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Does implementation of a reduced-risk blueberry insect control program enhance biological control?

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Abstract: A reduced-risk insect control program was implemented at commercial blueberry farms in Michigan, USA and the side effects on two important groups of natural enemies was monitored. The aphid parasitoid community responded after two years of implementation, with parasitism rates approx. 30% higher in the fields receiving reduced-risk insecticides. Total ground beetle captures were not statistically different between programs, but two dominant species, *Harpalus erraticus* and *Amara aenea*, increased in abundance in the reduced-risk program fields. Results are discussed in terms of the benefits growers may expect from adopting insect control programs based on new insecticides.

Key words: Reduced-risk, IPM, carabid, aphid.

Introduction

Changes to pesticide registration requirements in response to recent legislation have restricted availability of broad-spectrum insecticides for many United States food crops, and stimulated registration of insecticides designated as reduced-risk by the US-Environmental Protection Agency. For minor acreage crops, such as highbush blueberry (*Vaccinium corymbosum* L.), these changes provide the first opportunity for growers to implement an insect IPM program founded on insecticides expected to have lower impact on natural enemies than conventional chemistries. Insecticides recently registered for use in blueberry in the US include imidacloprid, spinosad, and tebufenozide. Although not always benign to natural enemies (Williams et al., 2003), these insecticides have lower human toxicity and potential for environmental contamination.

Growers will expect enhanced natural enemy activity if using products with lower toxicity than conventional pesticides, but this data must be gathered from field conditions before making recommendations regarding improved biological control. Our Blueberry RAMP Project is testing the hypothesis that natural enemy populations will increase when growers adopt reduced-risk insecticides in blueberry. Here, we report the response of ground-dwelling carabid beetles and aphid parasitoids. Increasing carabid activity/density has been shown to increase prey removal in blueberry (O'Neal et al., 2005a), and many blueberry insect pests spend a significant portion of their life cycle on or in the ground. Parasitism of blueberry aphids can reach over 60%, and high aphid populations are associated with use of broad-spectrum insecticides (Whalon & Elsner, 1982).

Material and methods

Study sites

This project was conducted at six blueberry farms in west Michigan. In spring of 2003, two 2-4 Ha fields of *V. corymbosum*, cv. Bluecrop or Jersey, with similar insect pest pressure were selected at each farm. Both fields at each farm were scouted weekly during 2003 and 2004 for insect pests, and natural enemies were sampled as described below. One of the fields was managed with the grower's conventional insecticide program based on broad spectrum insecticides, while the other field was managed in response to the weekly scouting results and was treated with reduced-risk insecticides (Table 1). The same fungicides and herbicides were applied to each field at each farm, and all applications were made by the growers using standard application technology.

Table 1. Conventional and reduced-risk insecticides registered for use against key insect pests in Michigan blueberry fields through the growing season.

Month	Crop stage	Target Pest*	Conventional	Reduced-risk
April	Pre bloom	Leafrollers	Methomyl, esfenvalerate	Tebufenozide
May	Bloom	CBFW CFW	B.t. B.t.	Tebufenozide Tebufenozide
June-July	Post bloom	CBFW OBLR BBA White grubs	Azinphosmethyl, esfenvalerate Phosmet, methomyl Methomyl	Tebufenozide Tebufenozide Imidacloprid (foliar) Imidacloprid (soil)
July-August	Mid-season	JB BBM BB aphid	Phosmet, carbaryl, esfenvalerate Malathion, phosmet Methomyl, imidacloprid	Imidacloprid Spinosad, imidacloprid Imidacloprid
July-Sept.	Pre-harvest	JB BBM	Phosmet, carbaryl Phosmet, malathion	Spinosad Spinosad, imidacloprid

*CBFW = cranberry fruitworm, *Acrobasis vaccinii*; CFW = cherry fruitworm, *Grapholitha packardii*; OBLR = obliquebanded leafroller, *Choristoneura rosaceana*; BBA = blueberry aphid, *Illinoia pepperi*; JB = Japanese beetle, *Popillia japonica*; BBM = blueberry maggot, *Rhagoletis mendax*.

Aphid and parasitoid sampling

Weekly scouting was used to determine when the percentage of bushes with aphids present reached ~20%. Thereafter, aphid densities were intensively sampled approximately every two weeks (5 June to 7 August 2003, and 9 July to 12 August 2004). Within each of four sub-sections of the fields, we located 5 bushes infested with aphids. On each bush, the number of aphids and mummies on each branch of first-year growth was recorded. All leaves with mummies were collected and held individually in 2 oz plastic cups until a parasitoid wasp emerged. Parasitoids were identified to genus or in the case of some hyperparasitoids, to family. Mean percent aphid parasitism was calculated for each field on each sampling date and the mean number of aphids per branch and percent parasitism were compared between programs using ANOVA (Statview v 4.57, Abacus Concepts, Berkeley, CA.).

Carabid sampling

Adult ground beetles were monitored using the methods of O'Neal et al. (2005b). Briefly, pitfall traps (13.5 cm height by 11 cm diameter plastic cups) were placed in the soil between bushes with the rim 1 cm below the soil surface, and covered by a rain guard supported by nails. Approx. 200 ml of ethylene glycol was placed in each trap and refilled as needed. Six traps were deployed in each field; three along a wooded field edge and three 50 m within the interior, and traps were evenly spaced 6-8 rows apart across the plot. Traps were emptied once a week from 8 May – 12 Oct. 2003 and 20 April – 13 Oct. 2004. All ground beetles were identified to morpho-species and voucher specimens were collected and identified to species.

To describe ground beetle activity throughout the season, we combined beetle catches by month and report mean captures per field per month. To determine the effects of insecticide program on carabid beetle activity/density, a mixed-model repeated measures ANOVA was used. This analysis was performed on the entire carabid community and on the five most abundant species.

Results and discussion

Aphid parasitoids

In the first year of transition to a reduced-risk insecticide program, aphid abundance was not significantly different between programs at any sampling date (P>0.05 for all dates), and the rate of aphid parasitism was also not significantly different between programs for any date (Fig. 1). Responses to the changing spray program were apparent in Year 2; aphid abundance was significantly lower in fields treated with the reduced-risk insecticide program, and aphid parasitism was significantly greater in the same fields by the Aug 9 sample (Fig. 1). Aphid parasitism was by the *Praon spp.* or *Aphidius spp.*, and there was also some hyperparasitism by one *Asaphes spp.*, one *Alloxysta spp.*, and two Pteromalidae species. There was no consistent response between years to the management program.

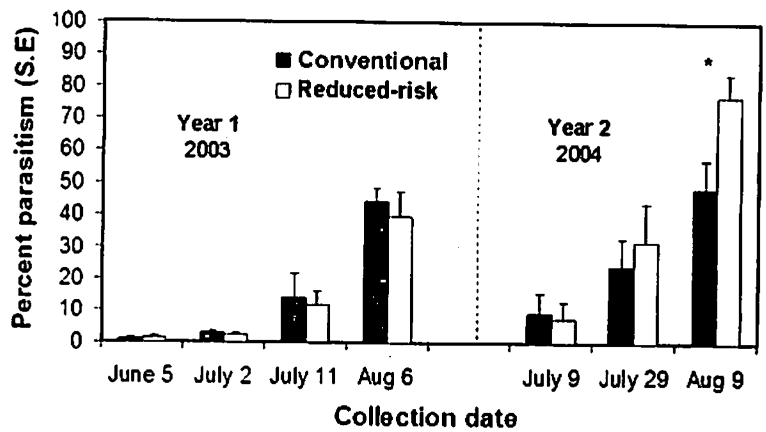

Figure 1. Parasitism of blueberry aphid, *Illinoia pepperi* in blueberry fields managed using two insecticide programs. The asterisk denotes a sample in which parasitism was significantly different between the two programs (P<0.05).

Carabids

During Year 1, 32 species of ground beetles were identified with *Harpalus pensylvanicus, Harpalus erraticus, Amara aenea, Pterostichus mutus, and Patrobis longicornis* being the five most common. Overall community abundance was similar in the first year, and only *H. erraticus* responded to the difference in insecticide programs, with greater abundance in the reduced-risk than the conventional fields (O'Neal et al., 2005b). A similar ground beetle community was observed in Year 2, that did not vary in overall species richness or abundance between the two insecticide programs. In Year 2, both *H. erraticus* and *A. aenea* were more abundant in the reduced-risk than in the conventional program fields. As a species that emerges as an adult late in the season (Fig. 2), it is likely that larval *H. erraticus* mortality is greater in fields receiving conventional rather than reduced-risk insecticides. However, it is not clear why other fall emerging species, such as *H. pensylvanicus*, did not respond to the difference in the insecticide program. Differences in carabid biology and behavior are likely to determine the degree of sensitivity under field conditions.

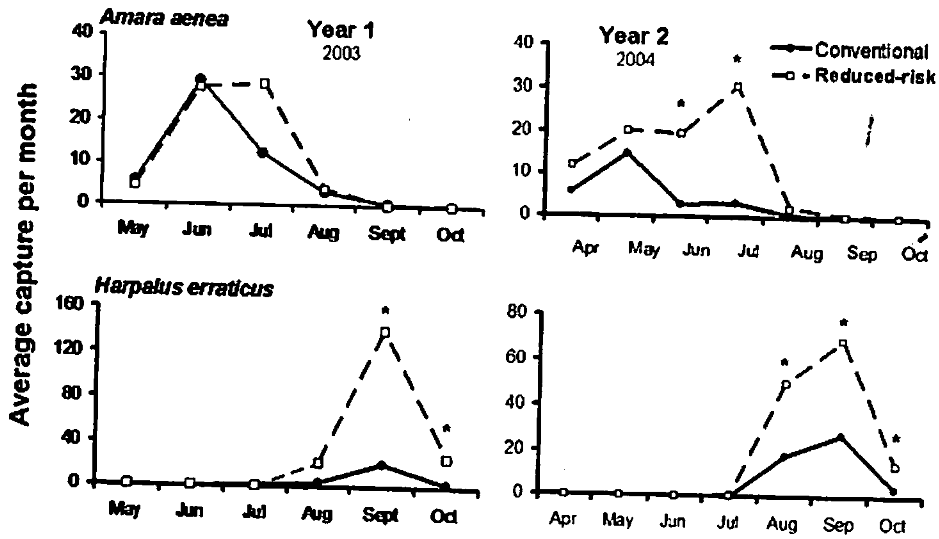

Figure 2. Captures of two carabid species in fields managed with reduced-risk or conventional insecticides. Dates with asterisks were significantly different between the two programs ($P<0.05$).

Taken together, the carabid and aphid parasitoid results indicate that some components of the natural enemy community in blueberry will respond positively to adoption of reduced-risk insecticide programs. Depending on the natural enemy in question, these changes may take more than one year to become apparent, and they may not be sufficient to provide a high degree of pest control. Availability of reduced-risk insecticides that provide pest control with low impact on natural enemies is expected to enhance the degree of pest suppression provided by natural enemies. Based on our current data, however, the increase in biological control will be small and may take multiple growing seasons to develop. The Blueberry RAMP project will continue to monitor the response of pests and natural enemies to the changing insecticide program for a further two years. In addition to this, measuring the degree of pest control achieved by increasing populations of natural enemies should be a priority, to provide growers with confidence that the additional cost of reduced-risk insecticides provides additional benefits above direct pest control.

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