Investigating the Effects of Companion Plantings on Predation of European Corn Borer Eggs in Bell Peppers

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Introduction

European corn borer (ECB) is the most serious annual pest of peppers in New Jersey. The majority of insecticide applications on peppers are for ECB management. Repeated insecticide applications for ECB frequently result in aphid outbreaks, as natural predators and parasites of those pests are eliminated. Management of ECB can be extremely difficult because larvae are protected from insecticide treatments once they have entered fruit. Additionally, control in organic production systems is harder to achieve because many effective insecticides are not permissible.

Intercropping with certain types of flowers can increase survivorship, reproduction and retention of beneficial insects in agricultural systems. Recent studies involving the use of dill, coriander and buckwheat as companion plantings to eggplant resulted in significant predation of Colorado potato beetle (CPB) eggmasses, decreased CPB survivorship, and increased coccinelid (ladybird beetle) presence. These three plants have flowers that are configured such that pollen and nectar are readily available to beneficials like ladybird beetles, syrphid flies, lacewings, and parasitoid wasps. Additionally, dill and coriander are commercially viable herbs, and both may be harvested for leaves and seeds.

This study utilized plantings of dill, coriander and buckwheat as companions to bell peppers for the purpose of observing the fate of ECB eggmasses in the peppers. ECB eggmass predation, parasitism and fruit infestation by ECB were assessed from bell pepper plantings with and without a companion planting. Additionally, predator populations were surveyed from companion flower plantings. With this study we have begun to assess the viability of conservation biocontrol as a tool to reduce overall insecticide use in peppers as well as minimizing insect injury.

Methods

In 2005 and 2006, two pepper fields were planted at the Snyder Research and Extension Farm in Pittstown, NJ. Both fields were approximately 120' long and were 21 (pepper) rows deep. Rows were on 3' centers, and peppers were spaced in single rows at 18" intervals. Black plastic, raised beds, and trickle irrigation were utilized. Pepper plants were staked and tied on both sides of the row. One field in each year had companion plantings of dill (cv. 'Bouquet'), coriander (cv. 'Santo') and buckwheat (one row of each plant type per planting). The companion plant rows were as long as the pepper rows. Companion plants were planted three times in sequence in an attempt to maintain flower presence at all times during the study. The first two plantings of dill and coriander went in as transplants both years. The final row was direct seeded each year. All plantings of buckwheat were direct seeded. Trickle tape was deployed over each row of companion plants the day of planting. Companion plants were on flat beds without plastic mulch. Weeding was by hand. Beginning on 7/12/05 and 7/5/06, sentinel ECB eggmasses were placed on 8 evenly spaced pepper plants in every fifth row. In the case of the field with the companion plants, every fifth row from the herbs. In 2005, egg masses were placed in the field on 7/12, 7/19, 7/26, 8/23, and 8/30/05. In 2006, egg mass placements were on 7/5, 7/11, 7/18, 7/25, 8/1, 8/8, 8/15 and 8/23. At 24 hours and 48 hours after placement, eggmasses were observed for signs of predation. At 48 hours, all eggmasses were retrieved and inspected for predation in the lab. Additionally, on the day of eggmass placement, companion flowers were observed visually for predators and sampled with aerial nets for predatory insects. In 2006, at the end of the study, all fruit were stripped from plants where ECB eggmasses had been deployed in both plots. Fruit were examined for ECB injury to determine the effect of flowers on fruit injury.

Results

In 2005, there was more predation of ECB eggmasses at 48 hours in the pepper plot with companion flowers (Table 1). Increases in predation at 48 hours ranged from 14% to 82%, with more consistent predation occurring later in the season as the second naturally occurring ECB egglaying event was taking place. In 2006, increases in eggmass predation with flowers ranged from 7% to 59% with one exception for the 8/8 release date. In this case, at 48 hrs. after release, there was -49% predation in the flower plot, due to a reduction in ladybird beetle predation (11 vs. 25 (flowers vs. no flowers) eggmasses preyed upon). In 2005, eggmass predation by ladybird beetles was 27% in peppers without flowers, and 39% with flowers. Lacewing predation of egg masses was 7% in peppers without flowers, and 13% with flowers. Eggmass predation by pirate bugs was 6% in both plots. In 2006, ladybird beetles preyed on 24% of eggmasses recovered from peppers without flowers, and 25% with flowers. Lacewing larval predation of eggmasses was 7% from peppers without flowers and 12% with flowers. Pirate bug predation of eggmasses was 3% without flowers and 4% with flowers. No parasitism of eggmasses was identified in either season.

In 2006, fruit from pepper plants where ECB eggs were placed were evaluated for ECB injury. Fruit from plants with companion flowers had significantly less ECB injury (Fig. 1).

Visual inspections of flowers indicated that coccinelids (ladybird beetles), chrysopids (lacewings) and syrphids (hover flies) were present on blossoms. Sweep samples of flowers did not collect all of these insect predators; however relative numbers two coccinelid species, one chrysopid, and several syrphid species were determined from sweep net samples. Additionally, anthocorids (pirate bugs) were observed feeding on eggmasses in the peppers in both plots each year. Based on visual inspection of predated eggmasses, it is clear that chrysopids and coccinelids were the dominant ECB predators present in each planting both years. These two insect families are known egg predators. The greatest numbers of coccinelids were sampled were from sweeps above the buckwheat (Table 3). Syrphid adults were sampled in highest numbers above coriander. The limited number of chrysopid adults sampled came from dill.

No aphid populations developed on either pepper plot in 2005 or 2006.

Conclusions

Increases in ECB eggmass predation on pepper plants where companion flowers were grown in both 2005 and 2006 confirm findings of previous studies indicating that dill, coriander and buckwheat are useful plants for recruiting and maintaining certain generalist insect and insect egg predators. A significant decrease in ECB injury to fruit in 2006 indicates that increased eggmass predation translates directly to improved control.

Although the level of control obtained in this study through predator recruitment and retention by companion flowers may not be commercially acceptable, it may be utilized in conjunction with other control tactics as part of a viable IPM program. For example, several newer insecticide chemistries labeled for ECB control in peppers (including the commonly used material spinosad) are less toxic to the predators found in this study. It may be possible to reduce the number of applications of these materials with the increase in predation resulting from the use of companion flowers. Another possibility is the incorporation of egg parasites such as the wasp *Trichogramma ostriniae* into the pepper/companion flower system to improve ECB control. A further benefit of this system is the complete lack of aphid pests in the peppers. This was a result of increased predator populations (principally the Coccinelids, Syrphids, and Chrysopids) and the absence of synthetic pyrethroid applications for ECB control. Further research will focus on the interaction between companion flowers and use of the biorational insecticide, spinosad for control of ECB in peppers.

Table 1. 2005 average predation of ECB egg masses per plant 48 hrs. after released when planted with and without flowers.

Release Date	Flowers	Mean Number of Egg Masses Eaten/plant*	Relative % Predation with Flowers
July 14	No	0.19	50%
	Yes	0.38	
July 21	No	0.56	28%
	Yes	0.78	
July 28	No	0.78	14%
	Yes	0.91	
August 25	No	0.09	82%
	Yes	0.51	
September 1	No	0.31	51%
	Yes	0.63	

* 2 eggmasses/plant

Table 2. 2006 average predation of ECB egg masses 48 hours after release when planted with and without flowers, 2006.

Release Date	Flowers	Mean Number of Egg Masses Eaten/plant *	Relative % Predation with Flowers
July 5	No	0.19	59%
	Yes	0.46	
July 11	No	0.20	53%
	Yes	0.43	
July 18	No	0.29	43%
	Yes	0.51	
July 25	No	0.48	14%
	Yes	0.56	
August 1	No	0.30	35%
	Yes	0.46	
August 8	No	0.55	-49%
	Yes	0.28	
August 15	No	0.37	7%
	Yes	0.40	
August 23	No	0.31	35%
	Yes	0.48	

*2 eggmasses per plant

Table 3. 2006 sweep samples of predators (avg. specimens/row) from companion flower rows.

Flower	Syrphid adult	Lacewing adult	Coccinelid adult	Coccinelid larvae
Buckwheat	2.00	0.00	3.83	0.50
Coriander	20.00	0.00	0.00	0.00
Dill	1.25	0.25	1.00	0.40

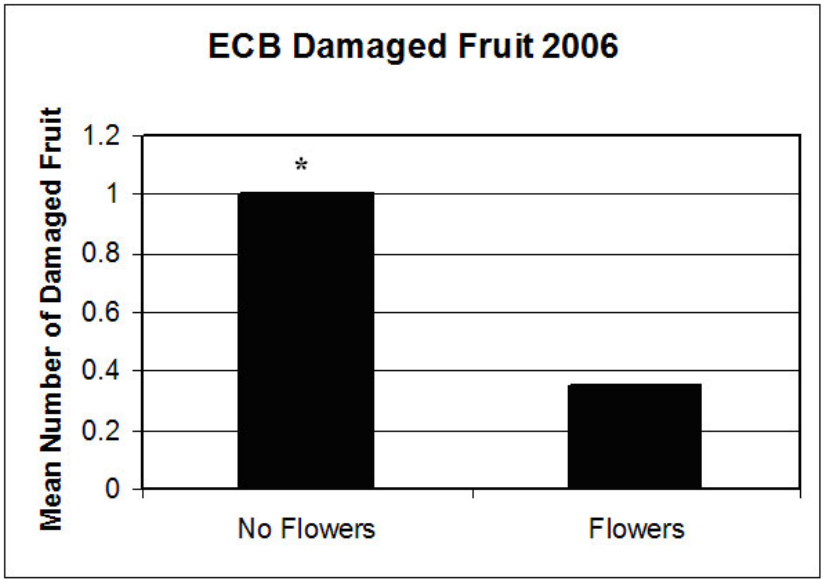
Species in order of abundance:

Coccinelid Adults – *Coleomegilla maculata* (pink spotted ladybird beetle), *Harmonia axyridis* (Asian ladybird beetle)

Lacewing Adults – *Chrysoperla carnea* (green lacewing)

Syrphid Adults – *Toxomerus marginatus* (flower fly), *Syritta pipiens*, *T. geminatus*

Figure 1. 2006 pepper fruit injury (per plant) from plots with and without flowers.



* Sig. difference. ANOVA, LSD p = .05