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PEST-PREDATOR INTERACTIONS IN UNTREATED COTTON FIELDS AT THREE PLANT GROWTH STAGES: 1- LOCATION IMPACT

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ABSTRACT

Impact of different agro-ecosystems on pest- predator interactions in untreated cotton fields at the three plant growth stages; plant establishment (PE), fruit formation (FF) and fruit maturation (FM) was studied in Egypt at Sakha (Kafr El-Sheikh Governorate) and Mallawi (Menia Governorate) Research Stations in the cotton season 1991. Direct counts of pests and predators were taken weekly from the two locations. Field observations on the efficiency of the predators were recorded. Population of pests and predators was affected by the diversity of the climatic factors and the habitats in the two working sites. It was generally higher at Sakha than at Mallawi. Moderate rates of infestation were recorded for most of the secondary pests as well as for the cotton leafworm (CLW). On the other hand, target pests; spiny bollworm (SBW) and pink bollworm (PBW), infestation increased sharply at the end of the season. Predator populations continued to increase through the season. Most of the predatory arthropods at both locations interacted significantly with the cotton pests throughout the season.

Key Words : Cotton, Pest-predator interaction, Egypt

INTRODUCTION

In cotton, there is frequently insufficient time to develop a favouarble balance natural enemies and pest species. Thus, natural enemies are unable to exert sufficient control in these temporary habitats to obviate the need for chemical intervention.

Cotton production in Egypt decreased about 30% in the eighties, as a result of pest attacks and the increased use of chemicals against bollworms, the spiny bollworms (SBW) *Earias insulana* Boisd. and the pink bollworm (PBW) *Pectinophora gossypiella* (Saund.). Accordingly, severe increase in numbers of secondary pests particularly the whitefly, *Bemisia tabaci* Genn., and aphid, *Aphis gossypii* Glov. was existed (Ellington, 1990). The intensive use of insecticides to control the bollworms has eliminated the impact of the native beneficial complex during the season, especially parasitoids (Hamed, 1984 and Fayad *et al.*, 1990). Many studies have shown that the native predators are the most effective biocontrol agents in the Egyptian cotton fields. Their active roles continue until the scheduled spraying of cotton, that starts by early July. At this time, a decline (up to 80%) in the predator's population usually occurs (El-Heneidy *et al.*, 1978; Fayad and Ibrahim, 1981; Hamed *et al.*, 1983; Stam and Tune, 1983; El-Heneidy *et al.*, 1987 and Kares *et al.*, 1988).

It is important to recognize the cotton growth and fruit production periods to confirm the changing patterns of insect pest problems and provide basis for Integrated Pest Management (IPM) programs (Falcon, 1972; Gonzalez and Wilson, 1982).

The present study was carried out as an Egyptian-American collaborative program on cotton IPM under the National Agricultural Research Project (NARP) financed by USAID. In this study, we focused on impact of pest- predator interactions in untreated cotton fields at two different geographical sites.

MATERIALS AND METHODS

In 1991 cotton growing season, 12 feddans at Sakha Research Station (Kafr El-Sheikh Governorate, north Egypt), and 4 feddans at Mallawi Research Station (Menia Governorate, middle-upper Egypt) were planted to represent two geographically distinct agro-ecosystems (Taher *et al.*, 1978). The experimental plots were purposely surrounded by clover and wheat during the winter season (1990/91) and maize during summer season to enhance native levels of biocontrol species. By early April, the recommended cotton varieties, Giza 86 and Giza 83 were planted at Sakha and mallawi experimental plots, respectively. Regular cultural practices were conducted throughout the season. In order to evaluate the natural pest predator interactions, no insecticides were applied in the test fields. Evaluations were done at three distinct

plant growth stages: Plant Establishment (PE) (from sowing date to 1*st* square), Fruit Formation (FF) (from 1*st* square to 1*st* open boll), and Fruit Maturation (FM) (from 1*st* open boll to harvest((Falcon, 1972). This was important because each of these plant stages has distinct morphological and physiological characteristics. The different plant characteristics lead to differences in the population numbers of specific or common feeders among the pest species, which in turn affects the natural enemies population at different growth stages (Legaspi *et al.*, 1989). Few days after germination, designated plants were inspected weekly and direct counts of cotton pests and their associated predators were taken. The total area sampled each week in each plot was 25 meters (= 100 hills = 200 plants). A stratified sampling technique was used (Legaspi *et al.*, 1989, and Ellington, 1990).

Counts of thrips, aphids, mites, whiteflies and jassids were estimated as less or more than 10 individuals/leaf. Three leaves were sampled, one from top, middle and lower part of each plant. The percentage of infested leaves was calculated from 600 leaves/200 plants. Actual numbers were counted for CLW, SBW and PBW. At the time of pest counts, each designated plant was inspected and direct counts of both immature and adult stages of the following predators were recorded: coccinellids: *Coccinella undecimpunctata* L. and *Scymnus interruptus* L.; chrysopid: *Chrysoperla carnea* (Steph.), anthocorids: *Orius spp.*; staphylinid: *Paederus alfierii* Koch; ants and four groups of true spiders: Lunx, Jumping, Webbing and Crab, including eggs and pupae of *C. undecimpunctata, C. carnea* and *S. interruptus*. Field observations on the efficiency of predatory species and their feeding behaviour were recorded in the two working sites.

Rate of cotton boll infestation was estimated weekly by dissecting 100 randomized green bolls collected from each site starting from the mid of FF stage, and continued until harvesting (Abdel-Salam *et al.*, 1991). Multiple regression analyses were used between each species (using combined numbers of feeding immature stages predator and/or adults) and the total numbers of each prey species, during each plant growth stage (cite lit. method for analyses used). Daily maximum and minimum temperature and R.H. data were recorded for the two sites.

RESULTS AND DISCUSSION

An evaluation of pest-predator interactions during the three growth stages was made as follows:

1. Plant Establishment (PE) Stage

During this stage, the plant establishes its root system, branching pattern and sets leaves. This stage lasted about 3 and 6 weeks at Sakha and Mallawi, respectively. Germinated seeds and seedlings of cotton are liable to be attacked by a range of polyphagous insects such as, cutworms and mole crickets (ground insect pests) and leaf sucking insects; thrips, aphids, mites, whiteflies and jassids. Plants percentage of infestation by thrips and jassids at Sakha and Mallawi reached a highest mean of 42 and 40%, respectively. They were the most abundant insect pests during this stage, while the incidence of the others was relatively low (Fig. 1). Few egg-masses of CLW were found by the end of the PE stage in both locations. True spiders were the predominant predatory arthropods at both locations (Figs. (2 & 3). Statistical analysis of the pest- predator interaction during PE stage are summarized in diagrams 1 & 2. Four and two groups of predatory species interacted significantly with the secondary pests at Sakha and Mallawi, respectively. At Sakha, three of the predators were shown in association with thrips and whiteflies and two of the predators were associated with jassids. At Mallawi, two predator groups showed significant interactions with aphids and only one with each of whiteflies and jassids.

Generally, secondary pests during PE stage were the most abundant preys. these pests are considered of minor economic importance during this stage as they did not significantly affect crop yield or quality.On the other hand, they provide food source for predators that occur in cotton fields.

2. Fruit Formation (FF) Stage

During this stage which lasted 10 weeks at Mallawi and 11 weeks at Sakha, the plants sets about 80% of its entire boll carrying-capacity during the first 5-6 weeks of blooming period. The FF is considered the most critical growth stage of cotton, because at this time the insects feed on squares, buds and flowers which lead to reduction in boll formation and increase in fruit drop (Abu El-Nasr *et al.*, 1978). In both cases, crop yield is affected adversely.

During this stage; aphids, whiteflies and jassids infestations were recorded. The highest infestations caused by jassids at both locations followed by the whiteflies at Sakha which reached a mean of 35.1%. Numbers of CLW reached a highest mean of 50.2 larvae/100 hills at Sakha in correspondence to 4.4 larvae/100 hills at Mallawi (Fig. 4). Early in this stage, SBW were recorded attacking small squares and plant shoots. Later, (around mid-FF stage) PBW were recorded in flowers.

All predatory species counted during this period in both locations were relatively high particularly at

Sakha. The highest populations of all species (except *C. carnea* and *Orius spp.*) were found at Sakha (Fig. 2). Numbers of *P. alfierii* were 59 individuals per 100 hills at Sakha and 1.4 individuals/100 hills at Mallawi. Predator's activity and abundance during FF period was much greater than that in PE. Statistical analysis of pest-predator interactions during FF stage is summarized in diagrams (1 & 2). During this period, all predatory species (except the rove beetle at Mallawi) interacted significantly with the cotton pests at both sites. *C. undecimpunctata* was the most active species at Sakha. Most of the predator species found interacted with CLW and the bollworms during this stage (Diagrams 1 & 2).

3- Fruit Maturation (FM) Stage

The fruit maturation stage starts from boll formation until the peak of plant full boll carrying capacity. This period lasted about 7 and 6 weeks at Sakha and Mallawi, respectively. Most of insect damage during this period sustained on green bolls and leads to additional destruction of bolls through secondary invasion of fungi and bacteria.

During the FM stage, highest means of percentage of infestations by sucking insect pests ranged between 17.2 and 36.2%. Aphid and whitefly rates exceeded that of jassidss. Rates were relatively higher at Sakha than Mallawi with all secondary pest species, but the differences were not significant (Fig. 1). Bollworm populations built up rapidly during FM stage to attain their maximum means of 19.5 and 12 leaves/100 hills by SBW and PBW, respectively. CLW population declined in the two sites compared with the levels during FF. Numbers of all key pets were relatively higher at Sakha than Mallawi and excessive damage often resulted (Fig. 4). Numbers of most predatory species continued to increase during this stage. However, numbers of *P. alfierii* declined drastically (Figs. 2 & 3). The numbers of predators were higher at Sakha than at Mallawi and coincided with overall higher populations of insect pests, particularly secondary pests.

Statistical analysis of pest-predator interactions during this stage are summarized in diagrams 1 & 2. During this period, except for the *Scymnus* at Sakha and *Orius* at Mallawi, all other predatory species were related significantly with most of the cotton pests.

Rate of Natural Infestation in the Green Bolls

Levels of infestations are given in terms of infestation percentage in green bolls which increased during the season with the highest figures at the end of the season in the two locations, particularly at Sakha (Abdel-Salam *et al.*, 1991). Data shown in figure 5 were derived from collections of green bolls at weekly intervals starting by mid-FF stage up to harvesting. Trends of infestation increased sharply towards the end of the season. In FF and FM periods, infestation was equal between the two bollworm species SBW and PBW at Sakha, whereas PBW infestation greatly exceeded that of SBW at Mallawi. Except for this sole case in all other comparisons, infestations were higher at Sakha than at Mallawi (Fig. 5). Percentage of infestation increased about 8 times in case of PBW at Sakha during FM stage compared with FF stage, while it increased only 2-5 times in the case of SBW at Mallawi during the same growth stage.

Field Observations

It was found that there are some types of preferences in case of *C. undecimpunctata* especially when aphids were rare. The coccinellid species *Cydonia vicina* var. *isis* and var. *nilotica* were observed late in the season. True spiders preyed efficiently on many insect pests but sometimes on wandering predatory species too. *S. interruptus* and *Orius spp.* were the most abundant predators attacked bollworm larvae inside open bolls. Ants were also recorded associated with the bollworms inside open bolls late in the season. The dominant ant species was identified by A. Bhatkar (Texas A & M) as *Pheidole* sp. (Fam. Formicidae). Some braconid cocoons of the parasitoid *Microplitis rufiventris* Kok., a larval parasitoid on CLW, were observed on the cotton plants. A few CLW larvae infected by virus were also found.

Generally, from data obtained and field observations, it has to be concluded that:

- The populations of the pests and natural enemies, particularly the predators were substantially different at the two sites. This result was agreed with the findings of Taher *et al.* (1978).
- Although the predatory species were recorded throughout the season, predator-pest associations and predator efficiency were different in the two locations depending on plant age and prey complex (Stam and Tune, 1983).
- Different levels of native predators have been recorded when insecticide applications were eliminated or when alternative control methods (such as the use of pheromones) are used to combat bollworm infestations (El-Heneidy *et al.*, 1978; Hamed *et al.*, 1983; Critchley *et al.*, 1985 and El-Heneidy *et al.*, 1987). In such cases, predator populations continued to increase through the season (Figs. 2, 3 and 6).

Diagram (1): Multiple regression analyses among cotton predators and pests at three growth stages, Sakha, 1991.

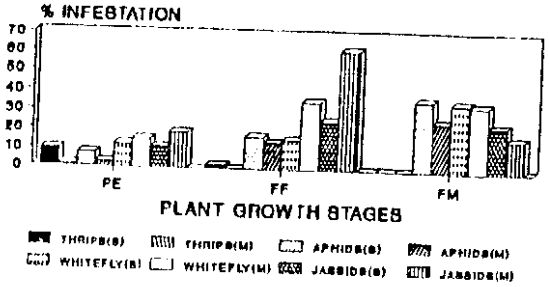
Coccinella	PE:	Thrips***, whitefly*, jassids***
	FF:	Thrips***, aphids***, whitefly***, jassids***, CLW*, SBW***
	FM:	Aphids***, whitefly***, jassids***, CLW*
Chrysoperla	PE:	———
	FF:	Whitefly***, SBW***, PBW***
	FM:	Aphids***, whitefly***, jassids***, CLW*, SBW***
Scymnus	PE:	———
	FF:	Thrips*, aphids***, whitefly***, jassids***, SBW***, PBW***
	FM:	———
Orius	PE:	Thrips***
	FF:	Whitefly*, jassids*
	FM:	Aphids***, SBW***, PBW***
Paederus	PE:	Thrips***, whitefly**
	FF:	CLW**, PBW*
	FM:	Aphids**, whitefly*, jassids***, CLW**, SBW***, PBW***
True spiders	PE:	Whitefly**, jassids***
	FF:	SBW**, PBW*
	FM:	Aphids*, SBW*

Diagram (2): Multiple regression analyses among cotton predators and pests at three growth stages, Mallawi, 1991.

Coccinella	PE:	Aphids*
	FF:	Whitefly**, jassids**, SBW**
	FM:	SBW*
Chrysoperla	PE:	Aphids*, whitefly**, jassids**
	FF:	Whitefly**, jassids***, SBW***
	FM:	SBW**, PBW**
Scymnus	PE:	———
	FF:	Aphids**, whitefly**, jassids**, SPW**, PBW**
	FM:	Aphids***, jassids***
Orius	PE:	———
	FF:	Whitefly*, CLW*, SBW**, PBW*
	FM:	———
Paederus	PE:	———
	FF:	———
	FM:	PBW*
True spiders	PE:	———
	FF:	Whitefly**, jassids**
	FM:	Jassids*, SBW*

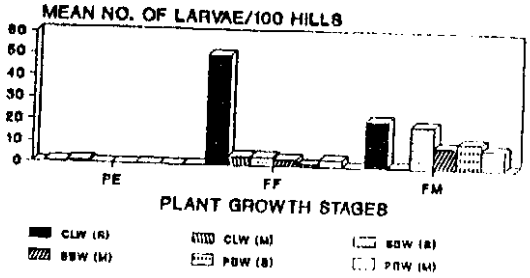
* Significant at P = 0.1
** Significant at P = 0.05
*** Significant at P = 0.01

Fig.(1):Foliage % infestation by secondary pests in three cotton growth stages in untreated fields 1991.



SAKHA (S), MALLAWI (M)

Fig.(4):Mean No. of larvae/100 hills of key pests in three cotton growth stages in untreated fields 1991.



SAKHA (S), MALLAWI (M)

FIG.(2):Mean no.of arthropod predator spp./100 hills in three cotton growth stages in untreated fields at Sakha 1991

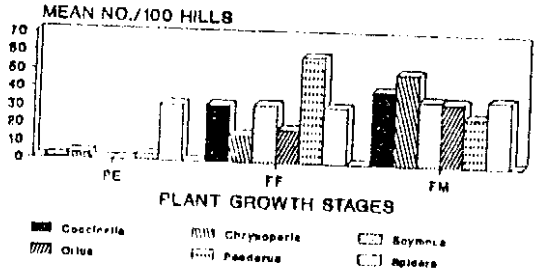
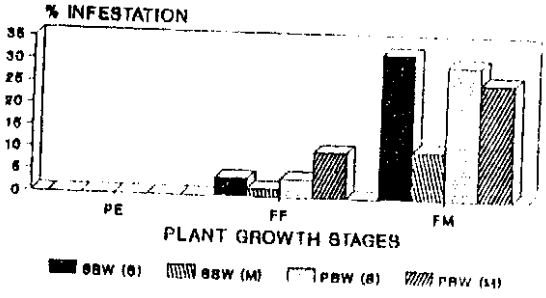


Fig.(5): Percent green boll infeststion by bollworms in three cotton growth stages in untreated fields 1991.



SAKHA (S), MALLAWI (M)

Fig.(3):Mean no.of arthropod predator spp./100 hills in three cotton growth stages in untreated fields Mallawi 1991.

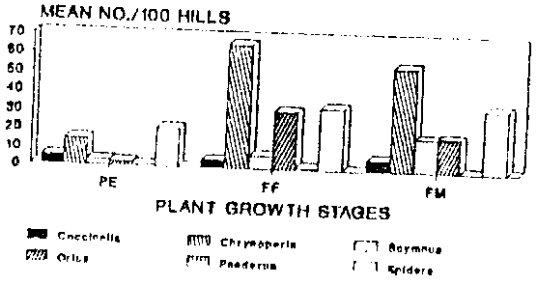
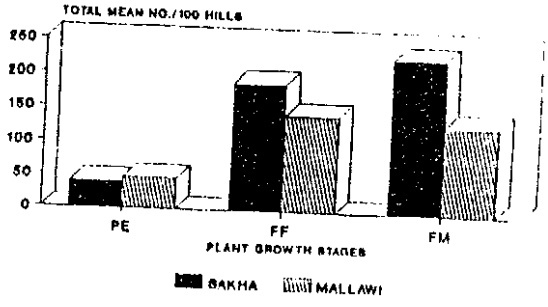


Fig.(6): Total mean number of arthropod predators/100 hills in three cotton growth stages in untreated fields 1991.



- Moderate rates of infestation were recorded for most of the secondary pests as well as for CLW. This may be due to the extended period of predator activity in the absence of insecticide disruption. On the other hand, the target pests PBW and SBW infestation increased sharply at the end of the season. This may be due to the reduced efficiency of the predators against these pests which are isolated and protected inside green bolls.
- It was observed that existence of clover beside cotton fields early in the season and until the FF stage has increased the migration of predators to cotton in considerable numbers. It was also observed that some predatory species such as *P. alfierii* and *S. interruptus* migrated from the cotton fields to surrounding maize, particularly when aphids were abundant on maize plants.
- From statistical analysis, it has been found that infestation between pests and predators was more significant at Sakha than at Mallawi. true spiders and rove beetles fed on bollworms in FF and FM growth stages, while *C. undecimpunctata* fed on CLW during the same two plant stage. Some predatory species were more abundant during certain growth stages.
- From the present study, it is obvious that there were potential relationships between predators and several preys in the Egyptian cotton fields. However, the study is not conclusive for purposes of implementation in Pest Management Programs. More field validation studies are needed before final recommendations can be made.

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