Wisconsin Vegetable Insect Pest Management Research Summer Field Trials

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Table of Contents

Evaluation of foliar insecticides for the control of Lepidopteran insect pests in cabbage

Purpose: The objective of this experiment was to assess the efficacy of foliar insecticides to control Lepidopteran insect pests in cabbage.

Materials and Methods

This experiment was conducted at the Arlington Agricultural Experiment Station, Arlington, WI in 2015. Cabbage, *Brassica oleracea* cv. 'Katlin', transplants were planted 1 June. Plants were spaced 18 inches apart within rows. Rows were 36 inches apart. The two-row plots were 6 ft wide by 20 ft long, for a total of 0.003 acres, and were separated by 2 guard rows (untreated) between plots. Plots were arranged into four replications with no alleys between replications. All plots were maintained according to standard commercial practices.

Four replicates of 7 experimental foliar treatments and 1 untreated control were arranged in a randomized complete block design. All foliar treatments were applied 3 Aug. Treatments were applied with a CO_2 backpack sprayer with a 6 foot boom operating at 30 psi delivering 20 gpa through four flat-fan nozzles (Tee Jet XR8002XR) spaced 18" apart while traveling at 3.5 ft / sec.

Immature life stages of imported cabbage worm (ICW), *Artogeia rapae,* cabbage looper (CL), *Trichoplusia ni*, and diamondback moth (DB), *Plutella xylostella,* were assessed by counting the number of larvae (large larvae, "L" and small larvae, "S") per plant on 10 destructively sampled, randomly selected plants from the center two rows in each plot (5 random plants per row). Larval counts occurred on Aug. 6 (2 DAT), Aug.11 (7 DAT) and Aug.18 (12 DAT). Means were separated using ANOVA with a Least Squared Difference (LSD) means comparison test (P=0.05).

During 2015 Lepidopteran pressure was average. ICW populations were the most prevalent of all Lepidopteran pests. No signs of phototoxicity were observed among treatments.

Table 1.Mean counts of Imported cabbageworm (ICW - large and small larvae and pupae), Diamondback moth (DM - large and small larvae), and Cabbage looper (CL - large and small larvae) per cabbage head.
***Using "Letter Display" ls means from proc glimmix data

		6 -Aug					
Treatment[1]	**Rate**	**ICW-L**	**ICW-S**	**DB-L**	**DB-S**	**CL-L**	**CL-S**
Exp Rate 1 [2]	0.04	7.25 b	10.75 ab	0.5 a	2.75 a	1.0 a	1.25 ab
Exp Rate 2 [2]	0.07	4.5 bc	3.75 bc	0.025 a	1.0 a	0.75 a	1 ab
Exp Rate 3 [2]	0.09	4 bc	5.5 bc	1.5 a	2.5 a	0.0 a	0.75 ab
Exp Rate 4 [2]	0.13	5.5 bc	6 bc	0.75 a	2.5 a	0.25 a	1.25 ab
Coragen[3]	3.5	9 ab	6.75 bc	0.25 a	2.0 a	0.25 a	1.25 ab
Avaunt[4]	3.5	3.5 c	2.25 c	1.5 a	3.5 a	0.25 a	0.25 b
Warrior II[3]	1.92	3 c	3.75 bc	0.25 a	2.75 a	1.0 a	0.5 ab
Untreated		19.5 a	21.25 a	1.5 a	3.25 a	1.0 a	2.5 a
	P	0.0043	0.0078	0.4566	0.9313	0.9152	0.3474
	LSD	0.3617	0.3911	0.3367	0.3895	0.3597	0.296

Means in a column followed by the same letter are not significantly different at □ = 0.05.
[1]All treatments except Untreated also had Induce at 0.125 % v/v
[2] Rate in lb ai/a [3] Rate in fl oz/a [4] Rate in oz wt/a

Table 2. Mean counts of Imported cabbageworm (ICW - large and small larvae and pupae), Diamondback moth (DM - large and small larvae), and Cabbage looper (CL - large and small larvae) per cabbage head.

		11-Aug					
Treatment[1]	**Rate**	**ICW-L**	**ICW-S**	**DB-L**	**DB-S**	**CL-L**	**CL-S**
Exp Rate 1 [2]	0.04	8.5 b	8.75 b	1.25 a	2.0 a	1.75 a	1.75 ab
Exp Rate 2 [2]	0.07	3.75 b-e	4 bc	1.25 a	1.25 a-c	0.25 b	1.75 ab
Exp Rate 3 [2]	0.09	9 bc	6.25 bc	0.75 a	0.5 b-d	0.25 b	1 a-c
Exp Rate 4 [2]	0.13	5.25 b-d	2.25 c	0.5 a	0.5 cd	0.5 b	0.75 a-c
Coragen[3]	3.5	2.5 de	2 c	0.5 a	0.25 cd	0 b	0.25 bc
Avaunt[4]	3.5	1.25 e	1.5 c	0.5 a	0.25 cd	0 b	0 c
Warrior II[3]	1.92	2.25 c-e	3.5 c	0.5 a	0 d	0.25 b	0 c
Untreated		34 a	43.5 a	1.5 a	2.5 ab	2.5 a	3.0 a
	P	0.0001	<.0001	0.7615	0.0211	0.0012	0.0138
	LSD	0.3930	0.4224	0.3556	0.2872	0.2345	0.2989

Means in a column followed by the same letter are not significantly different at □ = 0.05.
[1]All treatments except Untreated also had Induce at 0.125 % v/v
[2] Rate in lb ai/a [3] Rate in fl oz/a [4] Rate in oz wt/a

Table 3. Mean counts of Imported cabbageworm (ICW - large and small larvae and pupae), Diamondback moth (DM - large and small larvae), and Cabbage looper (CL - large and small larvae) per cabbage head.

		18-Aug					
Treatment[1]	**Rate**	**ICW-L**	**ICW-S**	**DB-L**	**DB-S**	**CL-L**	**CL-S**
Exp Rate 1 [2]	0.04	3 bc	2.25 b	0.25 b	0.5 a	1 b	0.75 b
Exp Rate 2 [2]	0.07	3 bc	0.75 b-d	0 b	0.25 a	1 b	0.75 b
Exp Rate 3 [2]	0.09	1.25 bc	1.75 bc	0.5 b	0.0 a	0.5 b	2.25 a
Exp Rate 4 [2]	0.13	5.75 b	1.25 bc	0 b	0.25 a	0.25 b	0.75 b
Coragen[3]	3.5	0.75 c	0 d	0 b	0.0 a	0 b	0.25 b
Avaunt[4]	3.5	1.75 bc	0.5 cd	0.5 b	0.0 a	0 b	0.25 b
Warrior II[3]	1.92	3.75 b	0.75 b-d	0.25 b	0.75 a	0.25 b	0.5 b
Untreated		47 a	38.75 a	3.75 a	0.25 a	10.75 a	2.75 a
	P	<.0001	<.0001	0.0262	0.5508	0.0002	0.0037
	LSD	0.4295	0.2983	0.301	0.2163	0.3268	0.2582

Means in a column followed by the same letter are not significantly different at □ = 0.05.
[1]All treatments except Untreated also had Induce at 0.125 % v/v
[2] Rate in lb ai/a [3] Rate in fl oz/a [4] Rate in oz wt/a

Evaluation of foliar insecticides for the control of onion thrips on Dry-bulb onion

Purpose: The objective of this experiment was to assess the efficacy of foliar insecticides applied at-threshold to control immature stages of onion thrips (OT), *Thrips tabaci*, on dry-bulb onion.

Materials and Methods

This experiment was conducted in a cooperating producer's onion field located near Markesan, WI on a muck soil. Onion, *Allium cepa* cv. 'Safrane', was direct seeded on 25 April, 2015. Plants were spaced 2.6 inches apart within rows. Rows were 9.4 inches apart. The six-row plots were 60 inches wide by 25 ft long on raised formed beds, for a total of 0.003 acres, and were separated by planted guard beds of the same dimensions between plots. All plots were maintained by the grower according to standard commercial practices.

Four replicates of 9 experimental treatments and 1 untreated control were arranged in a randomized complete block design. Applications were initiated when mean immature thrips populations had exceeded established thresholds of 3 immature thrips/ leaf. All foliar treatments were applied on 4 August and 11 August. Treatments were applied with a CO_2 backpack sprayer with a 6 foot boom operating at 30 psi delivering 22.1 gpa through four flat-fan nozzles (Tee Jet XR8002XR) spaced 18" apart while traveling at 3.5 ft / sec.

Immature life stages of onion thrips (OT) were assessed by counting the number of larvae per plant on 10 randomly selected plants in the central 2 rows of each plot. Larval counts occurred two times during August, on 11 Aug (7 DAT), after the first application and again 18 Aug (7 DAT) after the second application. Means were separated using ANOVA with a Fisher's Protected Least Squared Difference (LSD) means comparison test (P=0.05). Data are presented in **Table 1**.

No signs of phototoxicity were observed among treatments.

Table 1. Mean count of immature onion thrips per plant.

Treatment	Rate		11-Aug	18-Aug
Exirel	20.5	fl oz/a	4.85 d	4.82 c
Movento	5	fl oz/a	28.32 ab	52.45 a
Warrior II	1.94	fl oz/a	7.45 cd	29.02 ab
Agri-Mek	3.5	fl oz/a	18.4 ab	28.75 ab
Agri-Mek	16	fl oz/a	17.52 bc	39.72 a
Radiant	8	fl oz/a	21.525 bc	7.68 bc
Exp Rate 1	0.5	lb/a	23.90 ab	62.18 a
Exp Rate 2	1	lb/a	37.40 a	64.6 a
Exp Rate 3	2	lb/a	46.05 ab	36.25 ab
Untreated Control			19.55 ab	66.22 a
		P	0.0012	0.0081
		LSD	0.3828	0.4835

Means in columns followed by the same letter are not significantly different (Fisher's Protected Least Significant Difference Test, P = 0.05)
MSO 100 L added at 0.5% v/v

Registered and experimental foliar insecticides to control Colorado potato beetle and potato leafhopper on potato (HAES)

Purpose: The objective of this experiment was to assess the efficacy of foliar insecticides applied to early instar larvae of the first generation of Colorado potato beetle (CPB), *Leptinotarsa decemlineata*, and potato leaf hopper (PLH) adults, *Empoasca fabae*, on potato.

Materials and Methods

This experiment was conducted at Hancock Agricultural Experiment Station (HAES) located 1.1 mile (1.8 km) southwest of Hancock, Wisconsin on a loamy sand soil in 2015. Potato, *Solanum tuberosum* cv. 'Superior', seed pieces were planted on 24 April. Seed pieces were spaced 12 inches apart within rows. Rows were 3 ft apart. Two-row plots were 6 ft wide by 20 ft long, for a total of 0.003 acres. Two untreated rows separated plots while 12 ft tilled alleys separated replications. All plots were maintained according to standard commercial practices conducted by HAES staff.

Four replicates of 35 experimental foliar treatments and 2 untreated controls were arranged in a randomized complete block design. The foliar treatments were applied twice in succession when 75-90% of the first generation CPB was within the first and second instar larval stadia. The application dates were 16 June for Rimon and Dimilin treatments, 22 and 28 June for all treatments. Treatments were applied with a CO_2 pressurized backpack sprayer with a 6 ft boom operating at 30 psi delivering 20 gpa through 4 flat-fan nozzles (Tee Jet XR8002) spaced 18" apart while travelling at 3.5 ft / sec.

CPB efficacy was assessed by counting the number of small larvae (SL), large larvae (LL), egg masses (EM) and adults (AD) per plant on 10 randomly selected plants from the center two rows in each plot. Percent foliage defoliation (%DF) ratings were not made. Potato leafhopper (PLH) numbers were low and were not collected. Insect and larval counts occurred four times during June and July (**Tables 1-4**). The first set of counts occurred 25 Jun (9 and 3 DAT) after the first application. The second set of counts occurred on 29 June, 7 and 13 Jul (7, 15 and 21 DAT) after the first application and (1, 9 and 15 DAT) after the second application. Means were separated using ANOVA with a Fisher's Protected Least Squared Difference (LSD) mean separation test (P=0.05). No signs of phytotoxicity were observed among treatments.

Table 1. Mean Colorado potato beetle (CPB) counts per 10 plants of adults (AD), egg masses (EM), small (SL) and large (LL) larvae, percent defoliation and adult (AD) potato leafhoppers (PLH).

Treatment	Rate	CPB-AD 25-Jun	CPB-EM 25-Jun	CPB-SL 25-Jun	CPB-LL 25-Jun
Untreated		0 c	0.5 ab	57.75 a	5.75 c-e
Imidan (1st and 2nd appl)	1.33 lb/acre	0.25 bc	0.75 ab	0.5 e	0.25 ef
Imidan (1st appl)+Blackhawk (2nd appl)	1.33, 3.3 lb/acre	0.25 bc	1.0 a	12.25 de	0 e
Blackhawk(1st appl)+ Imidan (2nd appl)	1.33, 3.3 wt/acre	0 c	0.5 ab	5 e	0.5 ef
Blackhawk(1st appl)+Blackhawk (2nd appl)	3.3, 3.0 wt/acre	0 c	0.5 ab	11 de	0.75 ef
Athena (1st and 2nd appls)	17 oz/acre	.025 bc	0 b	11.75 de	3.5 de
Gladiator (1st and 2nd appls)	19 oz/acre	0 c	0.25 ab	5.75 e	0.25 ef
Brigadier (1st appl)+'Brigadier (2nd appl)	6.14, 5.0 oz/acre	0.25 bc	0.75 ab	3.5 e	0.75 ef
Brigadier (1st appl)+Athena (2nd appl)	16.4, 17.0 oz/acre	0.5 bc	0.75 a	1.25 e	1.5 ef
IKI 3106 (1st and 2nd appls)	16.4 oz/acre	0 c	0.25 ab	10 de	3.5 de
IKI 3106 (1st and 2nd appls)	11 oz/acre	0.25 bc	0.5 ab	16.5 c-e	2.25 de
Rimon (1 appl only)	12 oz/acre	0 c	0 b	4 e	14.25 b
Rimon (1st, 2nd and 3rd appl)	9.0, 8.0, 7.0 oz/acre	0.25 bc	0 b	0 e	2.25 de
Dimilin (1st and 3rd appls)	16 oz/acre	0 c	0 b	6.75 de	14.25 b
Dimilin (1st and 3rd appls)	12 oz/acre	0 c	0.25 ab	5.5 e	0.5 ef
Dimilin (1st and 3rd appls)	8 oz/acre	0 c	0 b	11.5 de	8.25 b-f
Dimilin (1 appl only)	5 oz/acre	0.25 bc	1.0 a	13 de	10 b-d
DoubleTake (1st and 2nd appls)	4 oz/acre	0.25 bc	0 b	0.25 e	1 ef
DoubleTake (1st appl)+Dimilin (3rd appl)	4.0, 16.0 oz/acre	0.25 bc	0.5 ab	9.5 de	1.25 ef

Exirel (1st and 2nd appls)+NIS	13.5, 0.1 oz/acre	0 c	0 b	4.5 e	3 de
Agri-Mek (1st and 2nd appls)+NIS	2.77, 0.1 oz/acre	0 c	0 b	16.75 c-e	1.5 ef
Exp.1 (1st and 2nd appls)+NIS	8.0, 0.1 oz/acre	0 c	0 b	11.75 de	1.25 ef
Exp.1 (1st and 2nd appls)+NIS	6.1, 0.1 oz/acre	0.5 bc	0.25 ab	14.75 de	2.5 de
Besiege (1st and 2nd appls)+NIS	8.9, 0.1 oz/acre	0.5 bc	0.25 ab	3.75 e	1.5 ef
Grandevo (1st and 2nd appls)	3 lb/acre	0 c	0.5 ab	9.75 de	5 c-e
Venerate (1st and 2nd appls)	8 qt/acre	0 c	0.25 ab	5 e	12.5 bc
Blackhawk(1st and 2nd appls)+APSA-80	3.3, 0.2 wt/acre	0 c	0 b	33.75 bc	0.5 ef
Blackhawk(1st and 2nd appls)+EXP.3	3.3, 0.2 wt/acre	0.5 bc	0.25 ab	10 de	1.5 ef
Agri-Mek (1st and 2nd appls)+APSA-80	14, 0.2 oz/acre	0.25 bc	0.25 ab	23.75 b-d	6.25 b-e
Agri-Mek (1st and 2nd appls)+EXP.3	14, 0.2 oz/acre	0 c	1.0 a	9.5 d-e	7.25 b-e
Exp. 2 (1st and 2nd appls)+MSO+Novodor	0.1, 0.125 lb/acre	0 c	0.5 ab	1 e	0.75 ef
Exp. 2 (1st and 2nd appls)+MSO+Novodor	0.2, 0.125, 2 lb/acre	0.75 ab	0.5 ab	17 c-e	2.5 de
Exp. 2 (1st and 2nd appls)+MSO+Novodor	0.4, 0.125, 2 lb/acre	0 c	0 b	4.75 e	0 e
Trident (1st and 2nd appls)	3 qt/acre	0.5 bc	0 b	12.5 de	6 c-e
Trident (1st and 2nd appls)	6 qt/acre	0 c	0.5 ab	8 de	0 e
Belay (1st and 2nd appls)	3 oz/acre	0 c	0 b	10 de	7.25 b-e
Untreated		1.5 a	0 b	40.75 ab	29.75 a
	P	0.0240	0.2111	< 0.001	< 0.001
	LSD	0.1685	0.2155	0.6713	0.5321

Means in columns followed by the same letter are not significantly different (Fisher's Protected Least Significant Difference Test, P = 0.05) (continued)
NIS 100 L added at 0.01% v/v

Table 2. (Continued) Mean Colorado potato beetle (CPB) counts per 10 plants of adults (AD), egg masses (EM), small (SL) and large (LL) larvae, percent defoliation and adult (AD) potato leafhoppers (PLH).

Treatment	Rate	CPB-AD 29-Jun	CPB-EM 29-Jun	CPB-SL 29-Jun	CPB-LL 29-Jun
Untreated		0.25 ab	0 b	15.5 a-c	15.5 ab
Imidan (1st and 2nd appl)	1.33 lb/acre	0.5 ab	0 b	0.25 h	1.5 e-i
Imidan (1st appl)+Blackhawk (2nd appl)	1.33, 3.3 lb/acre	0 b	0 b	2 e-h	1.5 e-i
Blackhawk(1st appl)+ Imidan (2nd appl)	1.33, 3.3 wt/acre	0 b	0 b	0.25 h	0.5 f-i
Blackhawk(1st appl)+Blackhawk (2nd appl)	3.3, 3.0 wt/acre	0.25 ab	0 b	0.75 f-h	1.25 g-i
Athena (1st and 2nd appls)	17 oz/acre	0.5 ab	0 b	1 f-h	0.75 g-i
Gladiator (1st and 2nd appls)	19 oz/acre	0.25 ab	0.25 ab	0.25 h	1 g-i
Brigadier (1st appl)+'Brigadier (2nd appl)	6.14, 5.0 oz/acre	0 b	0 b	4.5 b-f	2.25 c-i
Brigadier (1st appl)+Athena (2nd appl)	16.4, 17.0 oz/acre	0 b	0 b	0.5 f-h	4 e-i
IKI 3106 (1st and 2nd appls)	16.4 oz/acre	0 b	0 b	0.25 h	0.25 i
IKI 3106 (1st and 2nd appls)	11 oz/acre	0 b	0.5 b	0.75 f-h	1.75 g-i
Rimon (1 appl only)	12 oz/acre	0 b	0 b	1.75 e-h	3.5 c-i
Rimon (1st, 2nd and 3rd appl)	9.0, 8.0, 7.0 oz/acre	0 b	0.25 ab	0 h	0.25 i
Dimilin (1st and 3rd appls)	16 oz/acre	0 b	0 b	1.5 d-h	2.5 c-i
Dimilin (1st and 3rd appls)	12 oz/acre	0.25 ab	0 b	1.75 e-h	1.25 g-i
Dimilin (1st and 3rd appls)	8 oz/acre	0 b	0.5 ab	4.75 b-f	8.25 b-d
Dimilin (1 appl only)	5 oz/acre	0 b	0 b	3.5 d-h	15.5 b-e

DoubleTake (1st and 2nd appls)	4 oz/acre	0.5 ab	0.25 ab	2 d-h	2.75 c-i
DoubleTake (1st appl)+Dimilin (3rd appl)	4.0, 16.0 oz/acre	0 b	0 b	0.75 f-h	0 i
Exirel (1st and 2nd appls)+NIS	13.5, 0.1 oz/acre	0 b	0 b	0.75 f-h	0.25 i
Agri-Mek (1st and 2nd appls)+NIS	2.77, 0.1 oz/acre	0 b	0 b	0.5 f-h	1 g-i
Exp. 1 (1st and 2nd appls)+NIS	8.0, 0.1 oz/acre	0 b	0 b	0 h	2 d-i
Exp.1 (1st and 2nd appls)+NIS	6.1, 0.1 oz/acre	0 b	0 b	2.5 e-h	3.75 e-i
Besiege (1st and 2nd appls)+NIS	8.9, 0.1 oz/acre	0 b	0 b	1 f-h	0 i
Grandevo (1st and 2nd appls)	3 oz/acre	1.5 a	0 b	5.5 b-g	7.5 b-g
Venerate (1st and 2nd appls)	8 qt/acre	0.5 ab	0 b	9.25 b-d	14.75 bc
Blackhawk(1st and 2nd appls)+APSA-80	3.3, 0.2 wt/acre	0 b	0 b	0 h	0 i
Blackhawk(1st and 2nd appls)+EXP. 3	3.3, 0.2 wt/acre	0 b	0 b	2.5 e-h	4.75 d-i
Agri-Mek (1st and 2nd appls)+APSA-80	14, 0.2 oz/acre	0.75 ab	0 b	1.75 e-h	2 d-i
Agri-Mek (1st and 2nd appls)+EXP.3	14, 0.2 oz/acre	0 b	0 b	0 h	0 i
Exp.2 (1st and 2nd appls)+MSO+Novodor	0.1, 0.125 lb/acre	0 b	1.5 a	5 d-h	9.5 b-g
Exp.2 (1st and 2nd appls)+MSO+Novodor	0.2, 0.125, 2 lb/acre	0 b	0 b	16.5 ab	13 ab
Exp.2 (1st and 2nd appls)+MSO+Novodor	0.4, 0.125, 2 lb/acre	0.25 ab	0 b	5 c-h	8 b-h
Trident (1st and 2nd appls)	3 qt/acre	0 b	0 b	5.75 b-e	5.5 b-g
Trident (1st and 2nd appls)	6 qt/acre	0 b	0 b	9.25 b-f	7.5 c-i
Belay (1st and 2nd appls)	3 oz/acre	0.04	0.5 a	6.75 c-h	0 i
Untreated		0.5 ab	0 b	46 a	44.75 a
	P	0.4052	0.4924	< 0.001	< 0.001

	LSD	0.1871	0.1440	0.5274	0.5641

Means in columns followed by the same letter are not significantly different (Fisher's Protected Least Significant Difference Test, P = 0.05). (continued)

Table 3. Mean Colorado potato beetle (CPB) counts per 10 plants of adults (AD), egg masses (EM), small (SL) and large (LL) larvae, percent defoliation and adult (AD) potato leafhoppers (PLH).

Treatment	**Rate**	**CPB-AD** 7-Jul	**CPB-EM** 7-Jul	**CPB-SL** 7-Jul	**CPB-LL** 7-Jul
Untreated		0 b	0 b	14.5 b	15.75 a
Imidan (1st and 2nd appl)	1.33 lb/acre	0.25 ab	0 b	0.5 cd	2 c-g
Imidan (1st appl)+Blackhawk (2nd appl)	1.33, 3.3 lb/acre	0 b	0 b	0 d	0 g
Blackhawk(1st appl)+ Imidan (2nd appl)	1.33, 3.3 wt/acre	0 b	0 b	0 d	0 g
Blackhawk(1st appl)+Blackhawk (2nd appl)	3.3, 3.0 wt/acre	0 b	0 b	0 d	0 g
Athena (1st and 2nd appls)	17 oz/acre	0 b	0 b	0 d	0 g
Gladiator (1st and 2nd appls)	19 oz/acre	0 b	0 b	0 d	0.5 fg
Brigadier (1st appl)+'Brigadier (2nd appl)	6.14, 5.0 oz/acre	0 b	0 b	1 cd	1 e-g
Brigadier (1st appl)+Athena (2nd appl)	16.4, 17.0 oz/acre	0 b	0.25 a	0.25 cd	0 g
IKI 3106 (1st and 2nd appls)	16.4 oz/acre	0 b	0 b	0 d	0 g
IKI 3106 (1st and 2nd appls)	11 oz/acre	0 b	0 b	0 d	0 g
Rimon (1 appl only)	12 oz/acre	0 b	0 b	0.25 cd	0.25 fg
Rimon (1st, 2nd and 3rd appl)	9.0, 8.0, 7.0 oz/acre	0 b	0.25 a	0 d	0 g
Dimilin (1st and 3rd appls)	16 oz/acre	0 b	0 b	0.75 cd	0.75 e-g
Dimilin (1st and 3rd appls)	12 oz/acre	0 b	0 b	0.75 cd	0.25 fg

Dimilin (1st and 3rd appls)	8 oz/acre	0 b	0 b	13.25 b	5 bc
Dimilin (1 appl only)	5 oz/acre	0 b	0.25 a	0 d	5 c-f
DoubleTake (1st and 2nd appls)	4 oz/acre	0 b	0 b	0.25 cd	0.25 fg
DoubleTake (1st appl)+Dimilin (3rd appl)	4.0, 16.0 oz/acre	0 b	0 b	0.25 cd	0.5 fg
Exirel (1st and 2nd appls)+NIS	13.5, 0.1 oz/acre	0.25 ab	0 b	0 d	0 g
Agri-Mek (1st and 2nd appls)+NIS	2.77, 0.1 oz/acre	0 b	0 b	0 d	0 g
Exp.1 (1st and 2nd appls)+NIS	8.0, 0.1 oz/acre	0 b	0 b	0 d	0 g
Exp.1 (1st and 2nd appls)+NIS	6.1, 0.1 oz/acre	0 b	0 b	0 d	0 g
Besiege (1st and 2nd appls)+NIS	8.9, 0.1 oz/acre	0.25 ab	0 b	0 d	0.25 fg
Grandevo (1st and 2nd appls)	3 oz/acre	0 b	0 b	0.75 cd	8.5 b
Venerate (1st and 2nd appls)	8 qt/acre	0 b	0 b	5 cd	6.25 bc
Blackhawk(1st and 2nd appls)+APSA-80	3.3, 0.2 wt/acre	0 b	0 b	0	0.25 fg
Blackhawk(1st and 2nd appls)+EXP.3	3.3, 0.2 wt/acre	0 b	0 b	d	0 g
Agri-Mek (1st and 2nd appls)+APSA-80	14, 0.2 oz/acre	0 b	0 b	0 d	0 g
Agri-Mek (1st and 2nd appls)+EXP. 3	14, 0.2 oz/acre	0 b	0 b	0 d	0.75 fg
Exp. 2 (1st and 2nd appls)+MSO+Novodor	0.1, 0.125 lb/acre	0 b	0 b	0 d	3.5 d-g
Exp.2 (1st and 2nd appls)+MSO+Novodor	0.2, 0.125, 2 lb/acre	0 b	0 b	1.75 cd	7.75 b-d
Exp.2 (1st and 2nd appls)+MSO+Novodor	0.4, 0.125, 2 lb/acre	0 b	0 b	7.5 cd	0 g
Trident (1st and 2nd appls)	3 qt/acre	0 b	0 b	3.5 c	3.5 b-e
Trident (1st and 2nd appls)	6 qt/acre	0.75 a	0 b	0.25 cd	0 g

Belay (1st and 2nd appls)	3 oz/acre	0 b	0 b	0 d	0 g
Untreated		0 b	0 b	30.75 a	19 a
	P	0.5466	0.558	< .0001	< .0001
	LSD	0.0904	0.0599	0.3840	0.3665

Means in columns followed by the same letter are not significantly different (Fisher's Protected Least Significant Difference Test, P = 0.05) (continued)
NIS 100 L added at 0.01% v/v

Table 4. Mean Colorado potato beetle (CPB) counts per 10 plants of adults (AD), egg masses (EM), small (SL) and large (LL) larvae, percent defoliation and adult (AD) potato leafhoppers (PLH).

Treatment	**Rate**	**CPB-AD** 13-Jul	**CPB-EM** 13-Jul	**CPB-SL** 13-Jul	**CPB-LL** 13-Jul
Untreated		0.75 a-d	0	2.75 ab	10.0 a
Imidan (1st and 2nd appl)	1.33 lb/acre	1.25 a-d	0	0.25 bc	0.758 d-f
Imidan (1st appl)+Blackhawk (2nd appl)	1.33, 3.3 lb/acre	0.5 b-d	0	0 c	0 f
Blackhawk(1st appl)+ Imidan (2nd appl)	1.33, 3.3 wt/acre	2.25 a-c	0	0 c	0.75 d-f
Blackhawk(1st appl)+Blackhawk (2nd appl)	3.3, 3.0 wt/acre	0.25 cd	0	0 c	1 d-f
Athena (1st and 2nd appls)	17 oz/acre	1 a-d	0	0 c	1 d-f
Gladiator (1st and 2nd appls)	19 oz/acre	0.25 cd	0	0.75 a-c	4.25 bc
Brigadier (1st appl)+'Brigadier (2nd appl)	6.14, 5.0 oz/acre	1.25 a-d	0	0.5 a-c	5 c
Brigadier (1st appl)+Athena (2nd appl)	16.4, 17.0 oz/acre	2.25 ab	0	0.25 bc	0 f
IKI 3106 (1st and 2nd appls)	16.4 oz/acre	1 a-d	0	0 c	0.25 ef
IKI 3106 (1st and 2nd appls)	11 oz/acre	0 d	0	0 c	0 f
Rimon (1 appl only)	12 oz/acre	2 a-c	0	0 c	0 f

Rimon (1st, 2nd and 3rd appl)	9.0, 8.0, 7.0 oz/acre	0 d	0	0 c	0.5 ef
Dimilin (1st and 3rd appls)	16 oz/acre	0 d	0	0 c	0.5 ef
Dimilin (1st and 3rd appls)	12 oz/acre	0.5 b-d	0	0.75 a-c	0 f
Dimilin (1st and 3rd appls)	8 oz/acre	1 a-d	0	3 ab	1.75 c-f
Dimilin (1 appl only)	5 oz/acre	1 a-d	0	0 c	2 c-f
DoubleTake (1st and 2nd appls)	4 oz/acre	0.75 a-d	0	0 c	0.5 ef
DoubleTake (1st appl)+Dimilin (3rd appl)	4.0, 16.0 oz/acre	0 d	0	0 c	0 f
Exirel (1st and 2nd appls)+NIS	13.5, 0.1 oz/acre	0.75 a-d	0	0 c	0 f
Agri-Mek (1st and 2nd appls)+NIS	2.77, 0.1 oz/acre	0.25 cd	0	0 c	0 f
Exp.1 (1st and 2nd appls)+NIS	8.0, 0.1 oz/acre	0.5 b-d	0	0 c	0 f
Exp.1 (1st and 2nd appls)+NIS	6.1, 0.1 oz/acre	0.5 b-d	0	0 c	0 f
Besiege (1st and 2nd appls)+NIS	8.9, 0.1 oz/acre	0.25 cd	0	0 c	0 f
Grandevo (1st and 2nd appls)	3 oz/acre	2.25 a-c	0	3.25 a-c	4.25 c-e
Venerate (1st and 2nd appls)	8 qt/acre	0.25 cd	0	6.5 ab	5.25 bc
Blackhawk(1st and 2nd appls)+APSA-80	3.3, 0.2 wt/acre	1.5 a-d	0	0 c	0.25 ef
Blackhawk(1st and 2nd appls)+EXP. 3	3.3, 0.2 wt/acre	1 a-d	0	0 c	0.75 ef
Agri-Mek (1st and 2nd appls)+APSA-80	14, 0.2 oz/acre	1 a-d	0	0 c	0 f
Agri-Mek (1st and 2nd appls)+EXP. 3	14, 0.2 oz/acre	0 d	0	0 c	0 f
Exp.2 (1st and 2nd appls)+MSO+Novodor	0.1, 0.125 lb/acre	1.25 a-d	0	0 c	2 c-e
Exp.2 (1st and 2nd appls)+MSO+Novodor	0.2, 0.125, 2 lb/acre	1.75 a-d	0	1 a-c	2 c-e

Exp.2 (1st and 2nd appls)+MSO+Novodor	0.4, 0.125, 2 lb/acre	0.25 cd	0	0.25 bc	1.25 c-f
Trident (1st and 2nd appls)	3 qt/acre	3:00 AM	0	3.25 a-c	3.75 bc
Trident (1st and 2nd appls)	6 qt/acre	0.75 b-d	0	0.5 a-c	1 b-f
Belay (1st and 2nd appls)	3 oz/acre	1.25 a-d	0	0.5 a-c	0.25 e-f
Untreated		1.75 a-d	0	3.25 a	4 cd
	P	0.1908	.	0.167	< .0001
	LSD	0.3472	.	0.3466	0.3726

NIS 100L added at 0.1 % v/v, MSO added at 0.125 % v/v

Means in columns followed by the same letter are not significantly different (Fisher's Protected Least Significant Difference Test, P = 0.05) (continued)
NIS 100 L added at 0.01% v/v

Foliar insecticide treatments for the control of potato leafhopper in Wisconsin potato production

Purpose: The purpose of this experiment was to evaluate the efficacy of foliar insecticides *applied to potato for control of potato leafhopper (PLH), Empoasca fabae.*

Materials and Methods

This experiment was conducted at the Arlington Agricultural Experiment Station (AAES), Arlington, WI in 2015. Potato, *Solanum tuberosum* cv. 'Superior', seed pieces were planted on 6 May. Seed pieces were spaced 12 inches apart within rows. Rows were 3 ft apart. The two-row plots were 6 ft wide by 20 ft long, for a total of 0.003 acres. Two guard rows separated plots. . The plots were managed according to commercial pest management (herbicide and fungicide) practices as well as fertility recommendations prescribed by AAES.

Four replicates of 9 experimental foliar treatments and 1 untreated control were arranged in a randomized complete block design. The foliar treatments were applied 1 July. Treatments were applied with a CO_2 pressurized backpack sprayer with a 6 ft boom operating at 30 psi delivering 20 gpa through 4 flat-fan nozzles (Tee Jet XR8002XR) spaced 18" apart while travelling at 3.5 ft/sec.

PLH efficacy was assessed by counting the number of PLH nymphs (NY) on 25 randomly selected leaves in each plot while PLH adults (AD) were assessed by using sweep samples consisting of 25 sweeps per plot (**Table 1**). Insect counts occurred on three dates during July: 6 July (5 DAT), 9 Jul (8 DAT), and 16 July (15 DAT). Means were separated using ANOVA with a Fisher's Protected Least Squared Difference (LSD) mean separation test (P=0.05).
Aphid numbers were very low throughout the trial and were not included in the summary. No sign of phytotoxicity were observed.

Table 1. Mean adult (AD) and nymphal (NY) potato leafhoppers (PLH) per sample. PLH nymphs were assessed on 25 randomly selected leaves in each plot while adults were assessed by using sweep samples consisting of 25 sweeps per plot.

		6-Jul		9-Jul		16-Jul	
Treatment	**Rate**	**PLH-AD**	**PLH-NY**	**PLH-AD**	**PLH-NY**	**PLH-AD**	**PLH-NY**
Untreated		0.25 ab	0.0 a	0.25 ab	0.0 b	1.0 b-d	0.0 a
Sivanto	10 fl oz/a	0.25 b	0.5 a	0.25 ab	0.5 a	2.75 ab	0.0 a
Brigadier	5 fl oz/a	0 ab	0.0 a	0.0 b	0.0 b	0.25 cd	0.25 a
IKI 3106	16 fl oz/a	0.5 b	0.5 a	0.5 ab	0.5 ab	0.25 cd	0.0 a
Transform	2.5 fl oz/a	0.5 ab	0.0 a	0.5 ab	0.0 b	1.75 b-d	0.5 a
Rimon	12 fl oz/a	0.25 a	0.0 a	0.25 ab	0.0 b	1.75 bc	0.0 a
Exirel	13.5 fl oz/a	1.0 ab	0.0 a	1.0 a	0.0 b	6.5 a	0.75 a
Grandevo	3 lb/a	0.75 b	0.25 a	0.75 ab	0.25 ab	1.0 b-d	0.0 a
Venerate	8 qt/a	1.0 ab	0.0 a	1.0 ab	0.0 b	0.25 cd	0.0 a
Belay	3 fl oz/a	1.0 b	0.0 a	1.0 ab	0.0 b	0.0 d	0.0 a
	P	0.2463	0.7454	0.4615	0.2120	0.0027	0.6112
	LSD	0.2917	0.2956	0.2770	0.1400	0.3757	0.1881

Means in columns followed by the same letter are not significantly different (Fisher's Protected Least Significant Difference Test, P = 0.05).

Foliar insecticide treatments to limit the spread of *Potato virus Y* in Wisconsin seed potato production

Purpose: The purpose of this experiment was to evaluate the efficacy of varying rates of foliar-applied mineral oils, insecticides and feeding blockers in limiting the spread of potato virus Y (PVY) to foundation and certified seed potato. The goal is the refinement of PVY 'best management practices' to limit current season spread of the virus in seed potato using different application timing, application intervals, and tank mixes of mineral oils and selected feeding blockers in the PVY susceptible variety, Russet Norkotah.

Materials and Methods

This experiment was conducted at Langlade County Research Station, Antigo,WI in 2015. Potato, *Solanum tuberosum* cv. 'Russet Norkotah', seed pieces were planted on 20 May. Seed pieces were spaced 12 inches apart within rows. Rows were 3 ft apart. The four-row plots were 8 ft wide by 50 ft long, for a total of 0.009 acres. Replicates were separated by 12' alleys of bare ground. Drive rows for foliar applications were arranged to cover border rows and provide access for foliar applications to 4 row experimental plots. Natural sources of PVY inoculum are present in the local environment, and thus no PVY sap, or seed-borne inoculations were supplemented in the current experiment.

Four replicates of 7 experimental foliar treatments and 1 untreated control were arranged in a randomized complete block design. Foliar applications were initiated on 24 July and were re-applied once weekly for three weeks. Treatments were applied with a CO_2 pressurized tractor-mounted sprayer with a 12 ft boom operating at 40 psi delivering 28.4 gpa through extended range flat fan nozzle tips (Tee Jet XVS8004) travelling at 4.5 mph.

Aphid efficacy was assessed by counting the number of green peach aphid (GPA), potato aphid (PA), tarnish potato bug nymphs (TPB), and potato leaf hopper nymphs (PLH) on 25 randomly selected leaves in each plot (**Table 1**). Insect counts occurred on four dates after the last of the three applications: 12 Aug (5 DAT), 19 Aug (12 DAT), 26 Aug (19 DAT) and 2 Sept (26 DAT). Means were separated using ANOVA with a Fisher's Protected Least Squared Difference (LSD) mean separation test. Data are presented in **Table 1**. Incidence of PVY will be surveyed at the end of the experimental interval by counting all symptomatic plants in a sub-sample submitted to the University of Wisconsin's Post-Harvest Grow-out test in Wailea, Hawaii. These data indicate that none of the treatments had negative effects on potatoes within the plots and the grow-out test in Hawaii will reveal the effects of the various oil treatments on virus transmission.

Table 1. Mean insect counts for various foliar products applied to the canopy of 'Russet Norkotah' to limit the spread of Potato virus Y.

12 Aug (5 DAT)

Treatment	Rate	GPA	PA	Tot A	TPB	PLH
Untreated		3.75 a	0.0 a	3.75 a	0.25 a	0.25 a
Sivanto	10.5 fl oz/a	2.25 ab	0.0 a	2.25 ab	0.75 a	0.0 a
Transform	1.5 oz wt/a	0.25 b	0.0 a	0.25 b	0.25 a	0.0 a
PFR 97	1 lb/a	2.0 ab	0.0 a	2.0 ab	0.0 a	0.0 a
Fulfill	3.67 oz wt/a	0.0 b	0.25 a	0.25 b	0.25 a	0.0 a
Beleaf	2.8 oz wt/a	0.0 b	0.0 a	0.0 b	0.0 a	0.0 a
Assail	4 oz wt/a	0.0 b	0.0 a	0.0 b	0.25 a	0.0 a
Exirel	13.5 fl oz/a	0.75 ab	0.0 a	0.75 ab	0.75 a	0.0 a
	P	0.0868	0.4553	0.1230	0.7020	0.4553
	LSD	0.4169	0.0777	0.4240	0.2406	0.0777

19 Aug (12 DAT)

Treatment	Rate	GPA	PA	Tot A	TPB	PLH
Untreated		1.0 ab	0.25 a	1.25 ab	0.25 b	0.5 a
Sivanto	10.5 fl oz/a	1.75 a	0.25 a	2.0 a	0.0 b	0.25 a
Transform	1.5 oz wt/a	1.0 ab	0.0 a	1.0 ab	0.75 ab	0.25 a
PFR 97	1 lb/a	0.75 ab	0.25 a	1.0 ab	1.5 a	0.25 a
Fulfill	3.67 oz wt/a	0.0 b	0.25 a	0.25 b	0.25 b	0.75 a
Beleaf	2.8 oz wt/a	0.0 b	0.0 a	0.0 b	0.25 b	0.25 a
Assail	4 oz wt/a	2.25 a	0.0 a	2.25 a	0.25 b	0.0 a
Exirel	13.5 fl oz/a	0.25 b	0.0 a	0.25 b	1.5 a	0.25 a
	P	0.0608	0.7718	0.0929	0.0528	0.6831
	LSD	0.3353	0.1553	0.3505	0.2332	0.2266

26 Aug (19 DAT)

Treatment	Rate	GPA	PA	Tot A	TPB	PLH
Untreated		2.25 a	0.0 b	2.25 a	0.5 ab	0.25 ab
Sivanto	10.5 fl oz/a	0.0 b	0.0 b	0.0 b	0.0 b	0.0 b
Transform	1.5 oz wt/a	0.25 b	0.0 b	0.25 b	0.25 b	0.25 ab
PFR 97	1 lb/a	0.5 b	0.0 b	0.5 b	0.0 b	0.75 ab
Fulfill	3.67 oz wt/a	0.25 b	0.0 b	0.25 b	0.75 ab	1.75 a
Beleaf	2.8 oz wt/a	0.0 b	0.0 b	0.0 b	0.0 b	0.5 ab
Assail	4 oz wt/a	0.0 b	0.0 b	0.0 b	0.0 b	00. b
Exirel	13.5 fl oz/a	0.25 b	0.5 a	0.75 ab	1.0 a	0.5 ab
	P	0.0627	0.0207	0.0404	0.0334	0.3213
	LSD	0.2577	0.0897	0.2577	0.1954	0.2844

2 Sept (26 DAT)

Treatment	Rate	GPA	PA	Tot A	TPB	PLH
Untreated		4.25 ab	0.0	4.25 ab	0.5 ab	0.75 a
Sivanto	10.5 fl oz/a	3.0 a-c	0.0	3.0 a-c	0.0 b	0.0 a
Transform	1.5 oz wt/a	2.75 a-c	0.0	2.75 a-c	0.5 ab	0.0 a
PFR 97	1 lb/a	4.75 a	0.0	4.75 a	0.25 b	0.75 a
Fulfill	3.67 oz wt/a	0.25 c	0.0	0.25 c	0.0 b	1.25 a
Beleaf	2.8 oz wt/a	2.75 a-c	0.0	2.75 a-c	1.5 a	0.0 a
Assail	4 oz wt/a	3.25 a-c	0.0	3.25 a-c	0.25 b	0.0 a
Exirel	13.5 fl oz/a	0.75 bc	0.0	0.75 bc	0.0 b	0.25 a
	P	0.1155	0.0	0.1155	0.0421	0.2139
	LSD	0.4763	0.0	0.4763	0.2152	0.2547

Means in columns followed by the same letter are not significantly different (Fisher's Protected Least Significant Difference Test, P = 0.05).

Evaluation of systemic insecticides for the control of the Colorado potato beetle, potato leafhopper, and aphids on potato

Purpose: The objective of this experiment was to assess the efficacy of at-plant systemic insecticides to control Colorado potato beetle (CPB), *Leptinotarsa decemlineata*, potato leafhopper (PLH), *Empoasca fabae*, and potato colonizing aphid species on potatoes.

Materials and Methods

This experiment was conducted at Hancock Agricultural Experiment Station (HAES) located 1.1 mile (1.8 km) southwest of Hancock, Wisconsin on a loamy sand soil in 2015. Potato, *Solanum tuberosum* cv. 'Russet Burbank', seed pieces were planted on 24 April. Seed pieces were spaced 12 inches apart within rows. Rows were 3 ft apart. The four-row plots were 12 ft wide by 20 ft long, for a total of 0.006 acres. Two untreated guard rows separated plots. Plots were arranged in an 8 tier design with 12 ft alleys between tiers. All plots were maintained according to standard commercial production practices by HAES staff.

Four replicates of 8 experimental treatments and 1 untreated control were arranged in a randomized complete block design. Seed treatments were applied in 130 ml of water per 50 lb of seed on 23 April using a single nozzle boom applying 9.1 gpa equipped with a Tee Jet XR8002VS flat fan spray tip powered by a CO_2 backpack sprayer at 30psi. In-furrow insecticides were applied at planting with a CO_2 pressurized backpack sprayer operating at 30 psi with a 2 nozzle boom with Tee Jet 8001 flat fan nozzles delivering 11 gpa. Furrows were cut using a commercial potato planter without closing discs attached. Immediately after the in-furrow treatments were applied and all seed piece treatments were placed in open furrows, all seed was covered by hilling.

Stand counts were conducted on 26 May (32 DAP) by counting the number of emerged plants per 20 ft. section of row. CPB efficacy was assessed by counting the number of these insects per plant on 10 randomly selected plants in each plot. Defoliation ratings (% DF) were determined by visual observation of the entire plot. CPBs were recorded in the following life stages: adults (A), egg masses (EM), small larvae (SL), large larvae (LL). Potato leaf hoppers were recorded as nymphs (N) or adults (A). Adult PLH were sampled using sweep net techniques (15 sweeps per plot). PLH nymphs and aphids were assessed by visual inspection of 25 leaves per plot. Insect counts occurred on several dates throughout the summer, and insect count averages reflect time periods during the summer when specific life stages peaked in the plots (**Table 1**). Means were separated using ANOVA with a Fisher's Protected LSD means separation test (P=0.05). No signs of phytotoxicity were observed among experimental treatments.

Table 1. Mean Colorado potato beetle (CPB) counts per 10 plants of adults (AD), egg masses (EM), small (SL) and large (LL) larvae, percent defoliation and ad potato leafhoppers (PLH)

Treatment	Rate		Type[1]	CPB-A 9-Jun	CPB-A 20-Jul	CPB-EM 9-Jun	CPB-SL 23-Jun	CPB-LL 7-Jul	PLH-A 14-Jul	PLH-N 8-Jul
Untreated				4 ab	13.25 a-c	1.5 a	86.5 a	35.25 a	2.25 a-c	1.25 ab
Verimark	0.62	fl oz/cwt	S	3.25 bc	7.75 c	0.5 ab	5 c-e	10.75 ab	3.75 a	2:00 AM
AdmirePro	0.35	fl oz/cwt	S	2.75 bc	17.5 ab	1.5 a	20.5 a-c	28.5 a	0.75 cd	0 c
Cruiser	0.16	fl oz/cwt	S	5.5 ab	10 a-c	1.25 ab	13.75 b-d	9 ab	1.25 cd	0 c
Belay	0.6	fl oz/cwt	S	6.25 ab	5.5 c	0.25 ab	3 de	12.25 a	0.25 d	0.25 bc
Platinum	2.66	oz wt/a	IF	4.5 ab	5.5 c	0 b	0.5 e	2.75 bc	0.25 d	0 c
Verimark	13.5	fl oz/a	IF	1 c	1.5 d	0.25 ab	0.5 e	0.5 c	3.25 ab	0.5 bc
Sivanto	28	fl oz/a	IF	6.75 a	19.25 a	1.25 ab	57.25 ab	38.5 a	1.25 b-d	0.75 bc
Belay	12	fl oz/a	IF	3.25 ab	9.25 bc	0.5 ab	8.5 de	8 bc	1 cd	0 c
			P	0.0167	0.0003	0.1607	0.0003	0.0005	0.0056	0.0078
			LSD	0.3120	0.337	0.3019	0.7725	0.6393	0.3169	0.2448

Means in columns followed by the same letter are not significantly different (Fisher's Protected Least Significant Difference Test, P = 0.05).

[1] IF = In furrow, S = Seed treatment

Full season insecticide management programs for Colorado potato beetle in Wisconsin potatoes

Purpose: The purpose of this experiment was to evaluate various full-season, reduced-risk, insecticide programs designed to manage Colorado potato beetle (CPB) on potatoes in Wisconsin. With developing nicotinoid insecticide tolerance among CPB populations in the potato production areas in Wisconsin, several systemic based and foliar based programs were designed to evaluate their effectiveness on managing the CPB on potato.

Methods and Materials

This experiment was conducted in 2015 on a loamy sand soil at Hancock Agricultural Research station (HAES) located 1.1 mile (1.8 km) southwest of Hancock, Wisconsin in 2015. Potato, *Solanum tuberosum* cv. 'Russet Burbank', seed pieces were planted on 24 April. Plants were spaced 12 inches apart within rows. Rows were 3 ft apart. The 8-row plots were 24 feet wide by 40 feet long, for a total of 0.025 acres/plot. Replicates were separated by a 5 ft border of bare ground.

Three replicates of 12 full-season insecticide programs were arranged in a randomized complete block design. Systemic insecticides were applied in-furrow at planting (24 April for treatments 1-6). The first generation foliar applications were made on 19 and 29 Jun and were applied after peak egg hatch and prior to large larval population dominance (treatments 7, 10-12). Subsequent applications were made on 26 June (systemic rescue for treatments 1-6). Second generation CPB foliar applications were made to all treatments on 28 July. Treatment information is available in **Table 1**. All in-furrow treatments were applied at 11.0 gpa on 24 April using a two nozzle boom equipped with Tee Jet XR8001 flat fan spray nozzles powered by a CO_2 backpack sprayer at 30psi. Furrows were cut using a commercial potato planter without closing discs attached. Immediately after the in-furrow treatments were applied and all seed piece treatments were placed in open furrows, all seed was covered by hilling. Foliar insecticides were applied using a CO_2 pressurized sprayer with a 24 ft boom operating at 30 psi delivering 20 gpa through 16 Tee Jet XR8002XR flat fan nozzles spaced 18" apart while travelling at 4.0 ft/sec.

CPB efficacy was assessed by counting the number of egg masses (EM), small larvae (SL), and large larvae (LL) per plant on 10 randomly selected plants in each plot. Percent defoliation (% DF) ratings were taken by visual observation of the entire plot. Potato leafhopper (PLH), *Empoasca fabae*, efficacy was assessed by counting the number of adults collected from 15 sweep net samples in each plot. Aphid and potato leafhopper nymph populations were surveyed by visual assessment of 25 leaves per plot. Insect counts occurred on several dates throughout the summer and reported means were averaged across those dates (**Tables 2, 3**). Insect count averages reflect time periods during the summer when specific life stages peaked in the plots. Yield and quality data were collected after harvest (23 Sep) (**Table 4**). Means were separated using ANOVA with a Fisher's Protected Least Squared Difference (LSD) mean separation test (P=0.05). No signs of phytotoxicity were observed.

Table 1. Full-season, integrated pest and resistance management programs for control of the Colorado potato beetle.

	1st generation CPB					2nd generation CPB				
Trt	**App Date**	**Insecticide**	**Rate**		**[†]Type**	**App Date**	**Insecticide**	**Rate**		**[†]Type**
	24-Apr	Platinum 75 SC	2.67	fl oz/a	IF	28-Jul	[a]Besiege 1.25 ZC	9	fl oz/a	F
1	26-Jun	Blackhawk 36WG	3.3	oz/a	F					
2	24-Apr	Belay 2.13 SC	12	fl oz/a	IF	28-Jul	[a]Agri-Mek 0.7 SC	3.5	fl oz/a	F
	26-Jun	Blackhawk 36WG	3.3	oz/a	F					
3	24-Apr	Belay 2.13 SC	12	fl oz/a	IF	28-Jul	Assail 30% AW/W	4.0	oz wt/a	F
	26-Jun	Blackhawk 36WG	3.3	oz/a	F					
4	24-Apr	Verimark 20 SC	10	fl oz/a	IF	28-Jul	Actara 25% AW/W	3	oz wt/a	F
	26-Jun	Blackhawk 36WG	3.3	oz/a	F					
5	24-Apr	[a]Verimark 20 SC	13.5	fl oz/a	IF	28-Jul	Radiant 1 SC	8	fl oz/a	F
	26-Jun	Blackhawk 36WG	3.3	oz/a	F					
6	24-Apr	Admire Pro 4.6SC	4.6	fl oz/a	IF	28-Jul	IKI 3106 50GA/L	16	fl oz/a	F
	26-Jun	Blackhawk 36WG	3.3	oz/a	F					
7	19-Jun	[c]Rimon 0.83 EC	12	fl oz/a	F	28-Jul	Exirel 10 SE	13.5	fl oz/a	F
	29-Jun	[c]Rimon 0.83 EC	12	fl oz/a	F					
8	19-Jun	IKI 3106 50GA/L SL	16	fl oz/a	F	28-Jul	Assail 30% AW/W	4.0	oz wt/a	F
	29-Jun	IKI 3106 50GA/L SL	13	fl oz/a	F					
9	19-Jun	[b]Agri-Mek 0.7 SC	3.5	fl oz/a	F	28-Jul	Besiege 1.25 ZC	9	fl oz/a	F
	10-Jul	[b]Agri-Mek 0.7 SC	3	fl oz/a	F					
10	19-Jun	[b]Blackhawk 36 WG	3.3	oz wt/a	F	28-Jul	[d]Exirel 10 SE	5	fl oz/a	F
	10-Jul	[b]Blackhawk 36 WG	2.5	oz wt/a	F					
11	19-Jun	[b]Radiant 1 SC	8	fl oz/a	F	28-Jul	Assail 30% AW/W	4.0	oz wt/a	F
	10-Jul	[b]Radiant 1 SC	6	fl oz/a	F					
12	19-Jun	[a]Athena 0.87 EC	17	fl oz/a	F	28-Jul	Coagen 1.67 SC	5	fl oz/a	F
	29-Jun	[a]Athena 0.87 EC	14	fl oz/a	F					

[†]F=foliar, IF=In furrow

Table 2. Mean lifestage counts per 10 plants of Colorado potato beetles and percent defoliation.

Table 2. Mean lifestage counts per 10 plants of Colorado potato beetles and percent defoliation.

Trt	Adults	Egg Masses	Small Larvae	Large Larvae	% Defoliation
1	2.4 ab	0.2 a	4.1 ab	0.9 a	0.4 a
2	1.4 ab	0.0 a	3.3 a	1.8 a	0.3 a
3	4.0 ab	0.2 a	2.4 ab	2.0 a	0.4 a
4	1.4 abc	0.1 a	1.1 a-d	0.4 bc	0.4 a
5	0.6 cde	0.2 a	2.1 abc	0.2 c	0.4 a
6	2.5 a	0.0 a	3.0 ab	1.6 ab	0.4 a
7	0.9 b-e	0.1 a	1.2 bcd	0.9 bc	0.3 a
8	0.5 cde	0.0 a	0.0 d	0.4 a	0.3 a
9	0.6 cde	0.0 a	0.5 cd	0.3 c	0.3 a
10	0.3 e	0.0 a	0.3 cd	0.3 bc	0.3 a
11	0.3 de	0.1 a	0.6 cd	0.4 bc	0.3 a
12	1.2 bcd	0.1 a	0.9 abc	0.5 abc	0.3 a
P	0.0014	0.5198	0.0049	0.0086	0.1018
LSD	0.15	0.05	2.77	0.1	0.17

Means in a column followed by the same letter are not significantly different at $\alpha = 0.05$.
Means transformed (square root X +1) prior to separation.

Table 3. Mean potato leafhopper PLH and aphid counts per 10 plants

Trt	PLH adults	PLH nymphs	Aphids
1	0.2 a	0.0 a	0.0 a
2	0.1 a	0.0 a	0.0 a
3	0.0 a	0.0 a	0.0 a
4	0.1 a	0.0 a	0.1 a
5	0.3 a	0.1 a	0.0 a
6	0.2 a	0.0 a	0.0 a
7	0.3 a	0.0 a	0.0 a
8	0.4 a	0.1 a	0.0 a
9	0.3 a	0.1 a	0.0 a
10	0.2 a	0.0 a	0.0 a
11	0.1 a	0.0 a	0.0 a
12	0.0 a	0.0 a	0.0 a
P	0.7296	0.1128	0.7162
LSD	0.44	0.1	0.1

Table 4. Mean yield estimates.

Trt	Total US #1 (lbs)	Proportion US #1-A
1	772.8 a	95.30% a
2	855.9 a	95.24% a
3	734.5 a	95.03% a
4	790.7 a	95.73% a
5	797.1 a	94.95% a
6	749.8 a	94.25% a
7	701.6 a	92.89% a
8	765.2 a	93.77% a
9	753.3 a	93.66% a
10	840.5 a	94.32% a
11	862.9 a	95.81% a
12	904.1 a	95.23% a
P	0.153	0.6255
LSD	137.39	2.93

Means in a column followed by the same letter are not significantly different at $\alpha = 0.05$.
Means transformed (square root X +1) prior to separation

Foliar insecticide treatments for the control of European corn borer on Wisconsin snap bean production

Purpose: The purpose of this experiment is to evaluate various foliar-applied, registered and experimental insecticides targeting populations of European corn borer (ECB), *Ostrinia nubilalis*, larvae in snap beans.

Materials and Methods

This experiment was conducted at the Del Monte Foods Experimental Plots, near Plover, WI in 2015. Snap bean, *Phaseolus vulgaris* var. DM04-88 was seeded on 3 June at a rate of 8 seeds per foot within rows. Rows were 30 inches apart. The two-row plots were 5 ft wide by 25 ft long, for a total of 0.003 acres. Replicates were separated by two untreated rows. All plots were managed per commercial management practices.

Four replicates of 11 treatments and 1 untreated control were arranged in a randomized complete block design. The foliar treatments were applied 1 July when plants had reached the flowering and pin-bean development stage. Treatments were applied with a CO_2 pressurized backpack sprayer with a 6' boom operating at 30 psi delivering 20.2 gpa through a flat-fan nozzle (Tee Jet XR8002VS) spaced 18" apart while travelling at 3.5 ft / sec.

Populations of ECB and associated damage estimates were surveyed 22 July from 25 plants from the center row of each plot by counting (1) total number of pods from 25 plants, (2) number of damaged stems, (3) number of damaged pods, and (4) the number of viable larvae observed in both stems and pods. Means were separated using ANOVA with a Least Squared Difference (LSD) option. Data are presented in **Table 1**. No overt signs of phytotoxicity were observed.

Treatment	Rate			Proportion Damaged Stems	Proportion Damaged Pods
Untreated				0.4 ab	0.0538 a
Blackhawk	3.3	oz wt/a		0.2 bc	0.0046 bc
Brigade	5	fl oz/a		0.3 a-c	0.004 bc
IKI 3106	16	fl oz/a		0.05 bc	0.1115 bc
Besiege	8	fl oz/a		0.05 bc	0 c
Rimon	12	fl oz/a		0.1 bc	0.0095 bc
Exirel	13.5	fl oz/a		0 c	0.0038 bc
Grandevo	3	lb/a		0 c	0.0042 bc
Venerate	8	qt/a		0.15 bc	0.0174 bc
Radiant	8	fl oz/a		0.2 bc	0.0178 bc
Belt	3	fl oz/a		0.4 ab	0 c
Coragen	5	fl oz/a		0.5 a	0.0322 ab
			P	0.0394	0.0375
			LSD	0.3995	0.0306

Means in columns followed by the same letter are not significantly different (Fisher's Protected Least Significant Difference Test, P = 0.05).

Foliar insecticide treatments for the control of European corn borer in Wisconsin processing pepper production

Purpose: Evaluate various foliar-applied, registered insecticides targeting populations of ECB larvae in processing pepper, with the goal of developing efficacy data in support of future registration of novel insecticides.

Materials and Methods

This experiment was conducted at Arlington Agricultural Experiment Station in Arlington, WI in 2015. Pepper, *Capsicum annuum* cv. 'Wonderful', transplants were planted 3 June. Plants were spaced 24 inches apart within rows. Rows were 6 ft apart. Plots were single rows, 6 ft wide by 30 ft long, for a total of 0.004 acres. Replicates were separated by a 12 ft border of bare ground. The trial was established over black plastic and sprinkler irrigated over the growing season. Experimental plots were managed according to commercial herbicide and fungicide recommendations for weed control and control of the pepper blight resulting from *Phytophthora capsici*.

Each plot was infested with European corn borer (ECB), *Ostrinia nubilalis*, egg masses on 31 July. In each plot, five successive plants were infested, each with 10 egg masses for a total of 50 egg masses applied in each plot. Egg masses were attached to plants mid-canopy and onto stems with green fruit. Each egg mass contained approximately 20-30 eggs / mass.

Four replicates of 6 experimental foliar treatments and 1 untreated control were arranged in a randomized complete block design. The foliar treatments were applied 3 Aug when plant growth stage was at flowering and mature fruit set. Treatments were applied by a CO_2 pressurized backpack sprayer with a 3' boom operating at 30 psi delivering 22 gpa through 2 flat-fan nozzles (Tee Jet 8002XR) spaced 18" apart @ 3.5 ft / sec.

Populations of ECB and associated damage estimates were surveyed on 19 Aug by counting (1) total number of fruit, (2) number of damaged fruit, and (3) the number of viable larvae observed in fruit. See **Table 1** for a summary of key field activity dates. Means were separated using ANOVA with a Least Squared Difference (LSD) option (P=0.05).

Table 1. Summary of key field activity dates.

Action	Planting	Infestation	Insecticide app.	Evaluation
Date	3 Jun	31 July	3 Aug	19 Aug
Days from last action		52	3	16

Natural populations of ECB at the experimental site are annually variable and require that experimental plots be artificially infested with test insects. No signs of phytotoxicity were observed.

Table 2. Mean yield and damage estimates per 5 plants in pepper.

Treatment	Rate		Total No. Fruit/ 5 plts	Proportion Damaged Fruit	# Larvae
Untreated			30 b	0.072 a	0.25 b
Radiant+Induce	7.2	fl oz/a	21.25 b	0.047 a	0.25 ab
Intrepid			20.75 b	0.696 a	0 b
Coragen	5	fl oz/a	22.5 a	0.098 a	0.5 ab
Avaunt	3.5	oz wt/a	28 ab	0.048 a	0.25 b
Belt	1.5	fl oz/a	24 ab	0.029 a	0.25 ab
Warrior II	1.92	fl oz/a	25.25 b	0.098 a	0.0 a
		P	0.1675	0.8755	<.0001
		LSD	0.269	0.1179	1.0234

Means in columns followed by the same letter are not significantly different (Fisher's Protected Least Significant Difference Test, P = 0.05).