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Insecticide Trial on Bell Peppers in Ohio, 1999

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Methods:

'King Arthur' red bell peppers were transplanted from size 200 plug trays into single-row beds on 20 May 1999 at the Ohio Agricultural Research and Development Center (OARDC) Vegetable Crops Branch at Fremont, Ohio. Plants were 12 inches apart and beds were on 5-ft centers. Each plot was 30 ft long by 15 ft (three rows) wide. There was an untreated guard row between adjacent plots and on field edges. There were 20-ft bare alleys between blocks.

Five treatments each with four replicates were set up in a randomized complete block design. Spinosad (Spintor 2SC from Dow AgroSciences) was tested at three rates (0.045, 0.067, and 0.089 lb AI/A, equivalent to 2.9, 4.3, and 5.7 fl oz of product per acre, respectively). The standard insecticide treatment was acephate (Orthene 75 SP from Valent Corp.) at 1.0 lb AI/A (= 1.3 lb product per acre). No adjuvant was used in the first two sprays (26 July and 2 August), but starting on 9 August, SpinTor and Orthene treatments included the adjuvant R-11 at 0.25% of volume. The untreated check treatment was not treated with any insecticides.

Insecticide treatments were initiated once second generation moths of the European corn borer (ECB) began emerging, as detected by a blacklight trap that was emptied six days per week. Treatments were continued until activity by the third generation of ECB moths subsided. Insecticide treatments were applied 10 times at weekly intervals; spray dates were 26 July; 2, 9, 16, 23, 31 August; 9, 14, 23 September, and 1 October. Sprays were applied with a tractor-mounted CO_2-pressurized research boom sprayer that delivered 38 gallons per acre using 60 psi pressure, D4-25 hollow cone nozzles spaced 15 inches apart, and speed of 3 mi/hr. For disease control in all plots, copper (Champ Formula 2F, 1.3 pt/acre) and Manex (1.5 qt/A) were used weekly from 14 July until 23 September, and Ridomil Gold (1 pt/A) was used once on 23 July.

Damage by European corn borer larvae and other insects was evaluated at harvests on 8 and 22 September and 6 and 21 October. All fully ripe red pepper fruit that were firm enough to pick (i.e., not rotten) were cut from a flagged 20-ft section in the center row per plot; fruit were counted, weighed, and cut open to evaluate insect infestation. Data were subjected to analysis of variance (ANOVA) followed by mean compasisons using LSD tests in the SAS JMP microcomputer program. Percentage data were transformed by arcsine square root before analysis. Data were analyzed for four individual harvests, and were pooled for analysis of cumulative harvests.

Results:

Blacklight trap sampling of adult European corn borer (Table 1) showed that three generations developed with peak catches on 7 June, 9 August, and 6 September 1999. All three generations were about normal in timing and number of moths caught per week. The first harvest showed damage by second generation larvae of ECB, the second harvest showed damage mostly by large second-generation larvae and some small third-generation larvae, and the third and fourth harvests showed damage mostly by third generation larvae. ECB was the only caterpillar species found in the first, second, and fourth harvests. In the third harvest, 2% of total larvae found were corn earworm and 1% of total larvae found were an unidentified tortricid.

In untreated plots, insect damage was extremely high throughout the harvest season as demonstrated by low yields and low percentage of fruit that were clean of insect damage. Clean fruit made up only 33% of the first harvest, 7% of the second harvest, 2% of the third harvest, 7% of the fourth harvest, and 17% of pooled harvests (Table 2).

There was a significant effect of insecticide treatment on weight of fruit harvested ($P < 0.05$), for the second, third, fourth, and cumulative harvests (Table 2); yield was significantly higher in the standard Orthene treatment than in the untreated check. In SpinTor plots, yield was also significantly higher than in check plots and no different than in Orthene plots in the third and fourth harvests. In the second harvest, plots with the low and high rates of SpinTor had yields that were significantly higher than the check but significantly lower than Orthene plots, while yield with the middle rate of SpinTor was not different than the untreated check or the other SpinTor treatments.

The percentage of fruit that were clean of insect damage differed significantly among treatments in all harvests ($P < 0.02$); there was always significantly less good fruit in the untreated check than in other treatments (Table 2). Although damage in SpinTor plots was no different than in Orthene plots in the first harvest, damage in all SpinTor treatments was significantly lower than in the check but significantly higher than in Orthene plots in the second and third harvests as well as in the cumulative harvest. In the fourth harvest, the same trend was apparent for the low and high rate SpinTor treatments but damage in plots treated with the middle rate SpinTor was not different than the Orthene or other SpinTor treatments.

The best summary of results for all variables can be seen by estimating the yield of good fruit, which combines the total yield and percentage of clean fruit (Table 2). For the cumulative harvest data, analysis of this variable showed SpinTor treatments to be no different than each other but all three were intermediate and statistically different than the untreated check and the standard Orthene treatment.

Discussion:

Under the conditions of heavy pressure from European corn borer seen in this trial, the standard Orthene was not able to provide acceptable control in the first harvest but Orthene did provide good control in remaining harvests. The intermediate performance of SpinTor could perhaps be attributed to the 7-day spray schedule. SpinTor is known to have short persistence, and it might need to be applied on a 5-day schedule during periods of heavy pest pressure. This trial was a good contrast with the 1998 Ohio pepper trial, when pest pressure was lighter than usual; SpinTor applied on a 7-day schedule in 1998 resulted in yield and damage no different than where Orthene was used. Among the rates of SpinTor tested, there does not seem to be an advantage to using the higher rate (5.7 oz/A) than the low rate (2.9 oz/A) for control of European corn borer on peppers.

Table 1. Weekly capture of European corn borer moths in a blacklight trap at Fremont, Ohio, in 1999.

DATE (end of week)	FEMALE	MALE	TOTAL
5/4	0	0	0
5/11	0	0	0
5/18	16	15	31
5/25	31	25	56
6/1	37	27	64
6/8	45	50	95 (peak 1st)
6/15	7	16	23
6/22	2	2	4
6/29	3	0	3
7/6	0	1	1
7/13	1	0	1
7/20	21	26	47
7/27	31	34	65
8/3	92	88	180
8/10	114	107	221 (peak 2nd)
8/17	70	33	103
8/24	180	61	241
8/31	228	98	326
9/7	535	391	926 (peak 3rd)
9/14	119	154	273
9/21	2	12	14
9/28	2	4	6

Table 2. Yield of red pepper fruit per sample, and percentage of fruit that were clean of insect damage in four harvests at Fremont, Ohio, 1999; mean[1] of four blocked replicates.

HARVEST	TREATMENT	YIELD (KG)	YIELD (COUNT)	% GOOD[2]	ESTIMATED KG GOOD[3]
First (9/8/99)	untreated check	1.519	9.5	32.9 A	0.482 A
	Spintor 2SC 2.9 oz/A + R-11	3.162	17.5	64.6 B	1.990 BC
	Spintor 2SC 4.3 oz/A + R-11	2.475	14.2	63.3 B	1.620 B
	Spintor 2SC 5.7 oz/A + R-11	2.506	13.2	61.3 B	1.628 B
	standard (Orthene 75SP 1.3 lb/A) + R-11	3.656	19.5	72.5 B	2.602 C
	ANOVA P value	*0.09*	*0.06*	*0.02 **	*0.007 **
Second (9/22/99)	untreated check	0.688 A	4.5 A	7.1 A	0.077 A
	Spintor 2SC 2.9 oz/A + R-11	3.287 B	18.5 BC	50.1 B	1.721 B
	Spintor 2SC 4.3 oz/A + R-11	1.931 AB	10.0 AB	52.6 B	1.181 AB
	Spintor 2SC 5.7 oz/A + R-11	3.162 B	17.2 BC	54.0 B	1.772 B
	standard (Orthene 1.3 lb/A) + R-11	5.938 C	28.2 C	97.7 C	5.775 C
	ANOVA P value	*0.005 **	*0.015 **	*0.0001 **	*0.0001 **
Third (10/6/99)	untreated check	1.425 A	8.5	2.5 A	0.046 A
	Spintor 2SC 2.9 oz/A + R-11	5.519 B	28.5	60.1 B	3.409 B
	Spintor 2SC 4.3 oz/A + R-11	4.800 B	24.5	75.4 B	3.590 B
	Spintor 2SC 5.7 oz/A + R-11	4.900 B	26.8	72.2 B	3.448 B
	standard (Orthene 1.3 lb/A) + R-11	4.100 B	20.5	98.4 C	4.055 B
	ANOVA P value	*0.047 **	*0.07*	*0.0001 **	*0.0045 **
Fourth (10/21/99)	untreated check	0.363 A	2.2 A	6.7 A	0.053 A
	Spintor 2SC 2.9 oz/A + R-11	2.100 B	10.8 B	70.8 B	1.527 B
	Spintor 2SC 4.3 oz/A + R-11	2.194 B	11.2 B	73.5 BC	1.612 B
	Spintor 2SC 5.7 oz/A + R-11	2.894 B	16.0 B	62.6 B	1.952 B
	standard (Orthene 1.3 lb/A) + R-11	2.956 B	17.5 B	93.5 C	2.751 B
	ANOVA P value	*0.01 **	*0.02 **	*0.0003 **	*0.02 **
Cumulative	untreated check	3.994 A	24.8 A	16.6 A	0.644 A
	Spintor 2SC 2.9 oz/A + R-11	14.069 BC	75.2 BC	61.1 B	8.618 B
	Spintor 2SC 4.3 oz/A + R-11	11.400 B	60.0 B	69.8 B	7.973 B
	Spintor 2SC 5.7 oz/A + R-11	13.462 BC	73.2 BC	65.5 B	8.750 B
	standard (Orthene 1.3 lb/A) + R-11	16.650 C	85.8 C	90.9 C	15.110 C
	ANOVA P value	*0.0004 **	*0.0014 **	*0.0001 **	*0.0001 **

[1] within each column and for each harvest date, means followed by the same letter are not significantly different by LSD tests ($P > 0.05$).
[2] means shown are actual percentages but analysis results shown were based on arcsine square-root transformed data.
[3] estimated yield (kg) of fruit clean of insect damage = (total yield, in kg) x (% clean).