

Control of cabbage pests with insecticides in Ohio, 2009

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Objective: Evaluate efficacy and phytotoxicity of several insecticides against caterpillars as well as against flea beetles and aphids, including conventional formulations and experimental granular formulations, and Brigadier, a recently registered pre-mix.

Materials and methods:

The experimental design was randomized complete block with four blocked replicates and ten insecticide treatments. Products and rates are detailed in Table 1. Plug trays were seeded in a greenhouse on 6/12/2009 with 'Bravo' hybrid seeds (Rispen Seeds Inc., Beecher IL). Plots were established on 7/21/2009 at OSU's Waterman Agricultural and Natural Resources Laboratory at Columbus with transplanted plug seedlings. Each plot was one row 25 ft long with plants 18 inches apart. Rows were 10 ft apart to allow for spray roads between all rows and to minimize draft between plots.

Table 1. Products and rates of insecticides used in experimental treatments on cabbage, 2009.

Treatment	Rate of a.i. per acre	Rate of product
bifenthrin (Brigade 2EC) spray	0.033 lb a.i./A	2.1 fl oz product /A
carbaryl (Sevin XLR 4EC) spray	1.0 lb a.i./A	32 fl oz product/A
bifenthrin + carbaryl (Brigade 2EC + Sevin XLR 4EC) spray	0.033 lb + 1.0 lb a.i./A	tank mix 2.1 + 32 fl oz products/A
bifenthrin + carbaryl FG1 (foliar granule, type 1)	0.033 + 1.0 lb a.i./A	175 lb product/A (4.013 lb product/1000 ft ²)
bifenthrin + carbaryl FG2 (foliar granule, type 2)	0.033 + 1.0 lb a.i./A	175 lb product/A (4.013 lb product/1000 ft ²)
bifenthrin+imidacloprid (Brigadier 2EC) spray	0.0656 lb a.i./A	4.2 fl oz product /A
bifenthrin+imidacloprid FG1 (foliar granule, type 1)	0.0656 lb a.i./A	96.5 lb product/A (2.215 lb/1000 ft ²)
bifenthrin+imidacloprid FG2 (foliar granule, type 2)	0.0656 lb a.i./A	96.5 lb product/A (2.215 lb/1000 ft ²)
<i>Bacillus thuringiensis</i> (Dipel DF) spray	14.5 BIU/A	1 lb product/acre
untreated control	-	-

Insecticide treatments were applied at two-week intervals, on 8/12, 8/25, 9/8, 9/23, for four total applications, except B.T., which was applied once per week from 8/12 through 9/23, for seven total applications. Spray treatments were applied by a conventional tractor-drawn boom sprayer that applied 50 gallons per acre at 75 psi with ConeJet-12 nozzles and a travel speed of 2 mph. Granular treatments were applied with a modified hand-held Dustin-Mizer Model 1212 applicator (Earthduster LLC, Johnson AR) used concurrently with a Solo backpack sprayer that wet the granules and plants by applying water mixed with the adjuvant Nu Film 17 (Miller Chemical & Fertilizer Corp., Hanover PA) at 16 fl oz/acre in a spray volume of 50 gallons per acre.

Plots were scouted for insect pests nine times at weekly intervals from 7/27 to 9/22. Sample size was five whole plants per plot in first six weeks, and three whole plants per plot in last three weeks. Counts of individual caterpillar species were combined by calculating the mean number of larval units per plant, using weights of 1.0 for cabbage loopers over 0.5 inch, 0.67 for cabbage loopers under 0.5 inch and imported cabbageworms over 0.5 inch, 0.1 for imported cabbageworms under 0.5 inch and all diamondback moth larvae. Occasional species such as cross-striped cabbageworm, yellow-striped armyworm, fall armyworm, corn earworm, and yellow woollybear were assigned the same weight as imported cabbageworm: 0.67 if over 0.5 inch, and 0.1 if under 0.5 inch. The larval units were compared with a threshold number of larval units that was appropriate for each crop growth stage and air temperature on the day of scouting. Flea beetles were counted and their damage rated on a scale of 0 to 3: 0 for no damage; 1 for low (1-5 patches per plant); 2 for moderate (6-25 patches per plant); 3 for high (>25 patches per plant). Aphid colonies were rated on a scale of 0 to 3: 0 for none; 1 for low (1-3 colonies per plant); 2 for moderate (4-9 colonies per plant); 3 for high (>9 colonies per plant). Data were analyzed by SAS using PROC ANOVA with mean separations by LSD.

At harvest on 10/1/2009, heads on ten plants per plot were rated for marketability using a 6-point Greene's scale: 1 for no apparent insect feeding; 2 for minor insect feeding on wrapper or outer leaves, 0-1% leaf area eaten; 3 for moderate insect feeding on wrapper or outer leaves with no head damage, 2-5% leaf area eaten; 4 for moderate insect feeding on wrapper or outer leaves with minor feeding on head,

6-10% leaf area eaten, head unmarketable under normal market conditions; 5 for moderate to heavy feeding on wrapper and head leaves and a moderate number of feeding scars on head, 11-30% of leaf area eaten; 6 for considerable insect feeding on wrapper and head leaves with head having numerous feeding scars, over 30% of leaf area eaten. Heads are marketable if the rating is 1-3; unmarketable if the rating is 4-6. Three heads per plot were weighed and head diameter measured. Weights were recorded both by fresh market standards, with four wrapper leaves intact, and by processing standards, with wrapper leaves and green head leaves removed. Aphids on heads at harvest were rated as present or absent. Contamination of heads by insect frass and by granules was rated on a scale of 0 to 3, with 0 as none, one as light, two as moderate, and three as heavy. Contamination of heads by pepper spot or purpling was also rated on a scale of 0 to 3. Data were analyzed by SAS using PROC ANOVA with mean separations by LSD.

Results & Discussion:

The marketability of cabbage heads varied significantly among treatments ($P < 0.0001$); heads in the untreated control were significantly less marketable than all other treatments (Table 2). The highest marketability was in the Brigadier spray and bifenthrin spray treatments, which were significantly more marketable than heads in the carbaryl spray, bifenthrin + carbaryl FG1 granule, bifenthrin + imidacloprid FG1 granule, and BT spray treatments (Table 2). There were no significant differences among treatments in weight per head either by fresh market or processing standards, or in head diameter (Table 2). Contamination of heads by insect frass varied significantly among treatments ($P = 0.0008$), with significantly less frass in the bifenthrin + carbaryl spray, and bifenthrin + imidacloprid FG2 granule treatments, than in the untreated control, bifenthrin + carbaryl FG1 granule treatment, BT spray, and bifenthrin spray (Table 3). Contamination of heads by insecticide granules did not vary significantly among treatments ($P = 0.53$; Table 3). Pepper spot and purpling were found in some heads but did not vary significantly among treatments ($P = 0.13$; Table 3). No phytotoxicity was observed.

Weekly scouting showed the progression of insect infestation through the season. In the untreated control treatment, the caterpillar threshold for processing cabbage was never exceeded, but the fresh-market threshold was exceeded on 9/8 and 9/14 (Table 4). The insecticide treatments were first applied after the third week, when caterpillars were found in most plots although at density below the action threshold. The fewest larval units were generally found in the Brigadier spray, bifenthrin + carbaryl spray, and bifenthrin + imidacloprid FG2 granule treatments (Table 4). The number of larval units differed significantly among treatments in four weeks. On 8/17, there were significantly more larvae in bifenthrin + carbaryl FG1 granule and BT spray treatments than in all other treatments except for the untreated control ($P = 0.04$; Table 4). On 9/8, the untreated control and carbaryl spray treatments had significantly more larvae than all other treatments ($P < 0.0001$; Table 4). On 9/14, the untreated control had significantly more larvae than all other treatments ($P < 0.0001$; Table 4). On 9/22, the untreated control again had significantly more larvae than all other treatments ($P = 0.04$; Table 4). Comparing the efficacy of the same active ingredients in different formulations, caterpillar control by bifenthrin + imidacloprid as foliar granules (FG1 and FG2) was never significantly different than as a foliar spray. Caterpillar control by bifenthrin + carbaryl as FG1 foliar granules was significantly poorer than as FG2 or a foliar spray on one date, 8/17 (Table 4).

Flea beetle damage ratings varied among treatments in most weeks, with significantly more damage in untreated control, BT spray, and bifenthrin + imidacloprid FG1 granule treatments than in other treatments (Table 5). The trend was for the least damage by flea beetles in the Brigadier spray and bifenthrin spray treatments. Aphid infestation ratings varied among treatments in 4 of 9 weeks, with similar trends of the least damage in the Brigadier spray treatments (Table 6).

Summaries of weekly scouting data including density of individual caterpillar species is shown in Tables 7-15.

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Table 2. Marketability and size of cabbage heads at harvest on 10/1/2009.

Treatment	Marketability ^{a, b}	Aphid presence on head (scale 0-1) ^b	Weight per head (kg)		Head diameter (cm)
			Fresh market (with wrapper leaves)	Processing (green leaves trimmed)	
bifenthrin + carbaryl FG1	2.4 B	0.08 BC	2.54	1.84	18.3
bifenthrin + carbaryl FG2	2.2 BCDE	0.08 BC	2.48	1.82	18.4
bifenthrin + imidacloprid FG1	2.4 BC	0.03 C	2.22	1.92	18.4
bifenthrin + imidacloprid FG2	2.1 CDE	0 C	2.39	1.75	18.7
bifenthrin + imidacloprid (Brigadier) spray	2.0 E	0 C	2.69	1.84	18.4
bifenthrin + carbaryl spray	2.0 DE	0.03 C	2.29	1.68	17.5
bifenthrin spray	2.0 E	0.10 BC	2.66	1.90	18.5
carbaryl spray	2.4 B	0.10 BC	2.54	1.84	18.3
BT (Dipel) spray	2.3 BCD	0.18 AB	2.36	1.75	18.4
untreated	3.8 A	0.28 A	2.29	1.66	17.6
<i>P (treatment effect)</i>	<i><0.0001</i>	<i>0.0002</i>	<i>0.79</i>	<i>0.96</i>	<i>0.95</i>

^a Greene's marketability scale, 1 to 6; heads are marketable if rating is 1-3; unmarketable if rating is 4-6.

^b Within each column, means followed by same letter are not significantly different ($P>0.05$); mean separations by LSD.

Table 3. Contamination of cabbage heads at harvest

Treatment	Rating of contamination by insect frass on head (scale 0 to 3) ^a	Rating of contamination by granules on head (scale 0 to 3)	Rating of contamination inside head by pepper spot or purpling (scale 0-3)
bifenthrin + carbaryl FG1	1.8 A	1.2	0.3
bifenthrin + carbaryl FG2	0.9 CD	0.6	0.3
bifenthrin + imidacloprid FG1	1.2 BCD	0.9	0
bifenthrin + imidacloprid FG2	0.8 D	0.6	0.3
bifenthrin + imidacloprid (Brigadier) spray	0.9 CD	-	0
bifenthrin + carbaryl spray	0.7 D	-	0
bifenthrin spray	1.1 BCD	-	0.3
carbaryl spray	1.3 ABC	-	0
BT (Dipel) spray	1.5 AB	-	0.3
untreated	1.8 A	-	0.8
<i>P (treatment effect)</i>	<i>0.0008</i>	<i>0.53</i>	<i>0.13</i>

^a Within each column, means followed by same letter are not significantly different ($P>0.05$); mean separations by LSD.

Table 4. Plant size and caterpillar density on cabbage plants as determined by weekly plant scouting.

	Size of plants and threshold on 9 sampling dates								
	7/27	8/3	8/10	8/17	8/24	8/31	9/8	9/14	9/22
Number of leaves	7	8	11	14	22	-	-	-	-
Head diameter	-	-	-	-	2"	3"	4"	5"	6"
Temperature (mean; °F)	72	71	80	79	66	62	64	64	74
Threshold (processing) ^a	0.12	0.16	0.22	0.37	1.68	2.75	2.94	3.64	2.44
Threshold (fresh market) ^a	0.12	0.16	0.22	0.37	1.68	0.5	0.5	0.5	0.5
Treatment	Number of larval units ^{a, b} per plant								
bifenthrin + carbaryl FG1	0	0.02	0.04	0.31 A	0.31	0.05	0.20 B	0.11 BC	0.22 AB
bifenthrin + carbaryl FG2	0	0.01	0.04	0.07 B	0.01	0.04	0.09 B	0.03 C	0.05 B
bifenthrin + imidacloprid FG1	0	0	0.01	0.05 B	0.01	0.06	0.06 B	0.04 C	0.05 B
bifenthrin + imidacloprid FG2	0	0.01	0.10	0.01 B	0.02	0.01	0.02 B	0.06 C	0.03 B
bifenthrin + imidacloprid (Brigadier) spray	0.01	0	0.06	0.03 B	0	0	0.03 B	0.01 C	0 B
bifenthrin + carbaryl spray	0	0	0.02	0 B	0.01	0	0.03 B	0 C	0.01 B
bifenthrin spray	0	0	0.06	0.02 B	0.02	0.05	0.03 B	0.01 C	0.06 B
carbaryl spray	0	0.02	0.02	0.02 B	0.02	0.20	0.52 A	0.29 B	0.10 B
BT (Dipel) spray	0	0	0.04	0.29 A	0.04	0.09	0.11 B	0.09 BC	0.07 B
untreated	0	0	0.02	0.13 AB	0.05	0.31	0.71 A	0.60 A	0.44 A
<i>P</i> (treatment effect)	0.46	0.34	0.37	0.0415	0.08	0.15	<0.0001	<0.0001	0.0360

^a Larval units = (number of large cabbage looper larvae * 1.0) + (number of small cabbage looper larvae * 0.67) + (number of large imported cabbageworm larvae * 0.67) + (number of small imported cabbageworm larvae * 0.1) + (number of diamondback moth larvae * 0.1) + (number of large other species larvae * 0.67) + (number of small other species larvae * 0.1).

^b Within each column, means followed by same letter are not significantly different ($P>0.05$); mean separations by LSD.

Table 5. Damage ratings for flea beetles on cabbage as determined by weekly plant scouting.

Treatment	Flea beetle damage rating (scale 0 to 3) ^{a, b} on 9 sampling dates								
	7/27	8/3	8/10	8/17	8/24	8/31	9/8	9/14	9/22
bifenthrin + carbaryl FG1	0	0.3	0.3	0.4 C	0.9 ABC	0.4 B	0.6 BC	0.8	0.5 BCD
bifenthrin + carbaryl FG2	0.1	0.3	0.7	0.5 C	0.8 BC	0.4 B	0.7 BC	1.0	0.7 BCD
bifenthrin + imidacloprid FG1	0.1	0.1	0.4	0.7 BC	1.3 A	0.9 AB	0.8 AB	0.9	0.8 ABC
bifenthrin + imidacloprid FG2	0.2	0.1	0.5	0.3 C	0.6 C	0.5 B	0.3 C	0.5	0.5 BCD
bifenthrin + imidacloprid (Brigadier) spray	0.2	0.3	0.4	0.2 C	0.5 C	0.5 B	0.4 BC	0.5	0.1 D
bifenthrin + carbaryl spray	0.2	0	0.4	0.4 C	0.7 C	0.4 B	0.6 BC	0.7	0.3 CD
bifenthrin spray	0.2	0.1	0.6	0.3 C	0.5 C	0.3 B	0.3 C	0.5	0.3 CD
carbaryl spray	0	0.4	0.4	0.2 C	0.7 C	0.9 AB	0.5 BC	0.8	0.9 AB
BT (Dipel) spray	0.2	0.4	0.6	1.7 A	0.6 C	1.3 A	1.2 A	0.8	1.1 AB
untreated	0	0.1	0.8	1.2 AB	1.2 AB	1.1 A	1.3 A	0.8	1.3 A
<i>P</i> (treatment effect)	0.49	0.45	0.81	0.0002	0.0167	0.0242	0.0007	0.12	0.0047

^a 0 = none; 1 = low (1-5 patches per plant); 2 = moderate (6-25 patches per plant); 3 = high (>25 patches per plant).

^b Within each column, means followed by same letter are not significantly different ($P>0.05$); mean separations by LSD.

Table 6. Aphids on cabbage as determined by weekly plant scouting.

Treatment	Aphid density rating (scale 0 to 3) ^{a, b} on 9 sampling dates								
	7/27	8/3	8/10	8/17	8/24	8/31	9/8	9/14	9/22
bifenthrin + carbaryl FG1	0.3	1.3	1.3	1.0 AB	1.2	0.8 ABCD	1.1 A	0.8 BC	0.8
bifenthrin + carbaryl FG2	0.4	1.2	1.0	1.0 AB	0.9	1.0 AB	0.8 AB	0.9 BC	0.4
bifenthrin + imidacloprid FG1	0.4	1.0	1.1	0.5 C	0.9	0.6 BCD	0.9 A	0.8 BC	1.0
bifenthrin + imidacloprid FG2	0.8	1.0	1.2	0.8 ABC	1.2	0.6 CD	0.5 BC	0.7 CD	0.6
bifenthrin + imidacloprid (Brigadier) spray	0.8	0.9	0.8	0.3 C	1.1	0.2 E	0.4 C	0.2 D	0.3
bifenthrin + carbaryl spray	0.4	1.0	1.1	0.7 BC	1.1	0.7 BCD	0.5 BC	0.9 BC	0.6
bifenthrin spray	0.5	1.2	1.2	0.6 BC	0.6	0.5 DE	0.9 A	1.1 BC	0.5
carbaryl spray	0.6	1.1	1.3	1.2 A	1.1	1.1 A	0.9 A	1.3 AB	0.8
BT (Dipel) spray	0.6	1.3	1.2	1.0 AB	0.7	0.9 ABC	1.2 A	1.8 A	1.1
untreated	0.7	1.4	1.4	0.8 ABC	1.2	0.8 ABCD	1.1 A	1.3 AB	1.1
<i>P (treatment effect)</i>	<i>0.50</i>	<i>0.40</i>	<i>0.86</i>	<i>0.0233</i>	<i>0.38</i>	<i>0.0018</i>	<i>0.0006</i>	<i>0.0011</i>	<i>0.46</i>

^a 0 = none; 1 = low (1-3 colonies per plant); 2 = moderate (4-9 colonies per plant); 3 = high (>9 colonies per plant).

^b Within each column, means followed by same letter are not significantly different ($P > 0.05$); mean separations by LSD.

Table 7. Insects and insect damage found by scouting, Week 1 (7/27/09; pre-spray)

Treatment	Number of larval units per plant	Caterpillar damage rating	Number of ICW eggs per plant	Number of larvae per plant				Flea beetle damage rating	Number of flea beetles per plant	Aphid density rating
				ICW	DBM	CL	other			
bifenthrin + carbaryl FG1	0	0	0.15	0	0	0	0	0	0.15	0.3
bifenthrin + carbaryl FG2	0	0	0	0	0	0	0	0.05	0.3	0.4
bifenthrin + imidacloprid FG1	0	0	0.05	0	0	0	0	0.05	0.15	0.4
bifenthrin + imidacloprid FG2	0	0.05	0.10	0	0	0	0	0.15	0.05	0.8
bifenthrin + imidacloprid (Brigadier) spray	0.005	0.20	0.05	0	0	0	0.05	0.2	0.20	0.8
bifenthrin + carbaryl spray	0	0.15	0.05	0	0	0	0	0.2	0.25	0.4
bifenthrin spray	0	0.10	0.05	0	0	0	0	0.15	0.5	0.5
carbaryl spray	0	0.10	0.10	0	0	0	0	0	0.05	0.6
BT (Dipel) spray	0	0	0	0	0	0	0	0.15	0.4	0.6
untreated	0	0	0.05	0	0	0	0	0	0.05	0.7
<i>P (treatment effect)</i>	<i>0.46</i>	<i>0.47</i>	<i>0.38</i>	-	-	-	<i>0.46</i>	<i>0.49</i>	<i>0.80</i>	<i>0.50</i>

Table 8. Insects and insect damage found by scouting, Week 2 (8/3/09; pre-spray)

Treatment	Number of larval units per plant	Caterpillar damage rating	Number of ICW eggs per plant	Number of larvae per plant				Flea beetle damage rating	Number of flea beetles per plant	Aphid density rating
				ICW	DBM	CL	other			
bifenthrin + carbaryl FG1	0.015	0.25	0	0.15	0	0	0	0.3	0.05	1.3
bifenthrin + carbaryl FG2	0.005	0.20	0.2	0.05	0	0	0	0.3	0	1.2
bifenthrin + imidacloprid FG1	0	0.15	0.3	0	0	0	0	0.1	0	1.0
bifenthrin + imidacloprid FG2	0.005	0.10	0.3	0.05	0	0	0	0.1	0.15	1.0
bifenthrin + imidacloprid (Brigadier) spray	0	0.10	0.3	0	0	0	0	0.3	0	0.9
bifenthrin + carbaryl spray	0	0.15	0.1	0	0	0	0	0	0	1.0
bifenthrin spray	0	0.10	0.2	0	0	0	0	0.1	0.10	1.2
carbaryl spray	0.015	0.15	0.4	0.15	0	0	0	0.4	0	1.1
BT (Dipel) spray	0	0.20	0.3	0	0	0	0	0.4	0.05	1.3
untreated	0	0.10	0.3	0	0	0	0	0.1	0.05	1.4
<i>P (treatment effect)</i>	<i>0.34</i>	<i>0.86</i>	<i>0.87</i>	<i>0.34</i>	-	-	-	<i>0.45</i>	<i>0.29</i>	<i>0.40</i>

Table 9. Insects and insect damage found by scouting, Week 3 (8/10/09; pre-spray)

Treatment	Number of larval units per plant	Caterpillar damage rating	Number of ICW eggs per plant	Number of larvae per plant				Flea beetle damage rating	Number of flea beetles per plant	Aphid density rating
				ICW	DBM	CL	other			
bifenthrin + carbaryl FG1	0.04	0.8	0.5	0.1	0	0.1	0	0.3	0.1	1.3
bifenthrin + carbaryl FG2	0.04	0.7	0.1	0.4	0	0	0	0.7	0.4	1.0
bifenthrin + imidacloprid FG1	0.01	0.4	0.2	0.1	0.1	0	0	0.4	0.1	1.1
bifenthrin + imidacloprid FG2	0.10	0.5	0.2	0.3	0.2	0	0	0.5	0.6	1.2
bifenthrin + imidacloprid (Brigadier) spray	0.06	0.5	0.3	0.2	0.1	0.1	0	0.4	0.1	0.8
bifenthrin + carbaryl spray	0.02	0.4	0.3	0.1	0.1	0	0	0.4	0.1	1.1
bifenthrin spray	0.06	0.5	0.2	0.1	0.2	0.1	0	0.6	0.2	1.2
carbaryl spray	0.02	0.7	0	0.1	0.2	0	0	0.4	0.3	1.3
BT (Dipel) spray	0.04	0.6	0.2	0.1	0.3	0	0	0.6	0.4	1.2
untreated	0.02	0.7	0.3	0.2	0.1	0	0	0.8	0.9	1.4
<i>P (treatment effect)</i>	<i>0.37</i>	<i>0.39</i>	<i>0.35</i>	<i>0.13</i>	<i>0.49</i>	<i>0.62</i>	-	<i>0.81</i>	<i>0.27</i>	<i>0.86</i>

^a Within each column, means followed by same letter are not significantly different ($P>0.05$); mean separations by LSD.

Table 10. Insects and insect damage found by scouting, Week 4 (8/17/09; 5 days after first treatments)

Treatment	Number of larval units/plant ^a	Caterpillar damage rating	Number of ICW eggs/plant	Number of larvae per plant				Flea beetle damage rating ^a	Number of flea beetles per plant ^a	Aphid density rating ^a
				ICW	DBM	CL ^a	other			
bifenthrin + carbaryl FG1	0.31 A	0.8	0.2	0.3	0.1	0.4 A	0 B	0.4 C	0.3 B	1.0 AB
bifenthrin + carbaryl FG2	0.07 B	1.0	0.4	0	0	0.1 BC	0 B	0.5 C	0.3 B	1.0 AB
bifenthrin + imidacloprid FG1	0.05 B	0.8	0.1	0	0.2	0.1 BC	0 B	0.7 BC	0.8 B	0.5 C
bifenthrin + imidacloprid FG2	0.01 B	1.0	0.2	0	0.1	0 C	0 B	0.3 C	0.2 B	0.8 ABC
bifenthrin + imidacloprid (Brigadier) spray	0.03 B	0.6	0.3	0	0	0 C	0.1 B	0.2 C	0.1 B	0.3 C
bifenthrin + carbaryl spray	0 B	0.8	0.2	0	0	0 C	0 B	0.4 C	0.3 B	0.7 BC
bifenthrin spray	0.02 B	0.6	0.2	0.2	0	0 C	0 B	0.3 C	0.1 B	0.6 BC
carbaryl spray	0.02 B	0.8	0.2	0	0.2	0 C	0 B	0.2 C	0.1 B	1.2 A
BT (Dipel) spray	0.29 A	1.2	0.2	0.1	0.2	0.3 AB	0 B	1.7 A	4.2 A	1.0 AB
untreated	0.13 AB	1.1	0.1	0.3	0.1	0 C	0.4 A	1.2 AB	1.6 B	0.8 ABC
<i>P (treatment effect)</i>	<i>0.0415</i>	<i>0.08</i>	<i>0.77</i>	<i>0.09</i>	<i>0.15</i>	<i>0.0430</i>	<i>0.07</i>	<i>0.0002</i>	<i>0.0083</i>	<i>0.0233</i>

^a Within each column, means followed by same letter are not significantly different ($P>0.05$); mean separations by LSD.

Table 11. Insects and insect damage found by scouting, Week 5 (8/24/09; 12 days after first treatments)

Treatment	Number of larval units/plant	Caterpillar damage rating			Number of larvae per plant				Flea beetle damage rating ^a	Number of flea beetles/plant ^a	Aphid density rating
		Frame	Wrap-per	Head	ICW	DBM	CL	other			
bifenthrin + carbaryl FG1	0.31	1.6	0.6	0.5	0.10	0.20	0.25	0.05	0.9 ABC	0.9 AB	1.2
bifenthrin + carbaryl FG2	0.01	1.4	0.4	0.1	0.10	0	0	0	0.8 BC	0.3 B	0.9
bifenthrin + imidacloprid FG1	0.01	0.7	0.3	0.1	0.05	0	0	0	1.3 A	1.7 A	0.9
bifenthrin + imidacloprid FG2	0.02	1.0	0.1	0	0.10	0	0	0.05	0.6 C	0.5 B	1.2
bifenthrin + imidacloprid (Brigadier) spray	0.	1.1	0.4	0	0	0	0	0	0.5 C	0.1 B	1.1
bifenthrin + carbaryl spray	0.01	1.1	0.3	0	0.05	0	0	0	0.7 C	0.5 B	1.1
bifenthrin spray	0.02	1.1	0.2	0.1	0	0.10	0	0.05	0.5 C	0.2 B	0.6
carbaryl spray	0.02	0.9	0.2	0	0.10	0.05	0	0.05	0.7 C	0.5 B	1.1
BT (Dipel) spray	0.04	1.3	0.7	0.2	0.20	0.15	0	0	0.6 C	0.7 B	0.7
untreated	0.05	1.5	0.8	0.5	0.05	0.10	0	0.05	1.2 AB	0.6 B	1.2
<i>P (treatment effect)</i>	<i>0.08</i>	<i>0.11</i>	<i>0.0574</i>	<i>0.063</i>	<i>0.26</i>	<i>0.25</i>	<i>0.13</i>	<i>0.83</i>	<i>0.0167</i>	<i>0.0446</i>	<i>0.38</i>

^a Within each column, means followed by same letter are not significantly different ($P>0.05$); mean separations by LSD.

Table 12. Insects and insect damage found by scouting, Week 6 (8/31/09; 6 days after second treatments)

Treatment	Number of larval units/plant	Caterpillar damage rating			Number of larvae per plant				Flea beetle damage rating ^a	Number of flea beetles/plant ^a	Aphid density rating ^a
		frame	Wrap-per ^a	Head	ICW ^a	DBM	CL	other			
bifenthrin + carbaryl FG1	0.05	1.0	0.2 B	0	0.10 B	0.10	0	0	0.4 B	0.1 C	0.8 ABCD
bifenthrin + carbaryl FG2	0.04	1.1	0.0 B	0	0 B	0.10	0.05	0	0.4 B	0.3 BC	1.0 AB
bifenthrin + imidacloprid FG1	0.06	1.3	0.2 B	0	0.20 AB	0.10	0	0.05	0.9 AB	0.4 ABC	0.6 BCD
bifenthrin + imidacloprid FG2	0.01	1.2	0.1 B	0	0 B	0.05	0	0.05	0.5 B	0.0 C	0.6 CD
bifenthrin + imidacloprid (Brigadier) spray	0	0.9	0.0 B	0	0 B	0	0	0	0.5 B	0.1 C	0.2 E
bifenthrin + carbaryl spray	0	0.9	0.0 B	0	0 B	0	0	0	0.4 B	0.0 C	0.7 BCD
bifenthrin spray	0.05	0.9	0.0 B	0	0 B	0	0.05	0	0.3 B	0.0 C	0.5 DE
carbaryl spray	0.20	1.5	0.3 B	0.1	0.20 AB	0.05	0.20	0.10	0.9 AB	0.1 C	1.1 A
BT (Dipel) spray	0.09	1.1	0.3 B	0.1	0.15 AB	0.05	0.05	0.05	1.3 A	0.9 AB	0.9 ABC
untreated	0.31	1.3	0.7 A	0.1	0.35 A	0.05	0.25	0.05	1.1 A	1.1 A	0.8 ABCD
<i>P (treatment effect)</i>	<i>0.15</i>	<i>0.11</i>	<i>0.0062</i>	<i>0.22</i>	<i>0.0174</i>	<i>0.60</i>	<i>0.50</i>	<i>0.58</i>	<i>0.0242</i>	<i>0.0431</i>	<i>0.0018</i>

^a Within each column, means followed by same letter are not significantly different ($P>0.05$); mean separations by LSD.

Table 13. Insects and insect damage found by scouting, Week 7 (9/8/09)

Treatment	Number of larval units/plant ^a	Caterpillar damage rating			Number of larvae per plant				Flea beetle damage rating ^a	Number of flea beetles /plant ^a	Aphid density rating ^a
		Frame ^a	Wrap-per	Head	ICW	DBM	CL	other			
bifenthrin + carbaryl FG1	0.20 B	1.7 AB	0.1	0	0.42	0.17	0.17	0	0.6 BC	0 B	1.1 A
bifenthrin + carbaryl FG2	0.09 B	1.6 ABC	0	0	0.33	0	0.08	0	0.7 BC	0.1 B	0.8 AB
bifenthrin + imidacloprid FG1	0.06 B	1.3 BC	0	0	0.33	0.08	0	0.2	0.8 AB	0 B	0.9 A
bifenthrin + imidacloprid FG2	0.02 B	1.1 C	0	0	0.08	0.08	0	0	0.3 C	0 B	0.5 BC
bifenthrin + imidacloprid (Brigadier) spray	0.03 B	1.3 BC	0	0	0.08	0	0	0.2	0.4 BC	0 B	0.4 C
bifenthrin + carbaryl spray	0.03 B	1.1 C	0	0	0.08	0.17	0	0	0.6 BC	0 B	0.5 BC
bifenthrin spray	0.03 B	1.1 C	0	0	0.25	0	0	0	0.3 C	0 B	0.9 A
carbaryl spray	0.52 A	1.6 ABC	0.5	0.3	0.42	0.17	0.25	1.2	0.5 BC	0 B	0.9 A
BT (Dipel) spray	0.11 B	1.8 AB	0	0	0.25	0	0.08	0	1.2 A	0.3 AB	1.2 A
untreated	0.71 A	2.1 A	0.4	0.1	0.75	0	0.17	2.3	1.3 A	0.6 A	1.1 A
<i>P (treatment effect)</i>	<0.0001	0.0083	0.07	0.46	0.31	0.74	0.45	0.54	0.0007	0.0319	0.0006

^a Within each column, means followed by same letter are not significantly different ($P>0.05$); mean separations by LSD.

Table 14. Insects and insect damage found by scouting, Week 8 (9/14/09)

Treatment	Number of larval units/plant ^a	Caterpillar damage rating ^a			Number of larvae per plant				Flea beetle damage rating	Number of flea beetles /plant ^a	Aphid density rating ^a
		Frame	Wrap-per	Head	ICW ^a	DBM	CL	other			
bifenthrin + carbaryl FG1	0.11 BC	1.6 B	0.4 B	0.1	0 B	0	0	0.58	0.8	0 B	0.8 BC
bifenthrin + carbaryl FG2	0.03 C	1.0 CD	0.2 B	0.1	0.17 B	0.08	0	0	1.0	0 B	0.9 BC
bifenthrin + imidacloprid FG1	0.04 C	1.3 BC	0 B	0	0.17 B	0.08	0	0.17	0.9	0 B	0.8 BC
bifenthrin + imidacloprid FG2	0.06 C	1.0 CD	0.3 B	0	0 B	0	0	0.08	0.5	0 B	0.7 CD
bifenthrin + imidacloprid (Brigadier) spray	0.01 C	0.8 D	0 B	0	0.08 B	0	0	0	0.5	0 B	0.2 D
bifenthrin + carbaryl spray	0 C	1.1 CD	0 B	0	0 B	0	0	0	0.7	0 B	0.9 BC
bifenthrin spray	0.01 C	1.1 CD	0 B	0	0 B	0	0	0.08	0.5	0.1 B	1.1 BC
carbaryl spray	0.29 B	1.6 B	0.1 B	0.1	0.25 B	0	0.08	0.83	0.8	0 B	1.3 AB
BT (Dipel) spray	0.09 BC	1.6 B	0.3 B	0	0.08 B	0	0.08	0	0.8	0.3 A	1.8 A
untreated	0.60 A	2.3 A	1.8 A	0.3	0.58 A	0.25	0	2.75	0.8	0.5 A	1.3 AB
<i>P (treatment effect)</i>	<0.0001	<0.0001	<0.0001	0.29	0.0157	0.55	0.46	0.34	0.12	0.0002	0.0011

^a Within each column, means followed by same letter are not significantly different ($P>0.05$); mean separations by LSD.

Table 15. Insects and insect damage found by scouting, Week 9 (9/22/09)

Treatment	Number of larval units/plant ^a	Caterpillar damage rating ^a			Number of larvae per plant				Flea beetle damage rating ^a	Number of flea beetles /plant	Aphid density rating
		Frame	Wrap-per	Head	ICW	DBM	CL	other			
bifenthrin + carbaryl FG1	0.22 AB	1.3 BC	0.2 B	0.1 B	0	0	0	0.33	0.5 BCD	0	0.8
bifenthrin + carbaryl FG2	0.05 B	1.2 BC	0 B	0 B	0	0.17	0	0.33	0.7 BCD	0.1	0.4
bifenthrin + imidacloprid FG1	0.05 B	1.5 B	0.2 B	0 B	0	0.08	0	0.42	0.8 ABC	0.3	1.0
bifenthrin + imidacloprid FG2	0.03 B	1.2 BC	0 B	0 B	0.17	0.17	0	0	0.5 BCD	0	0.6
bifenthrin + imidacloprid (Brigadier) spray	0 B	0.9 C	0 B	0 B	0	0	0	0	0.1 D	0.1	0.3
bifenthrin + carbaryl spray	0.01 B	0.9 C	0.1 B	0 B	0.08	0	0	0	0.3 CD	0.1	0.6
bifenthrin spray	0.06 B	0.9 C	0 B	0 B	0	0	0	0.08	0.3 CD	0	0.5
carbaryl spray	0.10 B	1.4 BC	0.3 B	0.1 B	0.33	0.08	0	0.08	0.9 AB	0.3	0.8
BT (Dipel) spray	0.07 B	1.5 B	0.2 B	0 B	0.25	0	0	0	1.1 AB	1.8	1.1
untreated	0.44 A	2.4 A	1.7 A	0.9 A	0.67	0.33	0	0.50	1.3 A	2.2	1.1
<i>P (treatment effect)</i>	0.0360	<0.0001	<0.0001	<0.0001	0.32	0.13	-	0.42	0.0047	0.07	0.46

^a Within each column, means followed by same letter are not significantly different ($P>0.05$); mean separations by LSD.