.

Distribution: The Great Lakes Region (Ohio, Michigan, Illinois, Ontario, Quebec, New York), and New Jersey, but is not reported to be a major pest in other areas of significant parsley production such as Florida and California. In Ohio, carrot weevil is restricted to the northeastern part of the state. The carrot weevil has not been reported from the western side of state.

Damage: Eggs laid in stems hatch into larvae that can tunnel inside the petiole toward the root or drop to the soil then burrow into the root. Significant root loss or plant death can occur throughout the season and into September. Damage can vary by year, but it is usually moderate to severe. Damage of up to 100% can be seen in fields nearly surrounded by water, which causes many growers to suspect that the adults can fly short distances over ditches. Mild winters tend to increase damage, with more adults surviving through to spring to attack new plantings. There appears to be no cultivar preference, all cultivars are attacked equally. Damage tends to be much higher in muck soils on the eastern side of Ohio where fresh market parsley is grown, compared to mineral soils on the western side of the state where the processing crop is grown. Adults are very long lived and can survive adverse weather conditions. Adult weevils in need of food will walk to neighboring fields; new parsley fields farther away tend to be safer from invasion.

Importance: Carrot weevil is the number one pest of parsley!

Non-Chemical Control:
-Locate fields away from areas surrounded by woodlots, forest, or successional areas to reduce the number of overwintering locations for adult weevils.

- Parsley fields are on a three or five year rotation, with a conscious effort to locate newly planted fields away from previous parsley or carrot fields.

-Growers attempt to block areas (fields) to plant parsley and carrots; this makes the crop rotation component easier to manage.

- Leave fields unplowed over the winter, plow in spring/early summer after oviposition. Need residue from dying parsley plants for erosion control.

-Remove winter annual weeds from field, e.g., chickweed and henbit which can provide cover and act as a reservoir for overwintering carrot weevil adults.

-Traps of various designs have been used by growers to monitor the arrival of carrot weevil adults in carrot fields in the spring, but researchers and growers have found the traps to be ineffective for parsley management. For parsley, scouting is a more reliable monitoring tool than trapping.

- There is some biological control of early carrot weevil larvae from generalist predators.

-Nematodes applied foliarly have reduced larvae up to 50% compared to control plots, however, this may not be a cost effective application. Management of soil may increase native nematode populations.

-Only a few parasitoids have been seen in 1000's of adult weevils, making their impact on biological control of the adults virtually non-existent.

- Growers report seeing the carrot weevil fly, e.g., from the top of parsley foliage in the fall, which is something the carrot weevil does rarely, as reported in the scientific literature.

Chemical Control:
Initially, growers tried to spray only the field edge to control invading carrot weevil. This strategy works for carrots but not parsley, as they would see weevils showing up in middle of field at the same time as edges. Consequently, whole fields are being treated for weevil.

The only labeled insecticide for carrot weevil on parsley in Ohio was Guthion. Guthion is scheduled to have this use removed in September, 2012. In January, 2008, the Malathion 57EC label (Loveland) was amended to include carrot weevil on the list of target pests.

Organochlorine
None

Organophosphates
Azinphos-methyl (Guthion 50WP)
Rate = 1.0 lb / A; 1.25 lb ai / A / season in ’08, ’09, ’10; 1.0 lb ai / A / season in ’11, ‘12
PHI = 7 days
REI = 30 days
Efficacy = excellent but dependent on timing, up to 100% control (no unsprayed check)

Malathion (Malathion 57EC, Loveland)
Rate = 1-2 pints/A
PHI = 2 days
REI = 12 hours
Efficacy = Fair to good, based on lab bioassays in late 2007

Carbamates
Thiodicarb (Larvin 3.2F)
Rate = 16-30 fl oz/A; 60 oz/A/season
PHI = 7 days
REI = 48 hours
Efficacy (note, carrot weevil not a target pest) = poor, based on lab bioassays in late 2007

Methomyl (Lannate LV)
Rate = 1.5-3 pt/A; 8 applications / crop
PHI = 10 days
REI = 48 hours
Efficacy (note, carrot weevil not a target pest) = Good, based on 2 lab bioassays late 2007
Comment: No growers have used this product in the field, limited data from a previous study shows product efficacy is inconsistent.

Pyrethroids
Permethrin (Permethrin 3.2EC)
Rate = 4-8 fl oz/A

PHI = 1 day
REI = 12 hours
Efficacy = (note, carrot weevil not a target pest), unknown, probably fair

Zeta-cypermethrin (Mustang Max 0.8EC)
Rate = 2.24-4.3 fl oz / A
PHI = 1 day
REI = 12 hours
Efficacy (note, carrot weevil not a target pest) = fair
Comment: Fresh market growers don't use this product; it only stuns the adult weevils but does not kill them. Growers consider using this product to flush weevils out for scouting purposes. One processing grower uses this product for moth control, most likely the celery leaftier.

Cyfluthrin (Baythroid 2EC)
Rate = 0.8 – 3.2 fl. oz/A; limit 4 applications/season
PHI = 0
REI = 12 hours
Efficacy (note, carrot weevil not a target pest) = fair
Comment: Fresh market growers don't use this product; it only stuns the adult weevils but does not kill them. Growers consider using this product to flush weevils out for scouting purposes.

Neonicotinoid
Dinotefuran (Venom 70SG)
Rate = 1.0 – 3.0 fl. oz/A
PHI = 7 days
REI = 12 hours
Efficacy (note, carrot weevil not a target pest), poor to fair

Acetamiprid (Assail 30SG)
Rate = 1.8-4.0 oz/A
PHI = 7 days
REI = 12 hours
Efficacy (note, carrot weevil not a target pest) = poor to fair

Thiamethoxam (Actara 25WDG)
Rate = 1.5-5.5 oz/A; 11 oz max / season
PHI = 7 days
REI = 12 hours
Efficacy (note, carrot weevil not a target pest) = poor to fair

Imidacloprid (Provado 1.6F)
Rate = 3.75 fl oz/A
PHI = 7 days
REI = 12 hours
Efficacy (note, carrot weevil not a target pest) = poor to fair

Insect Growth Regulators

None

Other Products
Spinetoram (Radiant 1SC)
Rate = 5-10 fl oz/A; No more than 6 applications or 34 oz / season
PHI = 1 day
REI = 4 hrs
Efficacy (note, carrot weevil not a target pest on the label) = Very good in lab bioassay late in 2007.
Comments: Spintor is being phased out and replaced by Radiant (grower comment). Because of the new registration (September 2007), it has not been used by growers yet. Resistance management guidelines need to be observed, 2 applications then rotate to another mode of action.

Indoxacarb (Avaunt 30WG)
Rate: 2.5 – 6.0 oz/A; 24 oz max per season
PHI: 3 days
REI: 12 hours
Efficacy (note, carrot weevil not a target pest on the label): Very good in lab bioassay in late 2007

Beauveria bassiana (Mycotrol O)
Rate: ¼ to 3 qt/A
PHI: 0 days
REI: 4 hours
Efficacy: unknown (used for control of strawberry root weevil, pepper weevil)

*Steinernema riobrave (*BioVector)
Rate: 1 billion nematodes/A
PHI: unknown
REI: unknown
Efficacy: unknown

Pipeline Products:
IR-4 - Fipronil trials are now on hold due to possible water contamination concerns and worker exposure.

Thiocyclam (Evisect, from Arysta)
Etofenprox (Trebon, from Advan)
Metaflumizone (Alverde, from BASF)
Tolfenpyrad (Hachi, from Nichino)

To Do List:
Research
-The use of halofenozide or other materials that control insects like black vine weevil. We recognize there are no use labels for these products on food crops currently.

-The use of Capture (bifenthrin) for control as a contact spray, not systemic, prior to larvae tunneling inside petiole.

-The use of imidacloprid and thiamethoxam as soil application or seed treatment for systemic control of larvae, although previous studies did not show favorable control of adult weevils.

-The use of oxamyl (Vydate) for soil or foliar application for systemic control of larvae. Vydate is registered for carrot weevil control on carrots (federal label) and on celery (federal label but geographically restricted to FL, OH, PA, MI, TX) as a soil directed spray application.

-The use of phorate (Thimet) for soil or foliar application for systemic control of larvae. Thimet is a systemic that is registered for soil use on beans, potatoes, sweet corn, sugar beets, Other old organophosphates that could also be tested for soil use are ethoprop (Mocap) and tebufos (Counter), but these are likely to be similar to Guthion in their lack of support from EPA.

-Try to find insecticides that work on both larvae and adults.

-Verify that carrot weevils move mostly by walking; investigate flying aspect reported by one grower. This effort may be linked to verification that weevils seen flying by grower are in fact carrot weevil and not another species. Specimens will be sent to USDA/Beltsville for proper identification. We have every reason to believe that these weevils are the carrot weevil, but verification of species would be helpful.

-Determine the impact of weather on population size such as dry versus wet, during the spring or summer.

-It was mentioned that worker and ecological risk associated with Guthion is based on data collected from airblast sprayers on apples. Should this be recalculated for parsley?

-Determine actual worker risk and exposure through studies specifically targeting parsley.

-Field buffer (non parsley crop) set backs may be an issue, provide a reservoir for weevils to infest crop field.

Regulatory
-Re-examine fipronil for use on carrot weevil.
-International markets of parsley not an issue at this point, not trade concerns at this time.

Extension
-Remind growers of carrot weevil fact sheet and encourage them to use the scouting protocol developed by OSU entomologists. Factsheet is available both hard copy and online (**An Integrated Pest Management Program for Carrot Weevil in Parsley**. CV-1001-02. http://ohioline.osu.edu/cv-fact/1001.html).

Caterpillar Complex (armyworm, green cloverworm, variegated cutworm, webworms, loopers, celery leaftier, parsleyworm)

Biology & Life Cycle: These insects all have four life stages; egg, larva (caterpillar), pupa, and adult (moth for all except parsleyworm, which is a butterfly). The green cloverworm is the only species that migrates up from southern states every spring; the other species overwinter in Ohio or neighboring states. Female moths lay their eggs on host plants. Eggs hatch into caterpillars, which can feed on the plant. After completing their final larval stage, they will become pupae, and eventually emerge as adult moths or butterflies. There can be several generations per year.

Distribution: All of these caterpillars can be found throughout Ohio and much of the Midwest and beyond.

Damage: The larvae of these species are caterpillars that can cause feeding injury to the leaves or petioles of the parsley plant. The celery leaftier also rolls up and “ties” the leaves together for shelter.

Importance: Minor to none in fresh market parsley, can be a problem occasionally for processing parsley.

Non-Chemical Control: Pheromone traps could be used to monitor some of the moth populations as a trigger for field scouting for larvae, however, infestation from any of these insects is very sporadic in both fresh market and processing fields.

Chemical Control: There are several products and insecticide classes to choose from. Mustang Max was one product mentioned specifically by the processing grower.

Organochlorine
None

Organophosphates
Malathion (Malathion 57EC, Loveland)
Species = Cabbageworm, Cabbage looper
Rate = 1-2 pints/A
PHI = 2 days
REI = 12 hours
Efficacy = unknown, probably fair

Carbamates
Carbaryl (Sevin)
Species = Armyworm, Imported cabbageworm
Rate = 1-2 qts / A, 6 qts / A / season limit
PHI = 14 days
REI = 12 hours
Efficacy = unknown, probably good

Methomyl (Lannate LV)
Species = Imported cabbageworm, Cabbage looper
Rate = 1.5 pints/A, limit 8 applications / season; limit 12 pints / A / season
PHI = 10 days
REI = 48 hours
Efficacy = unknown, probably good

Thiodicarb (Larvin 3.2F)
Species = Cabbage looper, Armyworm
Rate = 16-30 fl. oz / A; limit 60 oz / A / Season
PHI = 14 days
REI = 48 hours
Efficacy = unknown, probably good

Pyrethroids
Cyfluthrin (Baythroid 2EC)
Species = Armyworm, Green cloverworm, Variegated Cutworms, Loopers
Rate = 0.8-3.2 oz/A; limit 4 applications / season; limit 12.8 oz / A / season
PHI = 0 days
REI = 12 hours
Efficacy = unknown, probably good

Permethrin (Permethrin 3.2EC, Pounce 3.2EC, Ambush 2EC)
Species = Armyworm, Green cloverworm, Loopers, Cutworms
Rate = 2.0-8.0 oz / A, cannot exceed 2.0 lbs ai/season (Permethrin 3.2EC)
Rate = 2.0-8.0 oz / A, cannot exceed 2.0 lbs ai/season (Pounce 3.2EC)
Rate = 6.4-12.8 oz/A, cannot exceed 2.0 lbs ai/season (Ambush 2EC)
PHI = 1 day
REI = 12 hours
Efficacy = unknown, probably good

Zeta-cypermethrin (Mustang Max 0.8EC)
Species = Armyworm, Green cloverworm, Loopers, Cutworms
Rate = 2.24-4.0 oz / A; limit 0.15 ai / A / season
PHI = 1 day
REI = 12 hours
Efficacy = good to fair, used by both fresh market and processing growers

Neonicotinoids
None

Insect Growth Regulators
Methoxyfenozide (Intrepid)
Rate = 4-10 oz/A
PHI = 1 day
REI = 4 hours
Efficacy = unknown, probably good

Other Products

Bacillus thuringiensis (Agree, Biobit, CryMax, DiPel, Javelin, XenTari)
Rate = 0.25-2.0 lbs / A (vary by product)
PHI = 0 days
REI = 4 hours
Efficacy = fair to good on small larvae, poorer on large larvae

Emamectin benzoate (Proclaim)
Species = Armyworm, Cabbage Looper
Rate = 2.4-4.8 oz/A; limit 28.8 oz / A / season
PHI = 7 days
REI = 48 hours
Efficacy = unknown, probably good

Spinosad (Spintor)
Species = Cabbage looper, Imported cabbage worm, Armyworm
Rate = 3-8 oz / A; limit 29 oz / A / season
PHI = 1 day
REI = 4 hours
Efficacy = unknown, probably good on small larvae, fair on large larvae

Pipeline Products:
None

To Do List:
Research
None

Regulatory
None

Extension
None

Flea beetles (a complex of Potato flea beetle, Eggplant flea beetle, Pale-striped flea beetle, Spinach flea beetle, etc.)

Biology & Life Cycle: In general, these insects share a common biology and life cycle. The adult beetle typically overwinters and emerges in the spring to damage early planted crops. There are four stages of development: egg, larva, pupa, and adult. There can be several generations per year.

Distribution: These beetles are common throughout Ohio and the Midwest.

Damage: The adult beetle causes the majority of injury by chewing very small holes in the leaves of the parsley plant. Larvae in soil are not known to cause significant injury.

Importance: Minor insect pests; uncommon on parsley.

Non-Chemical Control: None

Chemical Control: Several options exist for controlling the flea beetle complex.

Organochlorine
None

Organophosphates
None

Carbamates
Carbaryl (Sevin)
Rate = 0.5-1 qts / A; limit 6 qts / A / season
PHI = 14 days
REI = 12 hours
Efficacy = unknown, probably good

Pyrethroids
Cyfluthrin (Baythroid 2EC)
Rate = 2.4-3.2 fl. oz/A; limit 4 applications / season; limit 12.8 oz / A / season
PHI = 0 days
REI = 12 hours
Efficacy = unknown, probably good

Zeta-cypermethrin (Mustang Max 0.8EC)
Rate = 2.24-4.3 oz / A; limit 0.15 ai oz / A / season
PHI = 0 days
REI = 12 hours
Efficacy = unknown, probably good

Neonicotinoids

None

Insect Growth Regulators
None

Other Products
None

Pipeline Products:
None

To Do List:
Research
None

Regulatory
None

Extension
None

Plant bugs (Tarnished plant bug, Fourlined plant bug, others)

Biology & Life Cycle: Like all Hemiptera, plant bugs go through simple metamorphosis with egg, nymph, and adult stages. Females of most species use a knife-like ovipositor to insert eggs into plant stems or leaves. After hatching, the wingless nymphs (which resemble small, wingless adults) molt several times before becoming full-sized, winged adults. The adults will often mate and reproduce numerous times during late spring, summer, and early fall. Large nymphs or adults are usually the overwintering stage.

Distribution: Many species of plant bugs are found throughout Ohio, the North Central region, and beyond.

Damage: Plant bugs are a large, diverse family of insects that typically feed on plant parts with high rates of cell division, including buds and flowers. They feed by sucking sap from plants. They are believed to inject a toxic substance (possibly digestive enzymes) into the plant when feeding to break down plant tissues. Due to their feeding preference on buds, flowers, young developing fruit, or plant terminals, these bugs can cause economically important damage at relatively low densities.

Importance: Minor to none on parsley.

Non-Chemical Control: Weed management influences tarnished plant bug management, and possibly other plant bug populations. Preventing weeds from forming young buds and flowers will keep populations lower in the weedy areas. Once weeds flower and the tarnished plant bugs colonize them, the bugs will tend to remain in the weeds unless the weeds start to senesce, dry, or are mowed.

There are biocontrols that are being investigated to help reduce populations in these weedy areas, or along roadsides. Once the adults move into a crop, the type of management depends on the crop growth stage. When plants are vegetative, low densities can be tolerated. As plants begin to set buds, chemical controls may be needed. However, chemicals will have no effect on the egg stage inside of the plant tissue.

Chemical Control: Two insecticide options are listed below, though growers rarely if ever attempt to control this pest.

Organochlorine
None

Organophosphates
None

Carbamates
Carbaryl (Sevin)
Rate = 1-2 qts / A; limit of 6 qts / A / season
PHI = 14 days
REI = 12 hours

Efficacy = unknown, probably fair

Pyrethroids
Cyfluthrin (Baythroid 2EC)
Rate = 2.24-3.2 fl. oz/A; limit 4 applications / season; limit 12.8 oz / A / season
PHI = 0 days
REI = 12 hours
Efficacy = unknown, probably excellent

Zeta-cypermethrin (Mustang Max 0.8EC)
Species = Lygus bugs
Rate = 2.24-4.0 oz / A; limit 0.15 ai / A / season
PHI = 1 day
REI = 12 hours
Efficacy = unknown, probably excellent

Neonicotinoids
None

Insect Growth Regulators
None

Other Products
None

Pipeline Products:
None

To Do List:
Research:
None

Regulatory:
None

Extension:
None

Diseases of Parsley

Pythium Damping Off

Biology & Life Cycle: *Pythium* damping-off can be caused by several species of *Pythium*. Pre-emergence damping-off, seed decays, and root rots can be caused by this group of oomycete pathogens. *Pythium* rots can occur at any stage of plant development but are more prevalent on seedlings than older plants. Diseases caused by *Pythium* can occur over a wide range of temperatures, but those caused by *P. ultimum* and related spp. are most common during cold periods (below 55 degrees F) with high soil moisture.

Seedlings infected with *Pythium* often fail to emerge. Stems of infected seedlings appear water-soaked and translucent above the soil line. Diseased areas later turn brown and appear shrunken; eventually, the stem and smaller roots decay and the seedlings die. Cortical root tissue may appear soft and brown, and can be easily pulled from the vascular tissue, leaving a thin thread known as a “rat-tail”.

Pythium species survive also as oospores. During periods of high soil moisture, the resting spore germinates and infects seeds or young plants directly or through release of motile, infective zoospores. Germinating seeds release nutrients or by-products that can stimulate growth and attract zoospores of the pathogen.

Distribution: Widespread.

Damage: This seedling disease thins the stand, reduces yield, and results in bare patches in the rows of parsley, allowing weeds to establish, further reducing yield.

Importance: Very significant, usually in the spring.

Non-Chemical Control: Avoiding low spots and wet areas and using raised beds is helpful.

Chemical Control: Only one product is currently available to be applied in-furrow at planting.

Mefenoxam (Ridomil Gold)
Rate = 1-2 pts/A
PHI = 21 days
REI = 48 hours
Efficacy = unknown
Not being used in this crop
Expensive to use, foliar application

Pipeline Products:
The use of Ranman to control *Pythium* needs to be investigated, including other promising labeled and research compounds.

Thiram is not currently labeled as a seed treatment for parsley but has shown efficacy in reducing damping-off in numerous studies, some of which included parsley.

To Do List:
Research
-Parsley seed quality, germination and seedling vigor directly in response to *Pythium* spp. may need to be documented.
-Ranman, Thiram or other *Pythium* products need to be investigated for efficacy.
-Explore seed treatment options for *Pythium* spp. such as Apron and Thiram.

Regulatory
None

Extension
None

Rhizoctonia Damping Off

Biology & Life Cycle: Vegetable seedlings are often attacked by *Rhizoctonia solani*, a soilborne fungus capable of causing root, stem, and crown rots, particularly during hot, humid weather. *R. solani* can survive for many years by producing small (1 to 3-mm diameter), irregularly-shaped, brown to black structures (called sclerotia) in soil and on plant tissue. *R. solani* also survives as mycelium by colonizing soil organic matter as a saprophyte, particularly as a result of plant pathogenic activity. Sclerotia and/or mycelium present in soil and/or on plant tissue germinate to produce vegetative threads (hyphae) of the fungus that can attack a wide range of food and fiber crops.

The fungus is attracted to the plant by chemical stimulants released by actively growing plant cells and/or decomposing plant residues. As the attraction process proceeds, the fungal hypha come in contact with the plant and become attached to its external surface. After attachment, the fungus continues to grow on the external surface of the plant and causes disease by producing a specialized infection structure (either an appresorium or infection cushion) that penetrates the plant cell and releases nutrients for continued fungal growth and development. The infection process is promoted by the production of many different extracellular enzymes that degrade various components of plant cell walls (e.g. cellulose, cutin and pectin). As the fungus kills the plant cells, the hyphae continue to grow and colonize dead tissue, often forming sclerotia. New inoculum is produced on or in host tissue, and a new cycle is repeated when new substrates become available.

Distribution: This soil borne pathogen is prevalent across the state.

Damage: *Rhizoctonia* damage may occur at any time during the growing season, but is especially prevalent under hot and moist environmental conditions on young seedlings. *Rhizoctonia solani* can cause seed and seedling rot and root rot. Damping-off occurs when germinating seedlings are infected prior to or just after emergence. Diseased older plants become chlorotic, resembling plants with nitrogen deficiency. Disease losses result from stand reduction and premature death of diseased plants.

Importance: generally low-moderate importance in parsley in Ohio.

Non-Chemical Control: Avoidance and rotation are the two best strategies, though once a field is infested, the sclerotia can survive for many years.

Chemical Control: One product is available as a seed treatment.

Fludioxonil (Maxim 4 FS)
Rate = 0.08-0.16 fl. oz/100 lbs seed
PHI = Days to harvest
REI = 12 hours
Efficacy = unknown
Labeled for use on parsley, but may not be available commercially as a seed treatment.

Pipeline Products:
FarMore seed treatment (disease only), not currently labeled for parsley.

To Do List:
Research
Evaluate FarMore seed treatment against *Rhizoctonia*.
Evaluate other seed and soil treatments if they become available against *Rhizoctonia*.

Regulatory
None

Extension
Differentiate the disease symptoms and environmental conditions conducive to *Rhizoctonia* and differentiate them from *Pythium* in an OSU fact sheet.

Septoria Leaf Spot

Biology & Life Cycle: *Septoria* leaf spot is caused by *Septoria petroselini*, which is a seedborne pathogen that causes spots on parsley foliage (leaves and petioles). *Septoria petroselini* lives between crops in the soil on infested debris but can survive inside or on seeds as well. Spores formed on crop debris splash onto foliage and start the disease. Diseased parsley leaves and petioles remaining in the field after cutting serve as a source of inoculum for subsequently produced foliage. Wind and rain spread spores produced in the dark bodies formed in leaf spots to adjacent uninfected leaves.

Initially the fungus causes small, water-soaked, roughly circular spots scattered randomly over the leaf. These spots enlarge to become l/l6 to l/8 inch in diameter with dark margins and tan centers. Small, dark, circular fruiting bodies in which spores of the fungus are produced can be seen in the center of the lesions. Older leaves near the ground usually show symptoms first. Symptoms appear rapidly on younger foliage in rainy weather. When leaves are heavily infected, they drop prematurely.

Distribution: Across the state and throughout the region.

Damage: The disease causes rapid defoliation when weather is warm and moist, especially after a rainstorm. Although the symptoms may appear on the leaves and stems at any stage of plant development, they usually become evident after the first cutting, in mid-July. The fungus is most active between 60 and 80 degrees F when rainfall is abundant.

Importance: Can be a major concern.

Non-Chemical Control: Rid field of excess plant material to limit inoculum. Use seed at least two years old, since the viability of seedborne *Septoria* is very low after this much time.

Chemical Control: One product available.
Azoxystrobin (Quadris)
Rate = 6.2-15.4 oz / A; maximum 93 oz / A / season; limit 6 applications / season
PHI = 0
REI = 4 hours
Efficacy = very good to excellent
Notes = Only spray for this disease when symptoms appear, not used preventatively. Because of resistance guidelines, rotation with another effective compound outside of this group is necessary, but there are currently none labeled for parsley. Growers have used copper-based fungicides to treat this disease in the past, but it is minimally effective.
Max 6 applications, usually beginning in July.

Pipeline Products:
None

To Do List:

Research
-Evaluate other products to rotate with Quadris for resistance management.
-Evaluate Farmore seed treatment.
-Evaluate PCNB (pentachloronitrobenzene) as a seed and soil treatment.

Regulatory
-Pursue possible section 18 for Tilt (propiconazole) or Switch (Cyprodinil).
-Set up a mandatory seed testing program for this pathogen.

Extension
-None

Bacterial leaf spot (*Xanthomonas sp.*)

Biology & Life Cycle: Bacterial spot is caused by a bacterium, *Xanthomonas* sp. Little is known about the species attacking parsley, but other *Xanthomonas* pathogens are known to overwinter in crop residue in or on soil, on or in seeds, and on wild host plants. Seeds infested with the pathogen are a major source of inoculum for bacterial spot as well as the major means of long distance spread of the pathogen. Xanthomonads are not able to survive free in soil for a long time, but can survive up to 6 months in infected crop debris in soil. The bacterium penetrates leaves through stomata and/or wounds, and fruits through wounds created by wind-driven sand, insect punctures, or mechanical injury. Dissemination of the bacterium occurs between and within fields by water-splashing, aerosols, or during cultivating, hoeing, thinning of direct seeded plants, transplanting, or harvesting.

Distribution: The pathogen's prevalence may be seed lot dependent, and outbreaks have been sporadic in Celeryville, Ohio.

Damage: Characteristic bacterial spot symptoms can appear on the leaves and petioles. On leaves, symptoms begin as small, yellow-green circular lesions surrounded by a yellowish halo. These spots appear water-soaked under wet conditions.

Importance: Can be as devastating as the carrot weevil, perhaps more; presence on parsley seems to be on the increase.

Non-Chemical Control: A range of non-chemical options exist from crop rotation, to seed sanitation techniques (Clorox, hot water, etc.), to using fine tips on irrigation equipment to reduce damage to plants, to gentle cultivation to lessen plant injury, and lastly the removal of crop residue created by cultivation or mowing which many contribute to the spread of the disease.

Chemical Control: One family of products (fixed copper) is available for control.

Copper Hydroxide (Kocide 3000)
Rate = 1.25 lbs / A
PHI = 0 days
REI = 24 hours
Efficacy = Poor to fair
Notes = Growers use readily, tips can plug

Pipeline Products:
Kasumin (antibiotic) has not been requested as an IR-4 pipeline material at this time for parsley or any other food crop.

To Do List:
Research
-Evaluate antibiotic seed treatments such as Kasugamycin.
-Evaluate seed sanitation techniques such as hot water, Clorox, dry heat, etc.
-Identify where bacteria reside on the seed, possibly the seed coat?

-Evaluate the efficacy of other bactericidal products.

Regulatory
-Establish seed testing requirements

Extension
-None

Weeds of Parsley

Annual Grasses (Barnyard, Crab, Green foxtail, Yellow foxtail, Volunteer cereal rye)

Biology & Life Cycle: Seeds germinate in spring and the plant grows vegetatively during spring/summer. Flowers and seeds are set in mid to late summer; the plant dies in the fall.

Distribution: Across state and region.

Damage: Infestations can be severe.

Importance: The prominence of these weeds is field specific, but crabgrass may be the most difficult weed of the bunch to control. Weed residue can cause problems at harvest time, if leaves and stems intertwine with and contaminate the crop.

Non-Chemical Control: Cultivation, hand hoeing, difficult to control using these tactics alone.

Preemerge Chemical Control:
Lorox (Linuron)
Rate = 1 lb / A; Max 3 lbs / A / season
PHI = 30 days
REI = 24 hours
Efficacy = poor
Notes = Not used by growers

Prefar (Bensulide) mineral soil only
Rate = 5-6 qts/A, max 6 lbs ai / A / season
PHI = Days to harvest
REI = 12 hours
Efficacy = good

Postemerge Chemical Control (Muck Soils Only):
Lorox (Linuron)
Rate = 1 lb / A; Max 3 lbs / A / season
PHI = 30 days
REI = 24 hours
Efficacy = poor
Notes = Not used by growers

Postemerge Chemical Control:
Poast (Sethoxydim)
Rate = 1.5 pts / A; max 3 pts / A / season
PHI = 15 days
REI = 12 hours

Efficacy = good if weeds are small

Select (Clethodim) + COC
Rate = 6-8 oz / A; max 8 oz / A / season
PHI = 30 days
REI = 24 hours
Efficacy = excellent
Notes = Not used by growers, very new

Select Max (Clethodim) + NIS
Rate = 9-16 oz / A; max 16 oz / A / season
PHI = 14 days
REI = 24 hours
Efficacy = excellent
Notes = Not used by growers, very new

Pipeline Products:
Outlook herbicide.

To Do List:
None

Research
-Outlook may also provide control of annual grasses. Performance data are in the IR-4 database; however, there are currently no IR-4 project requests for parsley.

Regulatory
-None

Extension
-None

Perennial Grasses (Quackgrass)

Biology & Life Cycle: Perennial grasses reproduce from seed and a dense network of small rhizomes. Plant growth often begins in early March if there are a few successive warm days. Growth of quackgrass is most vigorous during the spring, while temperatures are relatively cool.

Distribution: Quackgrass is common throughout Ohio.

Damage: Competes with crop for light, nutrients, and water; potentially contaminates harvest.

Importance: Minor

Non-Chemical Control:
Cultivation between rows and crops, keep perennials down. Herbicides not always needed for control.

Preemerge Chemical Control:
None

Post emerge Chemical Control:
Poast (Sethoxydim)
Rate = 1.5 pts / A; max 3 pts / A / season
PHI = 15 days
REI = 12 hours
Efficacy = Good
Notes = Not used

Pipeline Products:
None

To Do List:
Research
-None

Regulatory
-None

Extension
-None

Annual Broadleaf Weeds (Mustards, Nightshade sp., Prostrate Pigweed, Redroot Pigweed, Common lambsquarter, etc.)

Biology & Life Cycle: Seeds germinate in spring and the plant grows vegetatively during spring/summer. Flowers and seeds are set in mid to late summer; the plant dies in the fall.

Distribution: Statewide

Damage: Competes with crop for light, nutrients, and water; potentially contaminates harvest.

Importance: Economic costs due to hand weeding are significant.

Non-Chemical Control: Cultivation helps control weeds except for Purslane; hand weeding is used to control spot outbreaks.

Preemerge Chemical Control:
Lorox (Linuron)
Rate = 1 lb / A; Max 3 lbs / A / season
PHI = 30 days
REI = 24 hours
Efficacy = Good-fair on Lambsquarter or Redroot pigweed

Post emerge Chemical Control (Muck Soils Only):
Lorox (Linuron)
Rate = 1 lb / A; Max 3 lbs / A / season
PHI = 30 days
REI = 24 hours
Efficacy = Poor on larger seedlings, timing of application is a key factor.

Pipeline Products:
Caparol registration needs to be submitted to IR-4.

To Do List:
Research
-Resubmit Caparol to IR-4 program for OH parsley. Outlook may also provide control of annual grasses. Performance data are in the IR-4 database; however, there are currently no IR-4 project requests for parsley.

Regulatory
-Caparol is registered in the IR-4 database for parsley in CA only (postemergent) and WA (seed crop); For reemergence use IR-4 has completed final report and is ready for submission.

Extension
-None

Purslane (*Portulaca oleracea)*

Biology & Life Cycle: Purslane is an annual weed, reproducing by seeds and adventitious roots, requiring warm temperatures to germinate. This weed will not tolerate shade. The stems are prostrate, to 30 cm long, succulent, glabrous, and reddish in color. The leaves are alternate, succulent, dark green to reddish green, flat, spatulate, and usually crowded at the ends of branches. The flowers are yellow and occur in groups of 1-3 in the axils of leaves and ends of branches. They are usually hidden by the closed sepals which only open on bright sunny mornings. The seeds are very tiny, 0.7 mm in diameter, black, flattened, rounded, borne in a small capsule, and are covered with bumps.

Distribution: Across the state of Ohio and throughout the region.

Damage: Competes with crop for light, nutrients, and water; potentially contaminates harvest.

Importance: THE key weed to control in this production system, causes yield loss due to excessive competition with crop. Expensive to remove via hand harvest.

Non-Chemical Control: Cultivation early can be effective, although cultivation later can result in high populations in field by spreading/dragging weed across fields. Hand weeding can be done, very expensive, plus crop damage, and adds to compaction problem. Weeds must be removed from field.

Preemerge Chemical Control:
Lorox (Linuron)
Rate = 1 lb / A; Max 3 lbs / A / season
PHI = 30 days
REI = 24 hours
Efficacy = Good if applied at seeding, control short lived
Notes = Very difficult to control this weed, must not be allowed to go to seed
Field needs to be clean for harvest purposes

Postemerge Chemical Control (Muck Soils Only):
Lorox (Linuron)
Rate = 1 lb / A; Max 3 lbs / A / season
PHI = 30 days
REI = 24 hours
Efficacy = Good initially, but does not control second flush
Notes = Long PHI may become a harvest issue due to short crop season, must be applied right after first cut. No residual control at low rate.

Pipeline Products:
Dual Magnum may be a solution but is not supported by Syngenta at this time due to indemnification issues. The herbicide Caparol has received registrations in WA (seed crop) and CA only (postemergent) according to the IR-4 database. Outlook may also provide control of purslane, however, there are currently no IR-4 project requests.

To Do List:
Research
-Find broadleaf active materials; Dual Magnum works well preemergent but is not supported by the company currently.
-Try sequential treatments to control weeds at low rates.

Regulatory
-Register Dual Magnum or other herbicides if their status changes.
-Work on reducing PHI of Lorox to 14 days.

Extension
-None

Perennial Broadleaf Weeds (Canada thistle, Dandelion, Yellow nutsedge, etc.)

Biology & Life Cycle: Perennial weeds live more than two years. They reproduce from vegetative (non-seed) parts such as tubers, bulbs, rhizomes (underground stems) or stolons (above-ground stems), although some also produce seed. Perennial weeds are the most difficult to control because of their great reproductive potential and persistence.

Distribution: Across the state of Ohio and throughout the region.

Damage: Competes with crop for light, nutrients, and water; potentially contaminates harvest.

Importance: Not a significant problem due to their control during other management practices.

Non-Chemical Control: Hand hoeing and removal.

Chemical Control: Spot spray with Glyphosate products.

Preemerge Chemical Control:
None

Post emerge Chemical Control (Muck Soils Only):
None

Pipeline Products:
None

To Do List:
Research
-None

Regulatory
-None

Extension
-None

Winter Annuals (Chickweed, Henbit, Purple deadnettle)

Biology & Life Cycle: Seeds germinate in fall and winter, and the plant grows vegetatively during the spring. Flowers and seed are set in late spring or early summer before the plant dies.

Distribution: Throughout Ohio and the north central region.

Damage: This complex of weeds plus rotational crops (winter cereals) may play a significant role in sheltering carrot weevil in the spring.

Importance: Chickweed germinates with cover crop, will be treated with Roundup when rye cover is killed, acts as a reserve for adult weevils, early April.

Non-Chemical Control: Field cultivation, hand hoeing and removal.

Preemerge Chemical Control:
None

Post emerge Chemical Control (Muck Soils Only):
Lorox (Linuron)
Rate = 1 lb / A; Max 3 lbs / A / season
PHI = 30 days
REI = 24 hours
Efficacy = Not applicable

Pipeline Products:
None

To Do List:
Research
-None

Regulatory
-None

Extension
-None

Additional sources used in strategic plan document

Boivin, G. 1985. Evaluation of monitoring techniques for the carrot weevil, *Listronotus oregonensis* (Coleoptera: Curculionidae). Canad. Entomol. 117: 927-933.

Ceresini, P. *Rhizoctonia solani* pathogen profile. North Carolina State University. http://www.cals.ncsu.edu/course/pp728/Rhizoctonia/Rhizoctonia.html

Ghidiu, G. M. & R. W. VanVranken. 1995. A modified carrot weevil (Coleoptera: Curculionidae) monitoring trap. Fla. Entomol. 78: 627-630.

Green Peach Aphid. http://ipm.ncsu.edu/AG136/aphids2.html

Lenzen, B., W. D. Hutchison. Aster Leafhopper. Department of Entomology, University of Minnesota. http://www.vegedge.umn.edu/VEGPEST/aster.htm

Ligenfelter, D. D. Pennsylvania State University, Dept. of Agronomy. Understanding the Organism: Weed Ecology, Biology, and ID. http://paipm.cas.psu.edu/1006.htm

Manitoba Agriculture Soils and Crops Branch. Purslane. http://www.umanitoba.ca/afs/Plant_Science/weeds/fab61s00.html

Miller, S. A.,□F. S.□Randall, R. C. Rowe. Bacterial Spot of Pepper. HYG-3123-96. http://ohioline.osu.edu/hyg-fact/3000/3123.html

Newton, B. Plant Bugs. The Kentucky Critter Files. Department of Entomology, University of Kentucky. http://www.uky.edu/Ag/CritterFiles/casefile/insects/bugs/mirid/mirid.htm

Polomski, B., B. McCarty. Broadleaf weeds. Extension Consumer Horticulturist, Turf Specialist. Clemson University. http://hgic.clemson.edu/factsheets/hgic2301.htm

Riedel, R. M.,□S. A. Miller, R. C. Rowe. Septoria Leaf Spot of Tomatoes. HYG-3112-96. http://ohioline.osu.edu/hyg-fact/3000/3112.html

Simonet, D. E. 1981. Carrot weevil management in Ohio vegetables. Ohio Report 66(6):83-85. Soybean Diseases. Seed and Soil-Borne Diseases of Field Crops. Bulletin 639-98. http://ohioline.osu.edu/b639/b639_12.html

Spring, A., E. Day. Dept. of Entomology, Virginia Tech. http://www.ento.vt.edu/~idlab/vegpests/vegfs/celeryleaftier.html

Stevenson, A. B. 1985. Early warning system for the carrot weevil (Coleoptera: Curculionidae) and its evaluation in commercial carrots in Ontario. J. Econ. Entomol. 78: 704-708.

Tarnished plant bug. Dept. of Entomology, Entomology Notes, Pennsylvania State University. http://www.ento.psu.edu/extension/factsheets/tarnished_plant_bug.htm

Torres, A. N.,□C. W. Hoy, C. Welty. An Integrated Pest Management Program for Carrot Weevil in Parsley. CV-1001-02. http://ohioline.osu.edu/cv-fact/1001.html

Torres, Angel N., and Casey W. Hoy. 2002. Sampling scheme for carrot weevil (Coleoptera: Cucurlionidae) in parsley. Environ. Entomol. 31:1251-1258.

Torres, Angel N., and Casey W. Hoy. 2005. Relationship between carrot weevil infestation and parsley yield. J. Econ. Entomol. 98:1213-1220.

Weed Control Guide for Ohio Field Crops. Bulletin 789. Control of Problem Weeds. Quackgrass. http://ohioline.osu.edu/b789/b789_94.html

Table 1. Chemical and Non-chemical Efficacy Rating for Insect Pest Management:

The following table is a compilation of information concerning the efficacy of various compounds and practices on insect pests. There is little direct data available on most of these insecticides, but we are making an estimate based on knowledge of these pests in other crops. This table compares the relative efficacy of available and potential products and practices for each pest thereby indicating where research and registration efforts are needed.

Insecticides (labeled)	Aphids	Leafhoppers	Carrot weevil	Caterpillars	Flea beetles	Plant Bugs	Whiteflies
Dinotefuran (Venom 70SG)	E	G					
Imidacloprid (Admire 2F, Alias 2F, Admire Pro 4.6F)							
Abamectin (Agri-Mek 0.15 EC, Abba 0.15EC)							
Acetamiprid (Assail 30SG)	E		F				
Azinphos-methyl (Guthion 50WP)			E				
Bacillus thuringiensis (B.t.) (Agree, Biobit HP WP, CryMax WDG, DiPel DF, Javelin WG, XenTari WDG)				F			
Carbaryl (Carbaryl 4L, Sevin 4F, Sevin XLR Plus, Sevin 50WP, Sevin 80S)		G		G	G	F	
Cyfluthrin (Baythroid 2EC)		G	F	G	G	E	
Cyromazine (Trigard 75WP)							
Dinotefuran (Venom 70SG)	E	G					
Emamectin Benzoate (Proclaim 5WDG)				G			
Flonicamid (Beleaf)	E						
Imidacloprid (Provado 1.6F, Pasada 1.6F)	E						
Indoxacarb (Avaunt)			VG				
Malathion (Malathion 5EC, Malathion 57EC, Malathion 8EC, Malathion 8 Aquamul)	G	F	G	F			

Efficacy Rating: **E**=Excellent, **VG**=Very Good, **G**=Good, **F**=Fair, **P**=Poor, **NE**=Not Effective

Insecticides (labeled)	Aphids	Leafhoppers	Carrot weevil	Caterpillars	Flea beetles	Plant Bugs	Whiteflies
Methomyl (Lannate 90SP, Lannate LV)	F		F	G			
Methoxyfenozide (Intrepid 2F)				G			
Permethrin (Pounce 3.2EC, Arctic 3.2EC Permethrin 3.2EC, Ambush 25WP, Pounce 25WP)	F	G	F	G	G	E	
Pymetrozine (Fulfill 50WDG)	E						
Spinetoram (Radiant)			VG				
Spinosad (Spintor 2SC, Entrust 80WP)			?	G			
Spiromesifen (Oberon 2SC)							G
Tebufenozide (Confirm 2F)				G			
Thiamethoxam (Actara 25WDG)	E	G					
Thiodicarb (Larvin 3.2F)			P	G			
Zeta-cypermethrin (Mustang 1.5EW)	F	G	F	G	G	E	
Insecticides (unregistered)							
Halofenozide			?				
Capture			?				
Imidacloprid (seed treatment)			?				
Thiamethoxam (seed treatment)			?				
Fipronil			?				
Non-chemical tactics							
Crop rotation/field buffers	NE	NE	G	NE	NE	NE	P
Remove winter annuals	NE	NE	F	F	NE	F	NE
Do not plant by wooded areas	NE	NE	F	NE	NE	NE	NE
Traps	NE	NE	P	F	NE	NE	P
Predictive models	NE	NE	F	P	P	NE	NE
Efficacy Rating: **E**=Excellent, **VG**=Very Good, **G**=Good, **F**=Fair, **P**=Poor, **?**=Efficacy unknown, **NE**=Not Effective							

Table 2. Chemical and Non-chemical Efficacy for Disease Pest Management:

The following tables are a compilation of information concerning the efficacy of various compounds and practices on disease pests. This table compares the relative efficacy of available and potential products for each pest thereby indicating where research and registration efforts are needed.

Management Tool	*Pythium* Damping Off	*Rhizoctonia* Damping Off	*Septoria* leaf spot	Bacterial leaf spot
Fungicides (labeled)				
Mefenoxam (Ridomil Gold)	?			
Fludioxonil (Maxim 4 FS) [ST]		?		
Azoxystrobin (Quadris)			E	
Copper Hydroxide (Kocide 3000)				F
Fungicides (unregistered)				
Apron [ST] (mefanoxam)	?			
Ranman (cyazofamid)	?			
Farmore [ST] (multiple ai's)		?	?	?
PCNB (pentachloronitrobenzene) [ST]			?	
Switch (Cyprodinil)			?	
Tilt (propiconazole)			?	
Kasumin				?
Non-chemical tools and tactics				
Crop rotation			F	
Seed Sanitation (Clorox)			?	?
Seed Sanitation (hot water)			?	?
Seed Sanitation (hot air)			?	?
Control weed reservoirs			F	

[ST] Seed Treatment

Efficacy Rating: **E**=Excellent, **G**=Good, **F**=Fair, **P**=Poor, **?**=efficacy unknown, **R**=Some resistance known in population

Table 3. Chemical and Non-chemical Efficacy for Weed Pest Management:

The following tables are a compilation of information concerning the efficacy of various compounds and practices on weed pests. The tables compare the relative efficacy of available and potential products for each pest thereby indicating where research and registration efforts are needed.

Herbicides	**Annual Grasses**	**Perennial Grasses**	**Annual Broadleaf's**	**Purslane**	**Perennial Broadleaf's**	**Winter Annuals**
Labeled						
Linuron (Lorox DF) -Pre	P		P	G		
Linuron (Lorox DF) -Post	P		P	G		?
Sethoxydim (Poast 1.5E)	G	G				
Bensulide (Prefar) –Pre	G					
Select (Clethodim) + COC	E					
Select Max (Clethodim) + NIS	E					
Roundup (Glyphosate) –spot spray					G	
Unregistered						
Outlook (Dimethenamid)	?					
Caparol (Prometryn)			?	?		
Dual Magnum (S-metolachlor)				?		
Non Chemical Options						
Crop Rotation	G	F	G	F	F	G
Cultivation	G	P	G	P	P	F
Hand Hoeing	F	P	F	P	P	P
Cover crops	F	P	F	P	P	F

Efficacy Rating: **E**=Excellent, **G**=Good, **F**=Fair, **P**=Poor, **?**=efficacy unknown, **R**=Some resistance known in population.

Table 4. General Timing of Crop Stages and Worker Activities of Parsley in Ohio.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Crop Stage	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
Planting												
Emergence												
1st Cutting												
2nd Cutting												
3rd Cutting												
Worker Activities												
Planting												
Insecticide spraying for carrot weevil												
Weed Spraying from within Tractor Cab												
Hand weeding												
Irrigation (hard pipe)												
Irrigation (traveler, little time in field)												
Cultivation (no contact)												
Harvest (multiple cuttings												

Table 5. General Timing of Key Insects and Diseases of Parsley in Ohio.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
INSECTS	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
Aphids												
Leafhoppers												
Plant Bugs												
Carrot weevil (adults)												
Carrot weevil (eggs/larvae)												
Flea beetles												
Armyworm												
Loopers												
Green cloverworm												
Variegated cutworm												
Webworms												
Celery leaftier												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
DISEASES	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
Pythium damping off												
Rhizoctonia damping off												
Septoria leaf spot												
Bacterial leaf spot												

Table 6. General Timing of Key Weeds of Parsley in Ohio.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
WEEDS	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
Annual Grasses:												
Barnyardgrass												
Crabgrass												
Green foxtail												
Yellow foxtail												
Perennial Grasses:												
Bermudagrass												
Quackgrass												
Annual Broadleafs:												
Common groundsel												
Common lambsquarter												
Common mallow												
Mustards												
Nightshade sp.												
Redroot pigweed												
Prostrate pigweed												
Prickly lettuce												
Purslane												
Perennial Broadleafs												
Canada thistle												
Dandelion												
Field bindweed												
Yellow nutsedge												

Table 7. Insecticide impacts on beneficial arthropods used on parsley in Ohio.

Insecticide	Impact on beneficial organisms	Insecticide	Impact on beneficial organisms
Organophosphates		**Miscellaneous Nerve Poisons**	
Malathion 57EC (malathion)	M	Agri-Mek (abamectin)	M
Guthion (azinphos-methyl)	D	Avaunt (indoxacarb)	L
Carbamates		Fulfill (pymetrozine)	L
Lannate (methomyl)	D	Pyganic (pyrethrins)	M
Sevin (carbaryl)	D	SpinTor (spinosad)	L
Larvin (thiodicarb)	D	Radiant (spinetoram)	L
Organochlorines		Oberon (spiromesifen)	L
Thionex (endosulfan)	M	**Insect Growth Regulators**	
Pyrethroids		Confirm (tebufenozide)	VL
Ambush, Pounce (permethrin)	D	neem (azadirachtin; Azatin)	M
Baythroid (cyfluthrin)	D	Trigard (cyromazine)	L / M
Mustang (zeta-cypermethrin)	D	Intrepid (methoxyfenozide)	VL
Neonicotinoids		**Miscellaneous Insecticides**	
Actara (thiamethoxam)	M	Beleaf (flonicamid)	U
Admire (imidacloprid)	M	*Bacillus thuringiensis* (B.t.)	VL
Assail (acetamiprid)	M	Mycotrol (*Beauveria sp.*)	L
Platinum (thiamethoxam)	M	M-Pede (soap)	L
Provado (imidacloprid)	M	Proclaim (emamectin benzoate)	M
Venom (dinotefuran)	M		

Impact: **VL**=very low, **L**=low, **M**=moderate, **D**=disruptive, **U**=unknown