BEMISIA GROWTH REGULATORS: CONSERVATION OF NATURAL ENEMIES?

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Abstract

As part of a large-scale, multi-institutional experiment in 1996 to examine and demonstrate strategies for management of *Bemisia tabaci* involving the use of two insect growth regulators (IGRs), we evaluated effects on the abundance and activity of native natural enemies. For parasitoids there were significant differences between insecticides regimes on 4 of 10 sampling dates. In general, parasitoid abundance and rates of parasitism were depressed in treatment plots receiving a rotation of conventional chemistry in comparison with those receiving IGRs. There was no apparent effect of any of the treatment variables on parasitoid emergence (immature survival). Results for arthropod predators are still preliminary, but densities were generally depressed in plots receiving a rotation of conventional chemistry in comparison with those receiving IGRs. These preliminary results suggest that use of IGRs for suppression of *B. tabaci* may help conserve populations of important natural enemies

Introduction

The maximization of natural pest control in crop production systems is a fundamental tenet of integrated pest management (Stern et al. 1959). It is generally recognized that natural enemies play a key role in regulating pest populations (e.g. Whitcomb 1980, Luff 1983), however their potential has been largely untapped, particularly in annual cropping systems. The most significant problem is the disruption of natural control by the widespread use of insecticides with broad toxicity to both pests and their natural enemies. Some of the best examples of this problem are found in the cotton ecosystem where insecticide use disrupts the control of key pests and may cause the outbreak of secondary pests (e.g. Leigh et al. 1966, Eveleens et al. 1973, Stoltz & Stern 1978).

A number of beneficial arthropod species naturally inhabit cotton fields (Whitcomb & Bell 1964, Gonzales et al. 1977, Anon 1984), yet we have only a rudimentary knowledge of how they function in pest control. Many of the predaceous species can be relatively abundant in untreated Arizona cotton (Naranjo & Hagler 1997, unpublished) and may play an important role in suppressing populations of *Bemisia tabaci* and other pests, such as lygus bugs, pink bollworm, and various other lepidoptera. Recent studies conducted in the Imperial Valley of California indicate that populations of many common predator species can be significantly reduced by the use of pyrethroid and organophosphate insecticides applied for control of *B. tabaci*. Populations of several groups of hymenopteran parasitoids of the genera *Eretmocerus* and *Encarsia* were also negatively impacted by these applications (Naranjo and Chu, Gerling and Naranjo, unpublished).

Mitigation of the whitefly problem in the southwestern U.S. will depend on a truly integrated approach to pest management and pesticides will continue to be an important component of this system. Within this framework we need to understand the impact of insecticides on predators and parasitoids and begin to develop management strategies that will enhance the efficacy of natural control. In 1996 two insect growth regulators (IGRs), buprofezin and pyriproxyfen, were granted emergency registration in Arizona. These compounds are known to be highly effective in suppressing whitefly populations (Ellsworth et al. 1997, Ishaaya and Horowitz 1992) and are generally thought to be relatively benign to natural enemies (Gerling and Sinai 1994, Jones et al. 1995a, b, Nagai 1990). A large-scale (» 80 hectares), multi-institutional experiment was initiated in 1996 to examine and demonstrate strategies for management of *B. tabaci* involving the use of these two IGRs (see Ellsworth et al. 1997 and Diehl et al. 1997). A key component of these studies was examination of the effects of these management systems on the abundance and activity of native natural enemies of *B. tabaci*.

Materials and Methods

The study involved three different insecticide regimes (buprofezin followed by pyriproxyfen, pyriproxyfen followed by buprofezin, and a rotation of conventional materials), three action threshold levels for initiating insecticide treatments, and application by either air or ground equipment. Each treatment was replicated 3 times in 1.6 hectare plots using a randomized block design. More detail is provided in Ellsworth et al. (1997).

Parasitoid abundance and activity was estimated by taking weekly leaf samples (20-30 per plot) from the 7th mainstem node. In the laboratory we counted all larval and pupal parasitoids of each genera (*Eretmocerus* and *Encarsia*) as well as all unparasitised 3rd and 4th instar *B. tabaci* nymphs on the entire leaf. For each plot and date we calculated an index of parasitism based on the percent of 3rd and 4th instar nymphs parasitized. A subsample of leaves was held to determine parasitoid species composition over the season and to measure treatment effects on parasitoid emergence (immature survival).

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The abundance of arthropod predators were estimated weekly with standard 38 cm sweepnets. Twenty-five sweeps were taken in each of 4 locations for a total of 100 sweeps in each plot. Predator samples were immediately frozen and will be subject to serological analyses (Hagler et al. 1993) to examine relative frequencies of predation on *B. tabaci* in relation to insecticide regime. We also sampled predator populations on whole cotton plants on a weekly to biweekly basis in selected plots throughout the season. These data will be used to determine the efficiency of sweepnet counts for estimating population densities of predatory arthropods.

Results

The first applications of insecticides were made between 3 and 8 July and half of the treatments plots required only one additional application for the entire season (see Ellsworth et al. 1997 for details on dates of all applications). *Eretmocerus* nr. *californicus* and *Encarsia meritoria* were present throughout the season, although the former species was dominate, comprising about 65% of all parasitoids collected. Over the experimental area as a whole, parasitoid populations were low during June, peaked in July and declined again during August and September. This pattern generally paralleled the density of host populations which declined steadily after the first insecticide applications in early July. Levels of parasitism were generally low throughout the season, peaking at around 30%, on average, in late July. Rates of parasitism reached 75% in some individuals plots treated with IGRs. A severe rainstorm in late July may have contributed to the decline in host and parasitoid populations.

Application method had only a minor effect on parasitoid abundance and activity with significant differences detected on only 3 or 10 sampling dates. In these instances, parasitoid density and rates of parasitism were higher in treatments receiving applications by ground. Examining insecticide type, there were significant differences between materials on only 4 of 10 sampling dates (Fig. 1). In general, parasitoid abundance and rates of parasitism were depressed in treatment plots receiving a rotation of conventional chemistry in comparison with those receiving IGRs. There were no differences in density or rates of parasitism relative to application thresholds. There also was no apparent effect of any of the treatment variables on parasitoid emergence. Emergence rates (immature survival) of both species averaged about 77%.

Much of the predator data is still being processed and analyzed and we can provide only preliminary results from whole plant samples at this point. Over the experimental area as a whole, predator populations were low during May and June, peaked in July and then declined in August. The complex was dominated by species of Heteroptera, primarily *Orius tristicolor*, *Geocoris* spp. and *Spanogonicus albofaciatus.* Further statistical analyses were not possible because whole plant samples were not collected in replicated plots. However, the general effects of the different insecticide treatments seem apparent (Fig. 2). Densities of predators were depressed in plots receiving a rotation of conventional chemistry in comparison with those receiving IGRs. This effect was most apparent immediately following the first applications in early July. The general decrease in August likely resulted from the effects of an insecticide application on 1 August to control lygus bugs. The late-July rainstorm mentioned above also may have contributed to this decline.

Discussion

The use of insect growth regulators is generally viewed as a positive step towards the conservation of natural enemies; however, there is relatively little field data available to test this hypothesis. Gerling and Sinai (1994) examined the effects of buprofezin on two parasitoid species of *B. tabaci* in the laboratory. They found that buprofezin reduced emergence of *Eretmocerus* spp, but not *Encarsia luteola*, treated as young immatures over and above that expected from host mortality alone. The reverse was true when parasitoid pupae were treated with buprofezin. Exposure of adults had no effect on longevity or reproduction. Jones et al. (1995b) also reported that buprofezin was not toxic to adults of four species of *Eretmocerus* and *Encarsia*. In a related study (Jones et al. 1995b), they reported results similar to Gerling and Sinai (1994) for *Eret. mundus*; buprofezin was toxic to young immatures, but not pupae.

Several laboratory studies have also evaluated effects on predators. Declercq et al. (1995) found that pyriproxyfen was toxic to the heteropteran predator, *Podisus maculiventris*, when exposed by direct contact, residual contact or ingestion. They also cite a German study that reported toxicity of this material to *Coccinella septempunctata* and *Chrysoperla carnea.* In contrast, Nagai (1990) reported no negative effects of pyriproxyfen on *Orius* spp. at field application rates. Studies of effects in the field are generally lacking.

Preliminary results from our study provide some evidence that IGRs have less of an effect on parasitoids and predators associated with *B. tabaci* compared with more conventional insecticides. Because we did not have an untreated control it is not possible to gauge the direct effect of either IGR. These results are encouraging and suggest that use of IGRs for suppression of *B. tabaci* may help conserve populations of important natural enemies.

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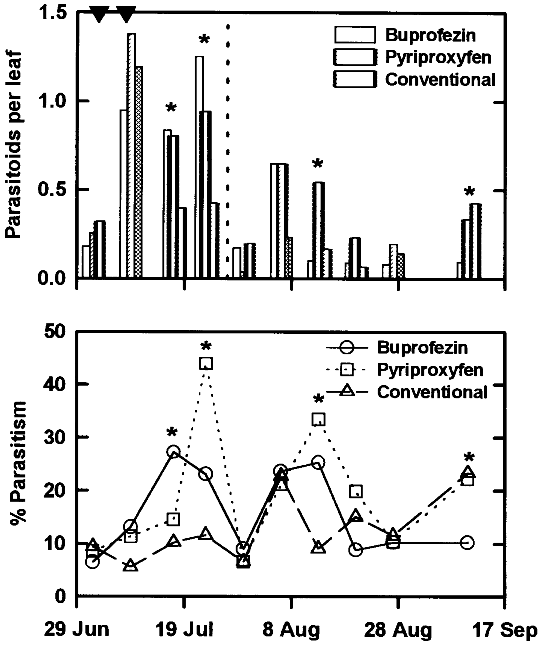

Figure 1. Density of parasitoids of *B. tabaci* and rates of parasitism in relation to 3 insecticide regimes. Asterisks denote dates on which there were significant differences among treatments. Arrows on top graph denote the range of dates on which the first applications were made and the vertical dotted-line denotes the timing of a severe rainstorm.

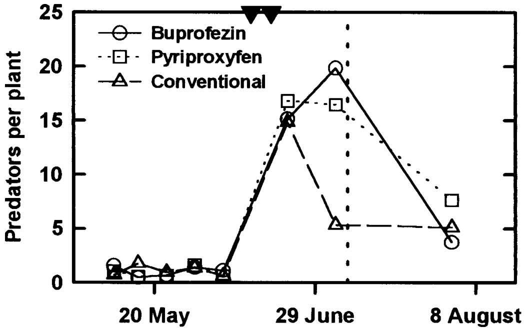

Figure 2. Density of arthropod predators in relation to 3 insecticide regimes. Statistical analyses were not performed because whole plant samples were not collected in replicated plots. Arrows on top of graph denote the range of dates on which the first applications were made and the vertical dotted-line denotes the timing of a severe rainstorm.