IMPACT OF NATURAL ENEMIES AND INSECTICIDES ON WHITEFLIES IN COTTON: A PARTIAL LIFE TABLE ANALYSIS

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Abstract

The number of sprays required to control whiteflies (*Bemisia tabaci* [strain B] = *B. argentifolii* Bellows &Perring) in Arizona has dramatically declined in the last two years. In 1995, Arizona averaged 6.6 sprays against whiteflies, but this declined to 1.99 and 1.81 sprays in 1996 and 1997, respectively (Williams, 1996, 1997, 1998). This dramatic reduction was coincident with the introduction of the insect growth regulators (IGRs), Knack® (pyriproxyfen) and Applaud® (buprofezin), to Arizona through Section 18 exemptions.

Data from an integrated whitefly management trial conducted on a commercial-scale in 1996 showed a prolonged period of suppression of whiteflies after the initial use of an IGR, up to 8 weeks below threshold (Ellsworth et al. 1997). In 1997, we continued our examination of whitefly management strategies under quasi-commercial conditions. The period of suppression lasted only 4-6 weeks in this year. In either case, the period of suppression exceeded the putative period of IGR residual activity.

Each year the scientific and industry community speculate many causes of the patterns of whitefly population fluctuation, especially 1995 versus 1996. The causes range from timely weather in the form of violent monsoons (as seen in 1996), direct residual activity of the IGRs (1996) or to the poor performance of other insecticides due to resistance (1995). Still others credit the increasing role of natural enemies (predators and/or parasitoids) in cotton due to a reduction of broadly-toxic insecticides.

The keys to management of whiteflies have been sampling and monitoring of populations, timely and effective use of insecticides, and avoidance of the pest problem. Significant advances have been made in the development and implementation of the former two keys (e.g., Ellsworth et al. 1995, 1996, 1997; Naranjo & Flint 1994, 1995; Naranjo 1996; Naranjo et al. 1997); however, the latter is a set of cultural and bio-intensive practices that are not all equally well-developed or understood. Chief among these factors is the conservation of natural enemies. With the broad use of 'Bt' cotton for lepidopteran control and the availability of selective insecticides such as the IGRs, growers have the opportunity to better manage their natural enemy community. This study was designed to uncover the myriad of factors contributing to mortality of whiteflies under field conditions and begin to identify active management practices that allow for enhanced natural enemy conservation.

We examined whitefly egg and nymph stages in the field under a set of different insecticide treated and untreated regimes over the course of four cohorts or generations (July, early August, late August, and September). In the July cohort which was timed before any spraying was initiated, there were not enough whiteflies to conduct the study. Instead, using clip cages to introduce adult whiteflies, we established at least 50 individuals per stage per plot. All remaining cohorts consisted of natural populations. The location of each individual was marked on leaves with a non-toxic felt-tip pen. Each stage was then examined every 2–4 days directly in the field with the aid of a hand lens. Sources of mortality were recorded as due to insecticides, predators, parasitoids, unknown and missing. This last category was often presumed to be associated with weather; however, other factors may have dislodged the insect, including chewing predation or insecticides.

Cohorts were established in 16-20 plots over four replicates. In addition to untreated plots, three insecticide regimes were examined—Applaud, Knack, or conventional insecticides ('95IRM'). The first post-spray cohort (early August) was established one day after spraying and continued for 14 days. The second cohort (late August) was conducted 14–27 days after initial spraying. The final cohort (September) was conducted in untreated plots only. Only the one IGR spray was made in the two IGR regimes during these studies. For the conventional regime, two sprays were made during the early August cohort and one spray during the late August cohort. *Lygus* bugs were sprayed with Vydate C-LV® one time over all regimes five days prior to the early August cohort.

Life table analyses are on-going and only preliminary results of the nymphal stage are presented. In the first generation (July) prior to any spraying, mortality was highest during the fourth instar and the major mortality factors overall were 'missing' and sucking predation. Missing during this period was believed to be due to chewing predation because of large, coincident *Collops* beetle populations. Parasitism accounted for less than 5% of observed mortality. About 16% of the cohort survived to adulthood.

The second generation (early August) showed similar patterns of mortality for the untreated with the majority of mortality during the fourth instar apportioned mainly to predation and missing. The Knack regime produced similar results to the untreated and had similar rates of mortality across instars. In contrast, the Applaud and 95IRM regimes

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had the majority of mortality expressed during the first instar (about 60%) with successively declining rates for subsequent instars. This is a reflection of the temporal similarity of insecticidal action in these two regimes. Applaud, a molting inhibitor, killed most of the insects in the first and second instars, and conventional insecticides are most effective against smaller instars. Mortality rates due to insecticides were highest in these two regimes and consequently mortality rates due to predation were lowest. There was essentially no survival in the insecticide treated regimes (0–1%) and only 4% survival in the untreated check. Parasitism rates throughout were very low (< 4%).

In the third generation (late August), the patterns of mortality shifted, in part because of the interval since spraying with the IGRs (14–27 days earlier). The untreated displayed the typical pattern of highest mortality during the fourth instar and most killed by predation. The Knack regime again mimicked the untreated with similar rates of predation. There was, however, significantly greater survival in the untreated and remaining regimes (about 8–10%) compared to Knack (about 1%). There was less mortality overall due to insecticides in any of the regimes including 95IRM which was the only regime with a spray during this generation. In Applaud and 95IRM regimes, there was more mortality due to missing than predation, while in Knack and the untreated the reverse was true. Rates of mortality due to predation were lowest for the 95IRM regime, a reflection of the disrupting influence of conventional insecticides on predator fauna. Parasitism was slightly higher throughout with no differences among treatments in mortality rates (2–4%).

The last generation (September) occurred late in the production cycle, after irrigation termination. The pattern of mortality in the untreated was decidedly different from the previous generations. The majority of mortality occurred in the first instar, in part due to a rain event resulting in missing individuals, but also due to higher predation in this instar. Mortality in subsequent instars was lower, and overall survival was much higher in this generation (23% adult emergence). Parasitism was still very low (3%), while predation remained the major source of mortality overall.

In summary, mortality factors were directly measured in natural populations subject to commercial management practices. In all cases, parasitism was a minor mortality factor even in the untreated plots, while predation was the largest or second largest source of mortality for nymphs in this study. Missing was an important source too; however, this was likely a result of chewing predation, weather or insecticides, depending on the timing of these respective factors. Insecticides also exerted significant mortality, but mainly early in the life cycle of the nymphs with diminishing direct impact two weeks later. The selective action of the IGRs combined with their "slow-acting" growth regulation led to enhanced levels of predation relative to the conventional regime and more similar to undisrupted untreated checks. IGRs combined with Bt cotton and the judicious use of broad-spectrum inputs could lead to better target and secondary pest control through enhanced natural enemy conservation.

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Disclaimer

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