Dynamics of Whiteflies and their Enemies in Cotton Fields: Implications for Pest Management

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ABSTRACT

The project, entitled "Integrated Pest Management for Cotton" commenced in September 1994 with scientists from four countries, Israel, Egypt, Ethiopia and Zimbabwe co-operating in a joint project funded by the Common Fund for Commodities through the International Cotton Advisory Committee. It seeks to improve the control of honeydew-producing sucking pests, through the use of novel insecticides, natural enemies, better spraying equipment and proper thresholds. Most of the experimentation, especially during the first two years of the project, was carried out in Israel and Egypt. This paper reports some of the more significant findings, with particular emphasis on the importance of natural enemies.

Introduction

The pest *Bemisia tabaci* (*s.l.*) can reach high populations in cotton fields and cause extensive damage that may manifest itself in three forms (Ohnesorge and Gerling, 1986). Direct damage through plant sucking and the loss of nutrients, production of honeydew that contaminates the lint directly and soils the cotton through the growth of black fungi and by transmitting viral diseases. The viral diseases of cotton, leaf crumple and leaf curl, do not occur in Egypt or Israel. This paper concentrates on experiments towards ameliorating the problems caused by the first two types of damage, employing biological ecological and toxicological studies to facilitate better pest management.

Management of whitefly infestations requires information about their dynamics, the influence of natural enemies, and the effects of insecticides upon the cotton invertabrate fauna. Whitefly dynamics in the cotton fields of both Egypt and Israel are similar in principle. Populations are relatively low from the onset of the season in March and April, remaining low until about mid July, when they increase. The increase may be moderate without creating major problems, or abrupt, causing major outbreaks. Population increases have usually been attributed to migration of the pests from adjacent fields of sunflowers, cucurbits such as melons or squash, or other vegetable crops. The relative importance of migration in the build-up of whitefly populations in the cotton fields was examined.

Predators and parasitoids are plentiful in the cotton field throughout the season (Rosenheim *et al.*, 1993, Gerling *et al.*, 1997). The former are usually somewhat generalist feeders, not specializing in whiteflies. However, several species include whiteflies in their diet and are active in reducing whitefly populations. In comparison, the parasitoids are specific in their diet and will grow explicitly at the expense of the developing whitefly nymphs. Thus, their roles and numbers can be determined with greater ease than those of the predators. We attempted to determine which predators feed on whiteflies in the cotton fields of both countries. The role of predator species as agents in reducing whitefly populations was assessed in order to estimate the potential damage to the natural control of the pest caused by killing the predators with insecticides.

Materials and methods

Observations in both countries were conducted once every 1-2 weeks. Samples of whitefly nymphs and parasitoids were taken by picking one infested leaf at about the 5th node from the top (Israel) or 3 leaves per plant (Egypt) and examining them under a dissecting microscope. All observed whitefly nymphs were checked for parasitization. Abundance of whitefly adults was monitored through weekly examinations of oil coated yellow traps (plastic boards of 16x20 cm) placed on the ground. Predators were sampled in the field by examining six, 1 meter sections in which all cotton plants were scanned and all predators, were registered (Gerling *et al.*, 1997).

In addition, the initial population of whitefly adults in two separate cotton fields in Israel (Maayan Zvi and Revadim), planted with the same Pima variety at the same time, were examined. Counts were taken early in June, as soon as the first whitefly adults arrived in the field, before locally developing population were apparent. All the whitefly adults on 40 cotton plants were counted by turning each leaf over and observing the number of insects on it. The observations were conducted in the cool, very early morning hours before whitefly adults began to fly. The numbers of migrant adults were used to analyze the importance of whitefly migration on population build-up in the cotton field. The influence of adjacent sunflower crops, as a source of both whiteflies and their natural enemies, was examined by counting adult whiteflies and their predators on all leaves of 10 sunflower plants once every two weeks from 9 June to 4 August 1998. We monitored build-up of whiteflies in yellow traps and on the cotton plants before, during and after the growth of the sunflower plants.

The sensitivity of natural enemies to insecticides was tested in cotton fields in Egypt. Tests consisted of treating two fields with various insecticides, some in commercial use and others still experimental or considered 'soft' materials (Table 2). Treated fields were compared with an untreated control. Whiteflies, predators and parasitoids were counted in all plots.

Results and Discussion

The population dynamics of the whiteflies show a typical pattern that is low before July but then rises abruptly. The pattern is similar for both outbreak and non-outbreak conditions, with the difference being in the numeric level that the whiteflies reach (Figure 1).

Counts of whitefly adults occurring on cotton in June in the two cotton fields showed that one – in Revadim, had 2.7 adult whiteflies/plant, whereas the second – in Maayan Zvi had 0.62 adults per plant, indicating a more abundant arrival of adults on the former. Nevertheless, seasonal dynamics of the former showed a generally low population level, at least until the end of August. The population in Maayan Zvi, which started with a very low number of whiteflies, rose speedily to reach damage-causing levels within a short time (Figure 2). It was concluded that outbreak conditions could occur in the absence of substantial migration into the cotton field.

Natural enemies were present in both treated and untreated cotton fields. The list of predators in the two countries differs somewhat (Table 1). However, most species were represented in both Egypt and Israel. The dynamics of predator occurrence indicate that some, especially Coleoptera, were most prevalent early on in the season. After mid-season only a few species remained, of which the lacewings and spiders were most prominant.

Of the many parasitoid species recorded attacking *B. tabaci* throughout the world, mainly *Encarsia lutea* and *Eretmocerus mundus* were found. These were prevalent in both countries and percent parasitism often exceeded 60% (Figure3). Parasitism was often equally high during high and low host populations, indicating that parasitoids probably did not control the whiteflies, but simply acted as an additional mortality factor.

Sunflowers were found to be a poor source of predators, hosting them only in low numbers. Whiteflies build-up to high numbers from early June through mid July. When the host plants started drying up, the adult whiteflies migrated to adjacent cotton fields. This migration was monitored on the yellow traps in which a large increase in adults was noticed during July. The resulting rise in populations of immature whiteflies occurred about two weeks later (Figure 2).

The experiments indicate that although providing refuge plants to support natural enemies for the control of whiteflies may be an option, it remains to determine which plant species could best serve this function. Sunflowers, often considered for this role, did not prove suitable in this study.

Cotton plants of the same variety but under different growing conditions were also found to either support whitefly development or not, irrespective of the size of whitefly migration into the field, emphasizing the importance of the plant role in regulating whitefly population development. Nevertheless, the role of natural enemies should not be underestimated. Both predators and parasitoids take a toll of whiteflies that may amount to over 80% of their populations. Should such a high percentage of whiteflies be allowed to mature and produce pest individuals, population growth would accelerate greatly and necessitate more insecticide treatments. The additional increase in treatment frequency would raise the direct cost to the grower and hasten the development of resistance. Thus, whitefly control schedules should refrain from insecticide treatments to facilitate the best activity of the natural enemies. If however, pest populations reach levels that endanger the quality and quantity of the cotton crop, the least harmful materials should be used to obtain reasonable whitefly control while delaying the onset of resistance.

Field tests were also undertaken on the impact of a range of newer insecticides on beneficial insect numbers. The material tested were Beauvaria bassiana, jojoba oil, diafenthiuron, pymetrozine, pyriproxyfen and a mineral oil. They were assayed for their effect against whitefly parasitism by Encarsia lutea and Eretomocerus mundus and the predators Chrsoperla carnea, Orius albidipennis, Campylomma nicolas, the predatory mite Amblyseius swirskii and a range of predatory spiders. The results are being analyzed and prepared for publication.

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Table 1. Predators found in cotton fields of Egypt and Israel during the study.

Family	Species-Egypt	Species, Israel
Acari-Phytoseiidae	*Ambleyseius swirskii*	*Ambleyseius swirskii*
Coccinellidae	*Coccinella undecimpuntata*	*Coccinella* spp.; *Hippodamia variegata.*
	Scymnus syriacus; S. interruptus	*S. levaillanti; S. syriacus; S. flavicollis*
Staphylinidae	*Paederus alfierii*	-
Chrysopidae	*Chrysoperla carnea*	*Chrysoperla carnea*
Anthocoridae	*Orius albidipennis; O. laevigatus*	*Orius albidipennis; O. laevigatus; O. niger*
Miridae	*Campylomma nicolas*	*Campylomma unicolor*
	-	*Deraeocoris pallens*
Spiders -	Several families	Same

Figure 1. Typical seasonal dynamics of *B. tabaci* populations in cotton, showing a high (Zora) and a low (Revadim) population pattern.

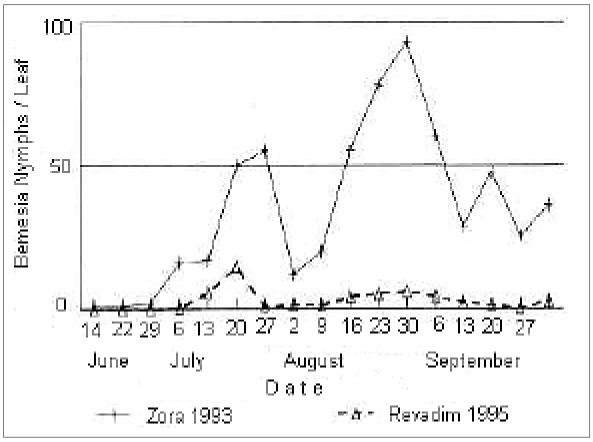

Figure 2. Population dynamics of *B. tabaci* at Revadim and Maayan Zvi in 1997.

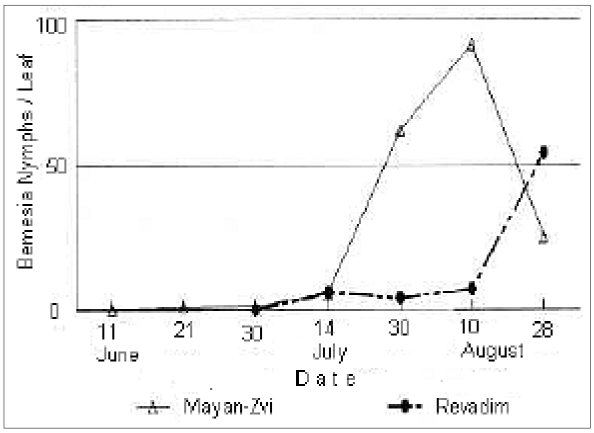

Figure 3. Parasitism of *B. tabaci* in selected cotton fields.