Michigan Vegetable Insecticide Evaluation Studies

2011

Vegetable Entomology Insecticide Evaluation Studies
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Evaluation of systemic and foliar insecticides for control of asparagus miner in asparagus

METHODS

In 2011, the MSU vegetable entomology lab conducted an insecticide trial in an experimental asparagus field in Hart, MI. This is a two-year old field, with asparagus crowns planted on 19 May 2010 and the drip irrigation system set up on 10 June 2010. In 2010, chemigation treatments were able to suppress asparagus miner damage (Figure 1), indicating that control of this pest could be attained through chemigation.

In 2011, we tested six insecticide treatments, including five products, and two application methods (chemigation through drip irrigation and foliar spray) (Table 1). None of the insecticides used in this trial are currently registered for use on asparagus. Drip treatments were applied twice during the season, on 25 May and 12 July. Drip applications were injected into the main irrigation line and allowed to flow into only the appropriate treatment drip lines; compounds that were tested in 2010 were assigned to the same plots in 2011. A red dye was used to indicate when the compound had completely moved through the lines. The time to flow through for the various treatments varied due to the spatial arrangement of the plots, but watering times were adjusted to be equal for all plots (including those that received no drip treatments). The main line was flushed with water between each treatment to prevent cross contamination.

Sometime in early July, drift from an herbicide application to an adjacent commercial field caused significant damage to the ferns in the experimental plot. We decided that the best course of action was to mow our field and reapply the drip treatments to the resulting new growth. Before mowing, three stem samples were collected from three replications for each drip treatment (the plots furthest from the herbicide drift damage), so we could run residue analysis to test how much of each compound's active ingredient was incorporated into the plants' stems. Stems from each plot were combined into one sample and submitted to Christine Vandervoort at Michigan State University for residue analysis. Immediately following mowing, the drip treatments were reapplied (12 July). Stems were collected 1-week and 3-weeks following the drip application and submitted for additional residue analysis.

Foliar applications of Movento were made on 24 May, 14 June, and 19 July. Foliar treatments were applied using a single-nozzle hand-held boom at 30 gallons/acre and 30 psi. The adjuvant Dyne-Amic was applied with Movento at a rate of 0.25% v/v. The first two application dates were before mowing, the third application was applied to new growth post-mowing.

Sampling for asparagus miner was done by visually surveying 10 plants per treatment and recording the number of damaged stems and miners present.

RESULTS

Unlike in 2010 (Figure 1), in 2011 the chemigation treatments did not result in suppression of asparagus miner damage. In 2011, the early season foliar application of Movento 240 SC significantly reduced the number of damaged stems after three weeks, compared to all other treatments (Figure 2). However, despite a second application of

Movento on 14 June (three weeks after the first application), subsequent sampling dates did not result in any significant differences between treatments. Asparagus miner numbers were quite high during this period, leading to heavy damage to all plots. The reason for the second application of Movento providing ineffective control is unclear, but one possibility is that this product is less successful at moving into the older, tougher fern, relative to the young fern earlier in the season.

After mowing the field on 12 July, the residue analyses showed that none, or only trace amounts, of the various drip treatments were incorporated into the plant tissue. In order for these compounds to provide protection against asparagus miners, they must be present in sufficient concentrations in the stem tissue when the asparagus miners begin to feed.

Future work will focus on improving the delivery of active ingredients into the asparagus stem. If consistent uptake of these chemigation treatments can be resolved, the combination of early season Movento and late season chemigation applications offers promise for improved asparagus miner control.

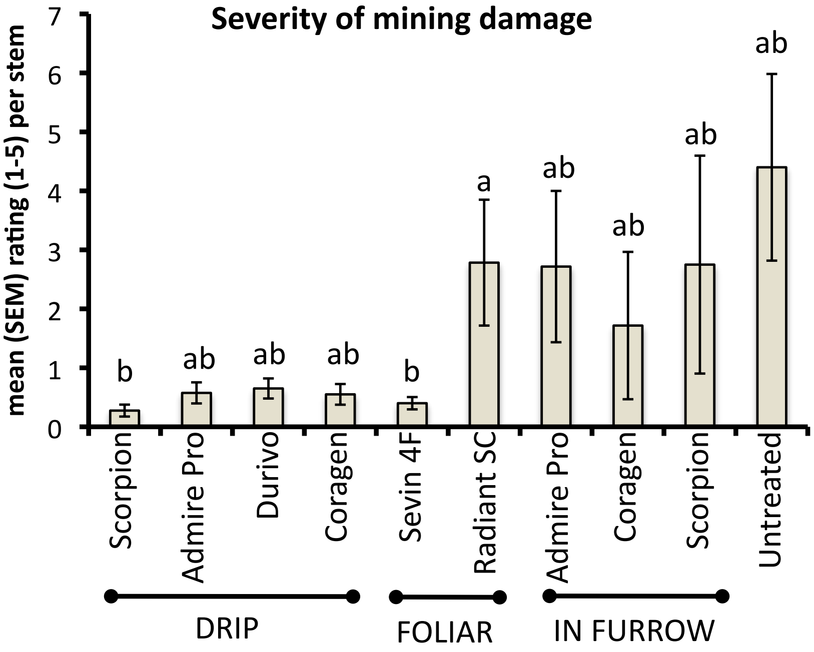


Figure 1. Asparagus miner damage on asparagus stems using a scale of 0-5 from summer 2010. (0 - no damage; 5 - severe damage).

Table 1. Treatment list with application modes, rates, and dates for asparagus trial conducted in Hart, MI, summer 2011.

Treatment	Insecticide class	Application mode	Rate	Application dates
Scorpion	neonicotinoid	drip	9.0 fl oz./A	25 May, 12 July
Scorpion	neonicotinoid	drip	10.5 fl oz./A	25 May, 12 July
Durivo	neonicotinoid + ryanodine receptor modulator	drip	13.0 fl oz./A	25 May, 12 July
Coragen	ryanodine receptor modulator	drip	5.0 fl oz./A	25 May, 12 July
Admire Pro	neonicotinoid	drip	10.5 fl oz./A	25 May, 12 July
Movento 240 SC + Dyne-Amic	acetyl CoA carboxylase inhibitor + adjuvant	foliar	8.0 fl oz./A + 0.25% v/v	24 May, 14 June
Untreated				

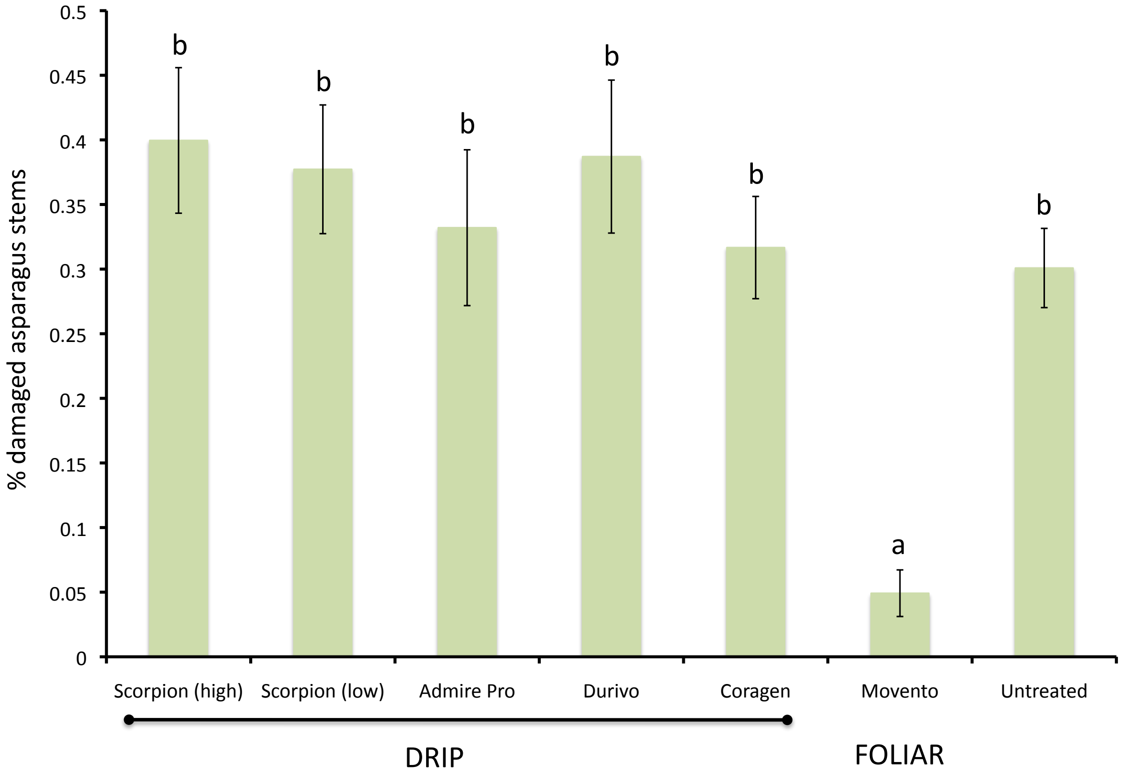


Figure 2. Percent asparagus stems damaged by asparagus miners on 14 June 2011. Movento was applied on 24 May and the drip treatments on 25 May 2011. Bars with the same letter are not significantly different (α= 0.05).

Field Insecticide Evaluations of Registered and Experimental Insecticides for Managing Onion Thrips on Onion

Onion thrips (*Thrips tabaci* Lindeman) is the most important insect pest of onions in the Great Lakes region. Adults and nymphs use their single sword-like mandible to rupture plant cells on the outer surface of leaves and other plant parts, and then suck out the contents by pressing their mouthparts onto the damaged surface. At first, damaged leaves turn silvery, but with continued severe damage, the leaves completely dry out, hampering photosynthesis and ultimately reducing plant growth and yield. Thrips are also vectors of *Iris yellow spot virus*, which causes a disease that can further reduce yield.

Currently, the most important tool for commercial onion growers is the judicious use of insecticides. Insecticides should be used as part of an integrated pest management strategy, keeping in mind the following points: (1) before making an application, determine the average number of thrips on your onions, and (2) check the weather forecast, since hot, dry spells will likely help the numbers of thrips rise quickly in the near future, but cool, wet weather will keep numbers low.

Most onion growers have to make multiple applications of insecticides in a season. Before choosing a product for onion thrips control, the following points should be considered: (1) there are relatively few products registered on onion, so (2) maximum application rates are quickly exceeded if the same product is applied multiple times in a season, therefore, (3) multiple products have to be used in rotation. Its important to use different products within a season, because the more often a product is used, the higher the chances are of onion thrips becoming resistant to it. So we need to find out which rotations/combinations are the most effective at suppressing onion thrips numbers while not exceeding maximum application thresholds.

METHODS

Ten insecticide treatments and an untreated check (Table 1) were tested for their control of onion thrips in a commercial onion field at Krummrey Farms, near Stockbridge, MI. Dry bulb onions (variety 'Sedona') were planted on 13 May 2011 into three-row beds, with 6 in. row spacing and beds spaced 25 in. apart. Treatments were replicated four times in a randomized complete block design. Plots were 15 ft. long. In 2011, an emphasis was placed on a program-based approach to the treatments. Thus, unlike in 2010, treatments were not repeated all season long, instead, the desired approach was to use a product for consecutive weeks and then rotate to a product in another chemical class. The exceptions to this approach were dictated by industry protocols. All treatments included the non-ionic surfactant Dyne-Amic at a rate of 0.5% v/v to improve penetrability of the insecticide into the onion leaves.

Foliar treatments were applied weekly using a single-nozzle hand-held boom at 50 gallons/acre and 40 psi (see Table 1 for exact applicaton dates). Plots were initially sprayed on 30 June when plants had an average of 4.6 leaves and the density of onion thrips averaged 0.2 nymphs/leaf (1.0 nymphs/plant). Thereafter, post-spray counts of adult and nymph thrips on 10 randomly selected plants from each plot were made 2-6 days after each foliar application.

Plots were also visually rated for thrips damage using a scale from 1 to 10. A rating of 1 indicated complete devastation by thrips (leaves all white instead of green), while a rating of 10 indicated no detectable thrips feeding. A rating of 8 or above would be considered commercially acceptable. Visual rating was made on 17 August 2011.

All onion bulbs in each plot were pulled on 14-15 August 2011 and left in the field to finish drying. On 23 August, bulbs were taken back to the lab for grading and weighing. US No. 1 grade bulbs were graded as jumbo (≥3 in. diam.), standard (2.0 to 2.9 in. diam.), and boiler (1.5 to 1.9 in. diam.) and the number in each class was recorded and weighed; extremely small or misshapen bulbs were discarded.

Data were analyzed using two-way ANOVA (treatment and block) and significant differences were determined with Tukey's test ($p=0.05$).

RESULTS

In July, thrips numbers built up gradually, with overall numbers peaking on 3 August. Increased rainfall and cooler temperatures in August led to a drop in thrips numbers across all treatments. All treatments resulted in a significant reduction to the seasonal mean number of thrips relative to the untreated check (Table 1). There were also some subtle differences between the insecticide treatments. In general, those treatments that had Radiant SC applications around weeks 4-6, a time when thrips numbers were at their highest, seemed to be the most effective.

On 17 August, most plots were visually rated at 7 or higher (mean = 6.7). The only significant difference was between the untreated check and the treatment consisting of Movento 240 SC/Lannate LV/Radiant SC/Agri-Mek SC (treatment 5, Table 1). Unlike in 2010, overall yield was good (avg. of 131,754 bulbs/acre or 448 cwt/acre). The weight or number of bulbs harvested in each size category was not different among treatments. Our stand count was uniform, supported by the lack of significant differences in the number of bulbs harvested per plot.

The results of this trial indicate that there are multiple insecticides (both registered and experimental) and insecticide rotations that can achieve good thirps suppression in the field. However, since not all insecticides have the same efficacy, the proper sequence of insecticides has to be carefully considered to achieve the best results.

Table 1. Seasonal average of onion thrips per plant and total yield in an insecticide trial conducted in Michigan in 2011. Numbers followed by different letters are statistically significant from each other.

Treatment	1	2	3	4	5	6	7	8	9	10	11
30 Jun	-	Radiant SC[b]	Radiant SC[b]	Radiant SC[b]	Movento 240 SC	Movento 240 SC	Vydate L	Vydate L	Movento 240 SC	Radiant SC[a]	Tolfenpyrad 15 EC + Lannate LV
7 Jul	-	HGW86 10 OD[a]	HGW86 10 OD[b]	Movento 240 SC	Movento 240 SC	Movento 240 SC	Vydate L	Vydate L	Movento 240 SC	Radiant SC[a]	Tolfenpyrad 15 EC + Lannate LV
14 Jul	-	Lannate LV	Lannate LV	Lannate LV	Lannate LV	Lannate LV	Agri-Mek SC	Assail 30 SG	Lannate LV	Tolfenpyrad 15 EC + Lannate LV	Radiant SC[a]
21 Jul	-	Radiant SC[b]	Radiant SC[b]	Radiant SC[b]	Lannate LV	Lannate LV	Agri-Mek SC	Assail 30 SG	Lannate LV	Tolfenpyrad 15 EC + Lannate LV	Radiant SC[a]
1 Aug	-	HGW86 10 OD[a]	HGW86 10 OD[b]	Movento 240 SC	Radiant SC[a]	Radiant SC[b]	Radiant SC[a]	Lannate LV	Agri-Mek SC	Agri-Mek SC	Agri-Mek SC
6 Aug	-	Lannate LV	Lannate LV	Lannate LV	Radiant SC[a]	Radiant SC[b]	Radiant SC[a]	Lannate LV	Agri-Mek SC	Agri-Mek SC	Agri-Mek SC
11 Aug	-	Radiant SC[b]	Radiant SC[b]	Radiant SC[b]	Agri-Mek SC	Agri-Mek SC	Lannate LV	Radiant SC[a]	Assail 30 SG	Tolfenpyrad 15 EC + Lannate LV	Tolfenpyrad 15 EC + Lannate LV
17 Aug	-	HGW86 10 OD[a]	HGW86 10 OD[b]	Movento 240 SC	Agri-Mek SC	Agri-Mek SC	Lannate LV	Radiant SC[a]	Assail 30 SG	Tolfenpyrad 15 EC + Lannate LV	Tolfenpyrad 15 EC + Lannate LV
Seasonal mean # thrips/plant	11.3 c	1.6 a	2.8 ab	2.1 a	2.4 a	2.1 a	2.8 ab	5.3 b	4.1 ab	4.1 ab	2.5 ab
yield (cwt/acre)	401	446	437	507	499	492	437	463	473	403	412

Rates: Agri-Mek SC (3 oz/A); Assail 30 SG (8 oz/A); HGW86 10 OD[a] (13.5 fl oz/A); HGW86 10 OD[b] (20.5 fl oz/A); Lannate LV (3 pt/A); Movento 240 SC (5 fl oz/A); Radiant SC[a] (7 fl oz/A); Radiant SC[b] (8 fl oz/A); Tolfenpyrad 15 EC (24 fl oz/A); Vydate L 2 pt/A. Applications were made at 40 psi, 50 Gal/A.

Field evaluations of registered and experimental insecticides for managing Colorado potato beetle on potatoes

The Colorado potato beetle is the most widespread and destructive insect pest of potato crops in the eastern United States and Canada. Its ability to develop resistance to insecticides makes it very important to continue testing the efficacy of both new insecticide chemistries and existing compounds. Such tests provide data on comparative effectiveness of products and data to help support future registrations and use recommendations.

METHODS

Seventeen insecticide treatments and an untreated check (Table 1) were tested at the MSU Montcalm Research Farm, Entrican, MI for control of Colorado potato beetle. 'Atlantic' potato seed pieces were planted 12 in. apart, with 34 in. row spacing on 12 May 2011. Treatments were replicated four times in a randomized complete block design. Plots were 40 ft. long and three rows wide with untreated guard rows bordering each plot.

A16901, Admire Pro, Brigadier 2SC, and Platinum 75 SG treatments were applied as in-furrow sprays at planting. One Brigadier treatment also required a second application at hilling, which was made by applying a narrow band to the soil on 14 June. Foliar treatments were first applied at greater than 50% Colorado potato beetle egg hatch on 16 June. Based on the economic threshold of more than one large larva per plant, additional first generation sprays were needed for Blackhawk (6 July), Endigo ZC (6 July), the two low rates of HGW86 10 OD (29 June), Leverage 360 (6 July), and Provado (29 June & 6 July). All applications were made using a single-nozzle hand-held boom (30 gallons/acre and 30 psi).

Post-spray counts of first generation Colorado potato beetle adults, small larvae (1st and 2nd instars), and large larvae (3rd and 4th instars) of five randomly selected plants from the middle row of each plot were made weekly, starting on 21 June. Plots were visually rated for defoliation weekly by estimating total defoliation per plot.

The numbers of small larvae, large larvae, and adults, as well as the defoliation ratings, were transformed (log + 1) prior to analysis. Analysis of variance was used for data analysis and ad-hoc Tukey means separation was used to compare treatment means ($P < 0.05$).

RESULTS

All treatments significantly reduced the number of large larvae per plant, compared to the untreated (Table 1). There were also significant differences in numbers of large larvae among the insecticide treatments. Admire Pro and Provado 1.6 F were some of the poorer performing products. Brigadier 2SC (a product containing bifenthrin and imidacloprid), performed as well as most other treatments when applied in-furrow, but when low rates were applied infurrow and then at hilling, eight other insecticide treatments had significantly fewer large larvae per plant. Except for Admire Pro, all treatments resulted in significantly fewer small larvae than the untreated control. The untreated plots had significantly greater defoliation compared to all other treatments. The seasonal defoliation average was 51.9% in the untreated plots, compared to less than 6% for all other treatments. Differences in defoliation among insecticide treated plots ranged from 0.6 to 5.4%. Neonicotinoid insecticides are still providing sufficient Colorado potato beetle control for Michigan farmers, but new chemical classes such as HGW86 10 OD and Tolfenpyrad 15 EC are also proving to be effective.

Table 1. Seasonal mean number of different Colorado potato beetle life stages and defoliation in an insecticide field-trial conducted by the MSU vegetable entomology laboratory.

Treatment	Insecticide class	Application mode	Rate	Adult[1]	Small Larva[1]	Large Larva[1]	% defoliation
Untreated				0.6 abc	6.1 e	5.5 e	51.9 f
HGW86 10 OD	Ryanodine receptor modulators	foliar	3.37 fl oz/A	0.2 ab	1.5 abc	1.5 ab	1.1 abc
HGW86 10 OD	Ryanodine receptor modulators	foliar	6.75 fl oz/A	0.4 abc	1.4 abcd	0.0 a	0.9 abc
HGW86 10 OD	Ryanodine receptor modulators	foliar	10.1 fl oz/A	0.3 abc	1.6 bcd	0.3 abc	1.6 abcde
Provado 1.6 F	neonicotinoid	foliar	3.8 fl oz/A	0.3 abc	2.9 de	1.1 d	2.6 bcde
Blackhawk	spinosyn	foliar	3.2 oz/A	0.3 abc	2.4 bcd	0.8 bcd	4.8 de
Endigo ZC	pyrethroid + neonicotinoid	foliar	3 oz/A	0.2 ab	3.0 cd	0.8 abcd	2.1 abcde
Leverage 360	pyrethroid + neonicotinoid	foliar	2.8 oz/A	0.3 abc	3.0 cd	0.6 abcd	2.6 bcde
Tolfenpyrad 15 EC	mitochondrial complex I electron transport inhibitor	foliar	14 fl oz/A	0.3 abc	1.1 abcd	0.6 abcd	3.0 bcde
Tolfenpyrad 15 EC	mitochondrial complex I electron transport inhibitor	foliar	21 fl oz/A	0.1 a	3.1 cd	1.2 d	2.1 bcde
Admire Pro	neonicotinoid	infurrow	8.7 fl oz/A	0.4 abc	0.9 ab	0.8 cd	2.0 bcd
Platinum 75 SG	neonicotinoid	infurrow	1.68 oz/A	0.6 bc	0.2 ab	0.1 abc	0.9 ab
Platinum 75 SG	neonicotinoid	infurrow	2.66 oz/A	0.2 ab	0.3 a	0.1 ab	0.6 a
A16901		infurrow	6.5 oz/A	0.6 c	0.4 ab	0.1 ab	5.4 cde
A16901		infurrow	10 oz/A	0.3 abc	0.3 a	0.1 ab	0.9 ab
Brigadier 2SC	pyrethroid + neonicotinoid	infurrow	25.6 oz/A	0.3 abc	0.8 abc	0.6 abcd	1.9 abcde
Brigadier 2SC	pyrethroid + neonicotinoid	infurrow	38.4 oz/A	0.4 abc	0.7 abc	0.2 abc	1.3 abcd
Brigadier 2SC	pyrethroid + neonicotinoid	infurrow+ at hilling	12.8 oz/A 12.8 oz/A	0.3 ab	1.5 abcd	1.2 d	4.5 e

[1] Different letters within a column denote statistically significant differences among treatments.

Susceptibility of Colorado potato beetle populations to imidacloprid and thiamethoxam

Imidacloprid (i.e.: Admire Pro) and thiamethoxam (i.e.: Platinum, Actara) continue to be the most common means of Colorado potato beetle control. Today, greater than 75% of the acres in the northeastern and midwestern United States are protected by these compounds (NASS 2006). Such consistent and heavy dependency on any compound sets the stage for resistance development. Further complicating the issue is the availability of generic imidacloprid formulations; these formulations drive down product cost, which will likely lead to even greater field exposure to these compounds. All of these reasons strongly support the need to continue monitoring resistance development and to encourage growers to adopt resistance management strategies.

Our objective was to continue gathering data on susceptibility to imidacloprid and thiamethoxam in Colorado potato beetle populations collected from commercial potato fields in Michigan and other regions of the United States. To accomplish this objective, 15 Colorado potato beetle populations (six Michigan populations and nine populations collected in other states) were bioassayed with imidacloprid and/or thiamethoxam.

METHODS

During 2011, six Colorado potato beetle populations were collected from two Michigan counties (Mecosta and Montcalm). Cooperators also provided populations from Idaho, New York, Maine, Virginia, and Minnesota. One susceptible laboratory strain was also tested (Table 1).

Adult Colorado potato beetles were treated with 1 µl of acetone/insecticide solution of known concentration applied to the ventral surface of the abdomen using a 50 µl Hamilton® microsyringe. A range of five to six concentrations was selected for each population, depending on the number of available beetles and known resistance history for each population. In each bioassay, 15-30 adults were treated with each concentration (seven to 10 beetles per dish and two to three dishes per concentration). Following treatment, beetles were placed in 100 mm diam. petri dishes lined with Whatman® No. 1 filter paper and provided with fresh potato foliage. They were kept at 25±1°C and the foliage and filter paper were checked daily and changed as needed.

Beetle response was assessed 7 days post treatment. A beetle was classified as dead if its abdomen was shrunken, it did not move when its legs or tarsi were pinched, and its elytra were darkened. A beetle was classified as walking and healthy if it was able to grasp a pencil and walk forward normally. A beetle was classified as poisoned if its legs were extended and shaking, it was unable to right itself or grasp a pencil, and it was unable to walk forward normally at least one body length. Beetles that had died due to *Beauvaria* spp. infection were excluded from analysis; these beetles were easily recognized by their pale, petrified appearance and/or presence of white filamentous fungi. Dead and poisoned beetle numbers were pooled for analysis. Data were analyzed using standard log-probit analysis (SAS Institute, 2009).

RESULTS

The imidacloprid LD_{50} value (dose lethal to 50% of the beetles) for the susceptible laboratory strain was 0.115 µg/beetle (Table 2). The LD_{50} values from the field for imidacloprid ranged from 0.476 µg/beetle (Sackett Potatoes Fields 1-2) to 8.480 µg/beetle (Main Farms Field R2) for Michigan populations (Figure 1). The imidacloprid LD_{50} values from the out-of-state populations ranged from 0.046 µg/beetle (Eden, ID) to 8.508 (Fryeburg, ME).

LD_{50} values for all but one population (Eden, ID) were significantly higher than the susceptible laboratory strain. Consistent with the past two years, all Michigan imidacloprid LD_{50} values were significantly higher than the susceptible comparison. In 2011, 57% of the Michigan samples were greater than 10-fold resistant to imidacloprid, compared to 60% in 2010 and 85% in 2009.

The thiamethoxam LD_{50} value for the susceptible laboratory strain was 0.112 µg/beetle (Table 1). LD_{50} values for thiamethoxam in Michigan ranged from 0.231 µg/beetle (Sackett Potatoes Fields 1-2) to 1.471 µg/beetle (Paul Main Field R2), and from 0.102 µg/beetle (Becker, MN) to 0.836 µg/beetle (Jamesport, NY) for out-of-state populations (Figure 1). One Michigan population (Main Farms Field R2) was more than 10-fold resistant to thiamethoxam.

Thiamethoxam resistance remains uncommon and has probably been delayed by the more prevalent use of imidacloprid in the field. However, now that some Michigan sites are showing greater than 10-fold resistance to thiamethoxam, it will be important to monitor thiamethoxam resistance even closer, even more important to avoid multiple applications of neonicotinoids in a single growing season.

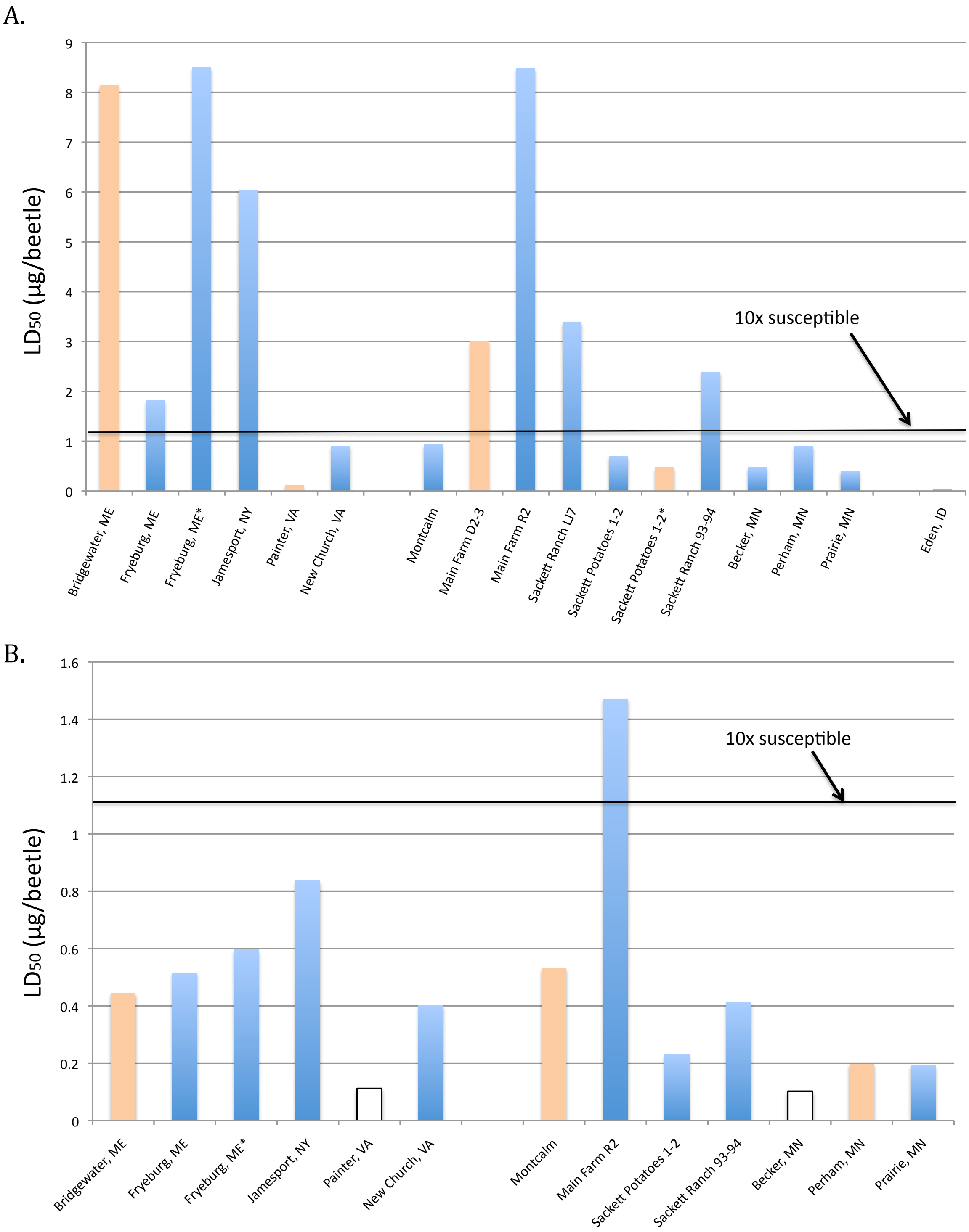
Table 1. Colorado potato beetle populations tested for susceptibility to imidacloprid and thiamethoxam in 2011.

Michigan populations
Montcalm Farm Summer adults were collected on 20 July 2011 from untreated potatoes at the Michigan State University Montcalm Potato Research Farm, Entrican, MI.
Main Farms Summer adults were collected by Mark Otto, Argi-Business Consultants, Inc. from commercial potato fields in Mecosta and Montcalm Counties.
Field D2-3 Adults were collected in Montcalm County in July 2011.
Field R2 Adults were collected in Mecosta County in August 2011.
Sackett Potatoes Field 1-2 Overwintered and summer adults were collected by Mark Otto, Argi-Business Consultants, Inc. from a commercial potato fields in Mecosta County. Overwintered adults were collected in June and summer adults in July.
Sackett Ranch Summer adults were collected by Mark Otto, Agri-Business Consultants, Inc. from commercial potato fields in Montcalm County.
Field LJ7 Adults were collected in July 2011.
Fields 93-94 Adults were collected in August 2011.
Out-of-state populations
Becker, Minnesota Overwintered adults were collected in late June 2011 by Ian MacRae, University of Minnesota, from the University of Minnesota Sand Plain Research Farm in Becker, MN.
Bridgewater, Maine Overwintered adults were collected on 17 August 2011 by Gary Sewell, University of Maine, from an organic seed farm near Bridgewater, ME.
Fryeburg, Maine Overwintered adults were collected in early June 2011 and summer adults in early August 2011 by Andrei Alyokhin, University of Maine, from a commercial potato field near Fryeburg, ME.
Eden, Idaho Summer adults were collected on 15 August 2011 by Erik Wenninger, University of Idaho, from a commercial field in Eden, Idaho.
Jamesport, New York Overwintered adults were collected on 25 May 2011 by Sandra Menasha, Cornell Cooperative Extension, from a commercial potato field in Suffolk County, NY.
New Church, Virginia Summer adults were collected on 21 June 2011 by Adam Wimer, Virginia Polytechnic Institute and State Universiy, from a commercial potato field near New Church, VA.
Painter, Virginia Summer adults were collected on 7 June 2011 by Jim Jenrette, Virginia Polytechnic Institute and State Universiy, from a commercial potato field in Painter, VA
Perham, Minnesota Summer adults were collected on 1 August 2011 by Chad Ingemann from a commercial potato field.
Prairie, Minnesota Summer adults were collected on 1 August 2011 by Chuck Schiemann from a commercial potato field.
Laboratory strain
New Jersey Adults obtained in 2008 from the Phillip Alampi Beneficial Insects Rearing Laboratory, New Jersey Department of Agriculture and since reared at Michigan State University without contact to insecticides.

Table 2. LD_{50} values (μg/beetle) and 95% fiducial limits for Colorado potato beetle populations treated with imidacloprid and thiamethoxam at 7 days post treatment.

IMIDACLOPRID	**LD_{50} (μg/beetle)**	**95% Confidence Intervals**
Michigan populations		
Montcalm	0.931	0.683 – 1.128
Main Farms D2-3	3.006	*
Main Farms R2	8.480	6.110 – 20.944
Sackett Potatoes 1-2 (overwinter) (summer)	0.697 0.476	0.603 – 0.802 *
Sackett Ranch LJ7	3.395	1.281 – 420.200
Sackett Ranch 93-94	2.386	1.812 – 3.005
Out-of-state populations		
Becker, Minnesota	0.473	*
Bridgewater, Maine	8.152	*
Freyburg, Maine (overwinter) (summer)	1.816 8.508	1.416 – 2.197 5.265 – 35.642
Eden, Idaho	0.046	0.041 – 0.053
Jamesport, New York	6.046	2.827 – 8.612
Painter, Virginia	0.113	*
Perham, Minnesota	0.904	0.630 – 1.228
Prairie, Minnesota	0.399	0.189 – 0.585
Virginia	0.897	0.620 – 2.466
Laboratory strain		
New Jersey	0.115	0.068 – 0.156
THIAMETHOXAM		
Michigan populations		
Montcalm	0.532	*
Main Farms R2	1.471	0.813 – 217.151
Sackett Potatoes 1-2 (overwinter)	0.231	0.201 – 0.265
Sackett Ranch 93-94	0.412	0.364 – 0.468
Out-of-state populations		
Becker, Minnesota	0.102	0.087 – 0.122
Bridgewater, Maine	0.445	*
Fryeburg, Maine (overwinter) (summer)	0.516 0.596	0.299 – 0.707 0.516 – 0.675
Jamesport, New York	0.836	0.685 – 0.978
Painter, Virginia	0.112	0.091 – 0.149
Perham, Minnesota	0.198	*
Prairie, Minnesota	0.193	0.164 – 0.224
Virginia	0.401	0.333 – 0.473
Laboratory strain		
New Jersey	0.112	0.098 – 0.130

* no confidence limits calculated due to insufficient fit to the model



* indicates 2nd generation adults where two populations were collected from same site

Figure 1. Susceptibility of field populations of Colorado potato beetle to imidacloprid (A) and thiamethoxam (B). Blue bars represent populations that had significantly greater LD_{50} values compared to the susceptible strain, orange bars indicate that confidence limits were not calculated, and white bars represent populations that were not significantly different from the susceptible strain.

Insecticide Residue Bioassay for control of Colorado Potato Beetle Adults

Neonicotinoid insecticides (Admire Pro, Platinum) continue to be the most common means of Colorado potato beetle control in Michigan. With such consistent use of these compounds, coupled with rising neonicotinoid resistance, it is important for growers to know what foliar options are available and effective for late-season Colorado potato beetle control.

Our objective was to investigate the efficacy of various foliar insecticides on Colorado potato beetles with differing levels of imidacloprid resistance. To accomplish this objective, we conducted insecticide residue bioassays with a field-collected population and a lab-reared, imidacloprid-selected strain of Colorado potato beetles.

METHODS

Six treatments, plus an untreated control, were tested at the MSU Muck Soils Research Farm, Bath, MI. 'Atlantic' potato seed pieces were planted 12 in. apart, with 34 in. row spacing on 13 June and 11 July 2011; potatoes planted on 13 June were used for an assay with Michigan-collected field beetles and those planted on 11 July for an assay with lab-reared, imidacloprid-selected beetles. Plots were 25 ft. long and one row wide with untreated rows separating all treatments. Treatments were replicated four times in a randomized complete block design.

The following six treatments were applied: Agri-Mek SC (3 fl oz/acre), Blackhawk (3.2 oz/acre), Coragen (5.0 fl oz/acre), Provado 1.6 F (3.8 fl oz/acre), Radiant SC (8.0 fl oz/acre), and Voliam Xpress (9.0 fl oz/acre). All applications were made using a single-nozzle hand-held boom (30 gallons/acre and 30 psi). Applications were made to the first planting on 26 July and the second planting on 7 September.

One hour post-application, foliage was collected from three different plants per plot and transported back to the lab. Two leaves from each plot were put into water picks and each placed in a separate small deli container with three adult Colorado potato beetles. Foliage was changed 2 and 4 days later, by collecting new leaves in the same manner and using them to replace the old leaves in the water picks. Each day, beetle response (alive, poisoned, or dead) and defoliation on a 0-5 scale (0: <5%, 1: 6-20%, 2:21-40%, 3: 41-60%, 4: 61-80%, 5: >85%) were recorded.

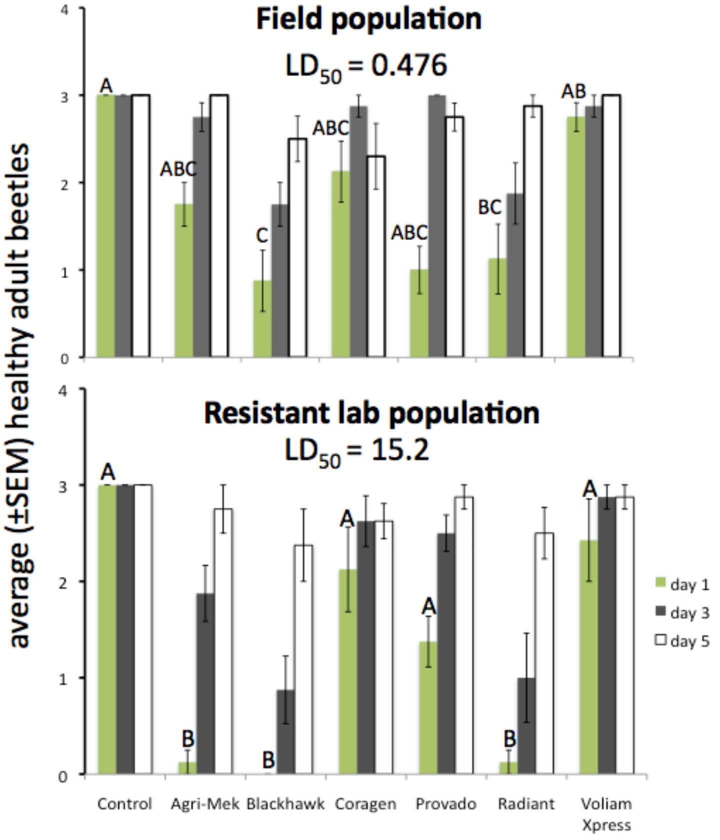
Two different strains of Colorado potato beetles were used in this experiment. The first was a Michigan field population collected by Mark Otto, Agri-Business Consultants, Inc., in mid-July. The second was a laboratory strain initially collected from Montcalm County, Michigan in 1997 and, since, intensely selected in the laboratory with imidacloprid to increase its resistance levels. The Michigan field population is only four times more resistant to imidacloprid compared to a susceptible laboratory colony, while the lab colony is more than 130 times more resistant than the susceptible colony, providing strains with different levels of imidacloprid resistance for testing against a variety of foliar insecticide options.

RESULTS

For the field beetles, Blackhawk SC and Radiant SC had the best knockdown activity and the longest residual effect among the tested beetles; both significantly better than the untreated control. Results for the resistant lab strain were similar, except that Agri-Mek SC also provided knockdown and residual effects. Response to Coragen and Voliam Xpress did not differ significantly from the untreated control, but these treatments resulted in less defoliation after one day, when compared Agri-Mek SC, Blackhawk SC, and Radiant SC. Surprisingly, the imidacloprid-resistant lab strain was sensitive to Provado 1.6F, with good short-term activity against both strains, but no residual effect after 3 days of field aging.

The lab strain's greater initial knockdown, especially for Agri-Mek SC, Blackhawk SC, and Radiant SC could be due to the fact that this strain has been in colony since 1997, and thus had no previous exposure to these compounds. In contrast, the field beetles have been exposed to all these compounds at some point in recent years, as they were collected from a commercial potato field with a history of reduced neonicotinoid sensitivity.

These results show that several foliar options are available for use as a second generation foliar insecticide to control summer adult Colorado potato beetles. However, growers should not expect lengthy residual control, requiring frequent scouting to assess potential needs for additional applications.



Different numbers above bars represent significant differences within a population for 24 hr old residue.

Figure 1. Colorado potato beetle response to foliar insecticides.