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λ-Cyhalothrin, Imidacloprid and Spinosad Impacts on Movement of Predatory Arthropods in Cotton[1]

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Investigations of the impact of insecticides on natural enemies have focused primarily on mortality induced by insecticides. However, the absence of natural enemies from a treated area may not be due solely to the direct result of mortality caused by the insecticide. The insecticide used may repel selected natural enemies. Some chemistries, particularly the pyrethroids and imidacloprid, are known to repel some arthropods (Hall and Thacker 1993, J. Econ. Entomol. 86: 537-543; Liu and Stansly 1995, Entomol. Exp. et Appli. 74: 137-143; Darvas and Polgar 1998, Pp. 188-259 *In* Insecticides with novel modes of action, I. Ishaaya and D. Degheele, Springer:Berlin). However, most reports of repellence have been under laboratory conditions in which the arthropods tested are offered a choice of treated vs untreated surfaces.

We propose that enumerating arthropods in a treated plot in comparison to an adjacent untreated plot at soon after treatment should give an indication of directed movement and possible repellence effects of the insecticide under evaluation. Theoretically, if the insecticide is repellent, those effects should be evident almost immediately after application. Therefore, our objective in this study was to detect repellence due to insecticides by measuring shifts in arthropod numbers between treated and untreated plots.

Large plots of DP20 RR cotton were planted on the University of Arkansas Delta Branch Experiment Station, Clarkedale, AR, in 2000 and was maintained according to University of Arkansas Cooperative Extension Service recommendations of fertility, water, weed and insect control (Baldwin et al. 2000, Univ. of Arkansas Coop. Ext. Service Pub. MP44, 149 p.; Johnson et al. 2000, Univ. of Arkansas Coop. Ext. Service Pub. MP144, 166 p). Cotton was planted on beds with a 96.5-cm row spacing. Plots were 16 rows (~15.4 m) wide by 121.9 m long arranged in randomized complete block

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design with four replications. Treatments were applied with a John Deere Hi-Cycle 6000 calibrated to deliver 93.5 L per ha. λ-cyhalothrin was applied at 0.028 kg ai/ha, imidacloprid at 0.027 kg ai/ha, and spinosad at 0.09 kg ai/ha. An untreated area 16 rows wide was located between and on either side of each treated plot. Pretreatment counts were made with a dishpan covered with 1.3-cm hardware cloth. Counts were made by bending plants over the pan, beating them against the hardware cloth to dislodge insects. Two beats were made so that ~ 0.8 m of row were sampled per stop. Insects were counted in four transects across each replicate. Transects were located 15.2 m from each end and were 30.5 m apart. Counts were made in rows 2, 4, 6, 8, 10, 12 and 14 of each plot and the untreated strip. Predatory insects were separated according to species and adult or immature stages. Spiders were also counted but not identified. Counts were made at pre-treatment, 1, 2, 3 and 7 d after treatment. Data were separated by species and also grouped according to adult or immature stages.

In the absence of published information and based upon personal observations, it was assumed that *Orius insidiosus* (Say) adults would typically move in the cotton canopy an average of 1.8 m per day and *Geocoris* spp. and coccinellid adults would move 3 m per day. Obviously, adults of these insects are capable of migrating from the study area in the 24-h period. It was further assumed that all immature stages of these insects would remain within the same row after treatment because their movement is limited by an inability to fly. For each insect species and developmental stage, the average density per transect point for each plot was calculated for each sampling interval. In analyzing the adult insects, only those transect points which could not have been reached by migration (using assumed distances) from another plot during that spray/sampling interval were used. Therefore, only pre-treatment and 1-d post-treatment counts were used for *Geocoris* spp. and coccinellids. Due to the size of the plots, any adults from these two groups found at 3 or 7-d post-treatment could have migrated from areas outside the treated plots, making it impossible to determine any repellence effect by that time. For immature insects and spiders, all transect points and all sampling dates were used in the analysis.

Each insecticide was analyzed separately. Data from the untreated plots on either side of each treated plot were used as controls. Therefore, there was an untreated-left and an untreated-right for each insecticide. Means were analyzed as a split plot where the whole plot structure was a randomized complete block with four replications and insecticide treatment as the factor. The split plot factor was sampling interval. Means were separated using a protected LSD at $P = 0.05$.

Repellent effects from λ-cyhalothrin, a synthetic pyrethroid, to any of the insects sampled were not detected in our study. With the exception of coccinellid adults, there was a significant decrease in numbers of insects sampled immediately following application of λ-cyhalothrin. Therefore, it is likely that any decrease in insect numbers was the result of mortality from exposure to this insecticide. Furthermore, no significant differences were detected in response to application of imidacloprid. Spinosad appeared to have a repellent effect with a significant decrease in adult predators from pre-treatment to 1-d after treatment (Table 1). A corresponding significant increase in adult predators occurred in the left-untreated plot next to the spinosad plot 1-d after application (Table 1). No repellent effects with this compound have been reported in the literature. Laboratory studies with this chemical and these predators should be conducted to confirm this finding.

Throughout the course of this study beneficial insect numbers were low, and thus, few differences were observed given variation typical with these insect populations.

Table 1. Mean number of predators at various sampling intervals after insecticide application

	Adults*/0.8-m of row		Non-fliers**/0.8-m of row			
Treatment	Pretreatment	Post 1-d	Pretreatment	Post 1-d	Post 3-d	Post 7-d
untreated-left	0.12	0.09	0.26	0.18	0.30	0.17
λ-cyhalothrin	0.12 a	0.02 b	0.24	0.08	0.13	0.15
untreated-right	0.17 a	0.10 b	0.13	0.24	0.22	0.19
untreated-left	0.11 aA	0.19 bA	0.25	0.18	0.28	0.25
spinosad	0.13 aA	0.05 bB	0.28	0.22	0.20	0.13
untreated-right	0.13 aA	0.05 bB	0.17	0.23	0.28	0.20
untreated-left	0.17 aA	0.08 aB	0.16	0.22	0.17	0.16
imidacloprid	0.08 aA	0.05 aB	0.22	0.12	0.18	0.14
untreated-right	0.09 aA	0.18 aA	0.28	0.22	0.28	0.13

* Adults of nabids, assassin bugs, spined soldier bugs and lacewings.

** Non-fliers were immature forms of the above species and spiders.

Means within a row followed by the same lower case letter and means within a column within an insecticide treatment followed by the same upper case letter, do not significantly differ ($P = 0.05$, LSD).

Previously reported repellent effects of λ-cyhalothrin and imidacloprid in the laboratory were not observed in these field studies with these insects. Future research would benefit from determining the actual distance key beneficial arthropods can and will move in a selected habitat during determined periods of time. Mark-recapture studies may be warranted for insecticide products showing potential to repel beneficial insects in the field.