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Cotton Production in the Presence of *Pectinophora gossypiella* (Saunders) in Central Greece

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Abstract: The aim of the present research was to study fluctuations of populations of *P. gossypiella* in various areas in the Prefecture of Larissa. Data were analyzed to found the relation between population density of the insect and cotton production and additionally, to explore year and local (area) conditions as factors affecting damage levels. Correlations on data between years (across all communities) revealed that, when cotton production was high then the number of adult male insects of *P. gossypiella* captured in pheromone traps was also high (r = +0.93). Our data indicate that, when the environmental conditions of specific years favored cotton production, then the population of *P. gossypiella* was high due to the availability of food (more flowers and bolls), in a kind of synchronization. In parallel, the presence of increased numbers of useful insects that predate cotton enemies may result in lower damages on cotton production. In years 2002 and 2003, the presence of the insect may contribute in lower cotton production in the areas where population of adult males trapped was high. The mean cotton production was generally low in the areas where population of *P. gossypiella* was high. In this case, although statistically not significant, the tension was negative (r = -0.37). Local conditions within each area have been proved important and these results were completely different compared to data concerning years. The specific conditions within each area determine the balance between the insect population and level of damage on cotton production. There were areas where the insect showed increased populations resulting in low cotton production. These areas may need special treatment with insecticides or other techniques in order to decrease insect populations.

Key words: Cotton production, *Pectinophora gossypiella*, population fluctuations

INTRODUCTION

Cotton is one of the main cultivations in Greece and 390,000 ha are cotton fields (10% of the total cultivated area) (NSOG, 2001). In Central Greece is the main cultivation (over 50% of total cultivated area) and 70,000 ha are in the Prefecture of Larissa. It is a well established cultivation in Larissa, Volos, Trikala, Farsala and Karditsa and represents the main income source of farmers in these territories of Central Greece. Cultivation period starts in March or April, ending in October.

The insect *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechidae) known as pink bollworm, is a small brown butterfly (up to 1 cm). It was first described by W.W. Saunders in 1843 as *Depressaria gossypiella* from specimens of damaged cotton in India in 1842 (Ingram, 1980). Second stage larvae are getting pink or rose and easily recognizable because of this characteristic color. In Greece, the insect has 3 to 4 generations per year. First generation appears in early June or even late

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May. Larvae penetrate cotton flowers to feed on anthers and pollen, resulting in low damages. Great damages cause the second and third generations that appear in early or middle July and middle August, respectively (Adkisson *et al*., 1963; Abdel-Rahim *et al*., 1976; Abdel-Hamid *et al*., 1999; Prasad, 1999; Tolis, 1999). In September, may appear the fourth generation. Second generation larvae penetrate fruits (bolls), feeding on immature seeds and fibers. After emerging, young larvae need only one hour at the most to penetrate fruits (Tolis, 1999; Giatropoulos, 2005). After completing their stages in about 15-20 days, they are leaving fruits from a small hole. Third and if possible fourth generation larvae usually remain in the fruits for overwintering.

In Central Greece, the insect is usually found at the axis from Larissa to Volos or Larissa to Farsala, causing great damages. In other territories the damages are lower, depending on how intense are the attacks. Sometimes, even if the populations of *P. gossypiella* are considerably high, damages are very low and below economic level (Buchelos *et al*., 1999). In general, little is known about the relationship of cotton production and the population of bollworms (Brazzel and Gaines, 1956; Abdel-Rahim *et al*., 1976; Benschoter and Leal, 1978; Aboul-Naga and Ghanim, 1979; Benedict *et al*., 1989; Buchelos *et al*., 1999). Fluctuations of insect population from year to year are high and cannot be predicted. In general, damage on cotton production may vary from 10-60%, in territories where there is no monitoring for insect populations or preventive insecticide applications. Carbamides and pyrethroids can be used for cotton protection (Agarwal *et al*., 1983, 1999), sometimes in combination with biological control (Butter *et al*., 1995).

Mating disruption was effective in preventing damage when applied early season (Singh and Singh, 1992), but damage levels were not proportionally reduced in relation to the reduction of trap catches (Lykouressis *et al*., 2004). In Greece, pheromone evaporators may be used from early June for reducing population of next generation. Catches of pink bollworm moths in pheromone-baited traps and damage caused were recorded in both insecticide-treated and control fields. Results showed that moth catches were highly reduced in the treated field and, therefore, mid-season installation of dispensers was successful. Damage (%) was significantly less in the treated compared with the control field (Lykouressis *et al*., 2004, 2005). Combination of parasitoids and mating disruption was also used to reduce damages in cotton fields (Ahmad *et al*., 2001). Pheromone traps for monitoring populations must cover extensive areas in order to get reliable data (Singh and Singh, 1992; Tolis, 1999; Lykouressis *et al*., 2005).

The aim of the present study was to study fluctuations of populations of *P. gossypiella* in various areas in the Prefecture of Larissa. Data were analyzed to found the relation between population density of the insect and cotton production and additionally, to explore year and local (area) conditions as factors affecting damage levels.

MATERIALS AND METHODS

The present study was conducted in 10 different communities of prefecture of Larissa, in Central Greece, one of the main cotton-productive areas of Greece. Monitoring of *P. gossypiella* lasted four years from 2002 to 2005. The monitoring system included four locations within each community and three traps in each location, at a distance between traps of 50 m (on the corners of an equilateral triangle). Pheromone traps used were the common Delta type and the type of pheromone used was Z7-Z11-16Ac for monitoring male adults. Trap type may influence total captures, but other parameters such as pheromone quantity or position of traps have no influence (Athanassiou *et al*., 2002). Because of the long recording period, common Delta type traps were preferred. In all cases, data were collected every three days, from late May until October. Data from traps recorded fluctuations

of insect population within each community and for the whole Prefecture of Larissa. Environmental conditions (rainfall, relative humidity, temperature) were also recorded. Cotton mean production in kg ha^{-1} was also calculated from harvesting data within each community. Correlations between cotton mean production and number of male adult insects were performed. Data transformations, ANOVA and correlations were based on the standard procedures described by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Year 2002 was warmer (in case of average temperature) and relatively wet in comparison to other years (Fig. 1). Year 2005 was also warm but with very low rainfall. From July to August (when second and third generations of the insect appear according to Adkisson *et al*. (1963), Abdel-Rahim *et al*. (1976), Abdel-Hamid *et al*. (1999), Prasad (1999) and Tolis (1999), rainfall was very low for years 2002 and 2004.

Table 1 presents mean cotton production and adult male insects of *P. gossypiella* captured in the 10 communities of Larissa, for years 2002-2005. Year 2005 exhibited the greatest insect population in comparison to other years (mean 16.9 adult males trapped), while communities 1, 4, 5, 6 and 9 showed high insect populations across almost all the years (over 10 adult males trapped in average). Year interaction to the factor area (the 10 communities) was found statistically significant (all factors showed significant interactions at $p<0.05$). Figure 2, presents the fluctuations of population within all areas (10 communities) and dates of recordings for years 2002-2005. Fluctuations of insect population were different from year to year and rather unpredictable. Insect population fluctuations (as shown in Fig. 2) showed statistically significant differences (recordings across years and areas showed significant differences at $p<0.05$) and this might be a common biological phenomenon for insect populations.

Correlations on data between years (insect populations and cotton production across all communities) revealed that, when cotton production was high then the number of adult male insects of *P. gossypiella* captured in pheromone traps was also high ($r = +0.93$, $p<0.05$). These adverse results may be at first surprising because it was expected, at high insect populations (at least for males trapped) the damages to be severe reducing considerably the mean cotton production (Brazzel and Gaines, 1956; Benschoter and Leal, 1978; Tolis, 1999). Present data indicate that, when the environmental conditions of specific years favored cotton production, then the population of *P. gossypiella* was high due to the availability of food (more flowers, bolls etc.), in a kind of synchronization. In parallel, the presence of increased numbers of useful insects that predate cotton enemies may result in lower damages on cotton production.

Table 1: Mean cotton production and adult male insects of *P. gossypiella* in the 10 communities (C_1-C_{10}) of Larissa, for years 2002-2005

Year	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	Mean
Cotton production (kg ha^{-1})											
2002	3700	4000	4300	4000	3700	3700	4400	4000	3800	4000	3960
2003	3000	4500	4500	4200	3800	3400	4500	3800	4000	2600	3830
2004	3500	4000	4400	4600	3800	3500	3600	1800	4800	4000	3800
2005	3950	5000	4700	4800	3740	3500	3800	3800	4700	4700	4270
Mean	3540	4380	4480	4400	3760	3530	4080	3350	4330	3830	3960
Mean No. of male insects trapped											
2002	23.0	3.0	5.0	2.0	15.0	11.0	2.0	11.0	7.0	12.0	9.1
2003	36.0	3.0	5.0	2.0	15.0	11.0	1.0	11.0	7.0	11.0	10.2
2004	8.4	2.3	7.0	1.7	15.9	11.6	0.7	2.7	3.4	11.6	6.5
2005	31.0	11.0	5.0	36.4	28.0	10.0	2.0	1.7	41.2	2.4	16.9
Mean	24.6	4.8	5.5	10.5	18.5	10.9	1.4	6.6	14.7	9.3	10.7

*Factor interactions were statistically significant at $p<0.05$

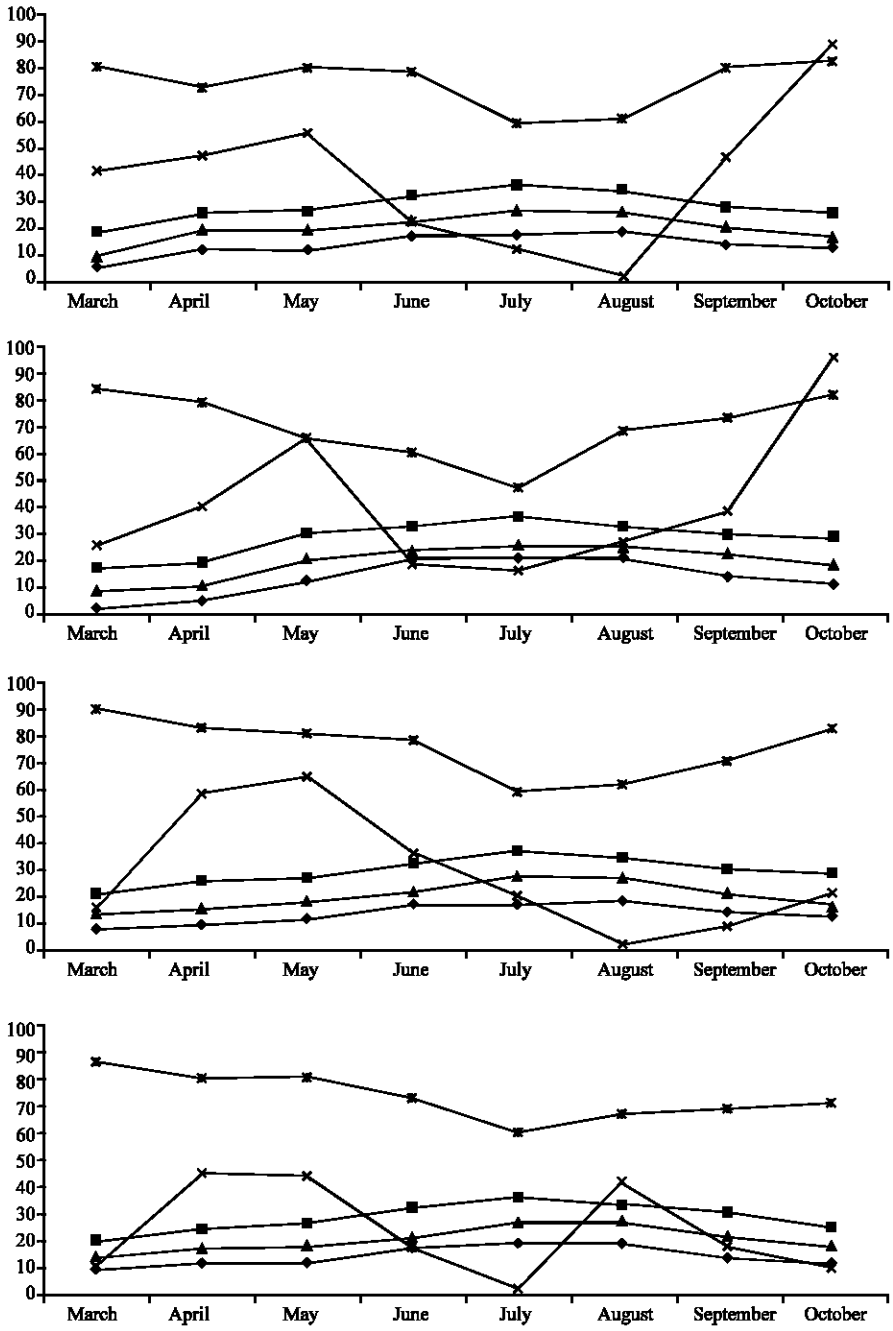

Fig. 1: Environmental data (♦) Minimum, (■) Maximum and (▲) Mean temperature in °C, mm of rainfall (×) and Relative Humidity (✱) during cultivation period in Larissa for years 2002-2005 (top to bottom)

In years 2002 and 2003, the presence of the insect may contribute in lower cotton production in the areas where populations of adult males trapped were high. The mean cotton production was generally low in the areas where population of *P. gossypiella* (estimated by traps) was high. These

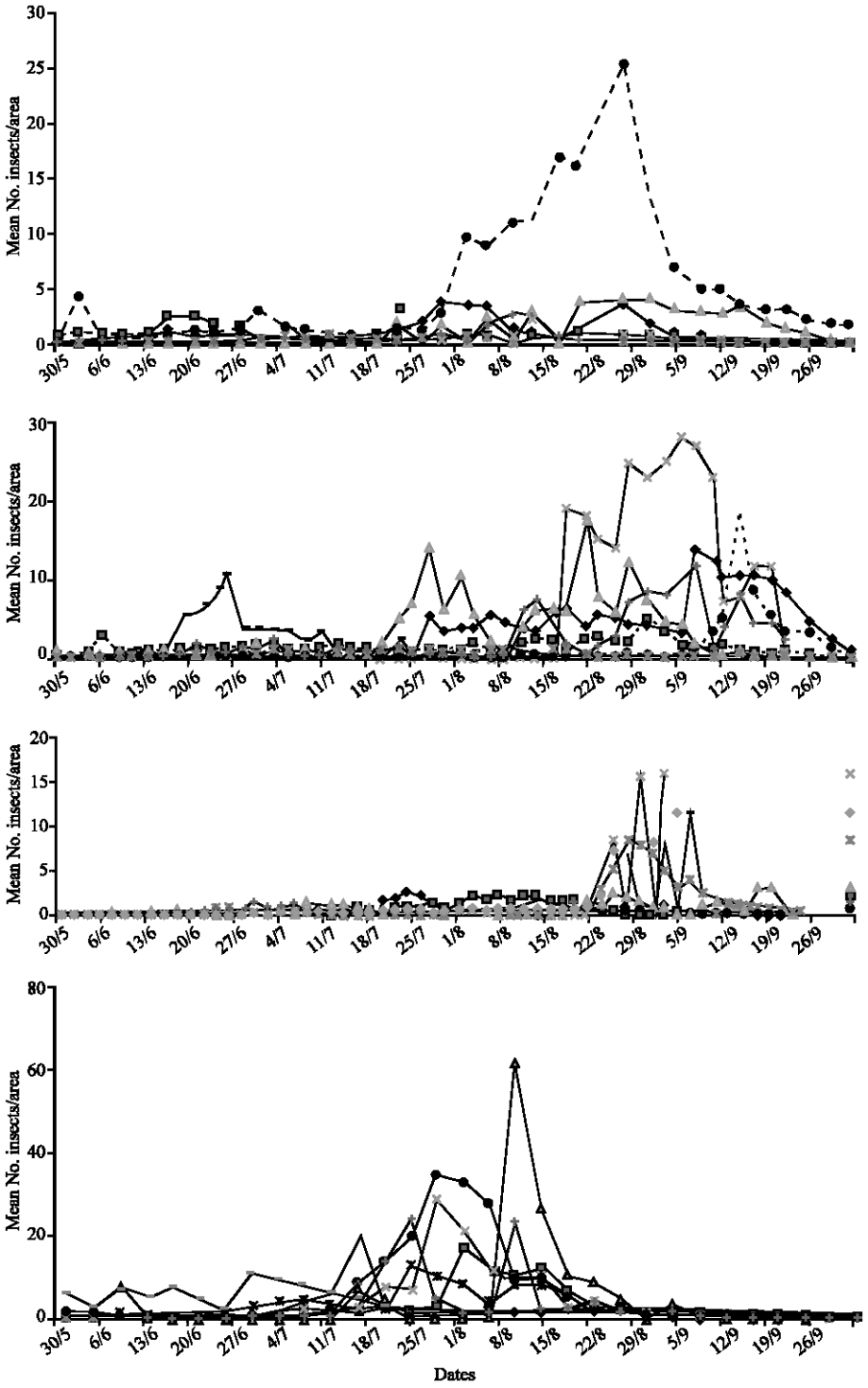

Fig. 2: Fluctuation of insect population across dates of sampling (recordings), within the ten different areas (communities = curves of data series), for years 2002-2005 (top to bottom)

indications were based on data correlations from all communities (across the four years). In this case, although statistically not significant, the tension was negative (r = -0.37). Local conditions within each area have been proved important and these results were completely different compared to data concerning years. The specific conditions within each area determine the balance between the insect population and level of damage on cotton production. There were areas where the insect showed increased populations (and possibly low populations of its enemies) resulting in low cotton production. These areas may need special treatment with insecticides or other techniques in order to decrease populations of *P. gossypiella* without harming useful insects. More warm and wet climatic conditions usually favor insect development, resulting in greater population density (Fye and Surber, 1971; Chaudhari *et al*., 1999). In our study, year 2005 was very warm and resulted in greater populations, but in 2002, a warm and wet year, insect population resulted in lower cotton production. It seems that level of damages may be depended on high temperatures and wet conditions (high relative humidity) and of course, the specific conditions within a cultivation area that may preserve high insect populations. High rainfall during the second and third generation development of the insect did not contributed in greater damages.

Concluding, our data within communities indicate that, when the environmental conditions of specific years favored cotton production, then the population of *P. gossypiella* was high due to the availability of food. In parallel, the presence of increased numbers of useful insects that predate cotton enemies may result in lower damages on cotton production. The specific conditions within each area determine the balance between the insect population and level of damage on cotton production.

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