The population dynamics of *Aphis gossypii* Glover (Homoptera: Aphididae) on cotton, in Greece

E.T. Kapatos, A. Sahinoglou, E.T. Stratopoulou
National Agricultural Research Foundation/Plant Protection Institute
P.O. Box 303, 380 01 Volos, Greece.

ABSTRACT

The population dynamics of Aphis gossypii Glover (Homoptera: Aphididae) on cotton was studied in Greece (region of Magnesia) during the 1992-1997 seasons. The experimental cotton fields (1-2 per year) were kept free from insecticidal treatments during the course of the study. In all cases, the aphid population increased soon after crop establishment, reaching high levels in late May but dropping to low levels by mid June. The population then maintained relatively low levels until mid July but then it gradually increased to reach high levels by mid August. It appears that the development of the aphid population during the rest of the season (middle August-October) was determined by the application of wide spectrum insecticides against the pink bollworm in surrounding fields from late July to early September. In 1994 and 1995 when three or four treatments were applied, aphid populations was maintained at high levels until the end of the season. During the years when such treatments were not applied, aphid populations declined by the end of August and remained at low levels for the rest of the season. It is assumed that two factors played the major roles in the population dynamics of A. gossypii in the experimental fields: 1) The action of predators (mainly species of Coccinelidae and Anthocoridae) 2) The reinfestation of the experimental fields by winged aphids coming from other heavily infested cotton fields or other hosts.

Introduction

Aphis gossypii Glover (Homoptera: Aphididae) is occasionally a serious pest of cotton in Greece. The problem seems to be related to the application of non rational chemical treatments against other pests of cotton, possibly having detrimental effects on the natural enemies of *A. gossypii*. Winged females of *A. gossypii* infest the newly emerged cotton plants in mid May. Several overlapping generations of wingless individuals are produced on cotton during the season. Winged aphids are produced towards the end of the season when the conditions of the cotton plants become unfavourable or at any time during the season if the density of aphids becomes very high.

An intensive study of the population dynamics of *A. gossypii* was carried out during the years 1992-1997. The objectives of the study were: 1) The estimation of mortality and recognition of the main mortality factors 2) The evaluation of the role of natural enemies on population dynamics of *A. gossypii*. This information was not previously available in Greece.

Materials and Methods

The study was carried out over six seasons (1992-1997) in 0.2 ha cotton fields (1-2 per year) that were kept free of insecticidal treatments during the course of the study. The daily mortality rate of *A. gossypii* was calculated on a weekly basis, using the discrete version of the most basic model of population growth and the balancing equation (Carey, 1993):

$$P_t = P_o (1+a-b)^t + E - I \qquad (1)$$

where P_t and P_o are the population estimates of two consecutive sampling dates, a is the daily birth rate, b is the daily mortality rate, t is the sampling interval in days, E is the in-migrants (the part of the population produced during a week by winged migrant aphids) and I is the out-migrants. This equation is unrealistic as a description of the development of insect populations over an extended period because it assumes constant birth and death rates and a constant proportion of reproducing individuals. However, it can provide approximations for short sampling intervals (e.g. weekly intervals) for which reasonably constant values can be assumed for these parameters.

During the study, as it is the usual for *A. gossypii* when there are no chemical treatments, the number of winged aphids produced in the experimental fields was almost negligible (except in September of 1994 and 1995) and therefore I can be eliminated from the equation. P, a and E were estimated at weekly intervals and b was calculated from the equation. Each calculated value of b represents the average daily mortality rate for a week.

The population of *A. gossypii* was estimated by regular sampling. The adopted sampling programme was based on a specific study which determined the main parameters for optimum sampling of *A. gossypii* on cotton (Kapatos *et al.*, 1996). In each growing season, samples were taken at weekly intervals from a number of randomly chosen plants, which was different each

year (40-112) according to the available resources and the expected variation. At the beginning of the season when the plants were small (less than 20 leaves), the whole plant was used for sampling but later, 10 leaves were taken from each plant, five from the upper and five from the lower part of the plant. The total number of leaves was also counted on the sampled plants. The samples were examined *in situ* and the population density of *A. gossypii* was expressed both as number of aphids per leaf and per plant. The infested leaves were taken back to the laboratory and two other parameters were determined: a) The proportion of adult females in the population b) The percent parasitism.

In order to estimate the daily birth rate, the following technique was used. On each sampling date, a number of randomly chosen females were enclosed on the leaves using clip cages that adequately sufficient ventilated. The following day the new offsprings were counted. The average number of births per female and the average proportion of the females in the population of two consecutive sampling dates were used to calculate the daily birth rate for the weekly sampling interval.

In order to estimate the number of aphids produced in the experimental fields by winged migrant aphids, a number of randomly chosen not infested branches were marked. A week later the aphids found on the leaves of those branches were counted. Under the assumption that winged aphids are not produced within the experimental field and taking into account that the average generation length of *A. gossypii* is approximately seven days, this number can be taken to represent the part of the estimated population that was produced by winged migrant aphids, after converting to the number of aphids per plant.

Further experiments were carried out during 1996 and 1997 in order to recognize the main mortality factors acting upon the population of *A. gossypii*. The mortality rate of the nymphs of *A. gossypii* from causes other than parasites and predators was estimated by enclosing a number of newly born nymphs (usually 100-200) with fine mesh nylon bags on leaves on various positions on the plants, after ensuring that no predators were present. After five or six days (i.e. before the expected day of maturation and reproduction) the surviving nymphs were counted. The results were expressed both as daily and weekly mortality rate. This mortality describes mainly the action of climatic factors.

the population of *A. gossypii* is followed by the mass appearance of predators (mainly coccinelids) that drastically reduce the aphid population. It is also probable that the very high population of *A. gossypii* during the period from mid August to September 1994 and 1995 was due to the reduced action of predators, caused by the insecticidal treatments applied during this periods against the pink bollworm.

The population of predators was also estimated by sampling at weekly intervals. Each week, several cotton plant branches (usually 60-80) were enclosed in plastic bags and taken back to the laboratory. The trapped insects were removed from the bags with glass vials and the predatory species were classified. The results were expressed as number of predators per 100 leaves.

Results and Discussion

The population and mortality rate of *A. gossypii* estimated at weekly intervals during the 1993 season indicated a delayed density dependent relationship between population and mortality, i.e. the changes in the mortality rate follow those of the population with a time delay (Figure 1). Broadly similar results were obtained in 1992, 1996 and 1997.

Up to the middle of August the pattern of changes of the population and mortality rate of *A. gossypii* estimated at weekly intervals during the growing season of 1995 were similar with those observed in 1993. However, unlike 1993, the population continued to increase until the middle of September and reached very high levels so that winged aphids were produced. On the other hand, mortality rate during the same period remained at relatively low levels and failed to control the aphid population (Figure 2). Similar results were obtained in 1994. In 1994 and 1995, three or four chemical treatments with broad spectrum insecticides were applied in the cotton fields surrounding the experimental fields against the pink bollworm during the period from late July-to early September. This did not occur in 1992, 1993, 1996 or 1997.

It appears from the total mortality rate, calculated as described previously and the mortality rate caused only by abiotic factors estimated with an independed method, that mortality from abiotic factors represented a rather small proportion of total mortality for the growing season of 1996 (Figure 3). On the other hand, percent parasitism was negligible (maximum weekly estimate 2,4% on 17 June 1996). It could be concluded, therefore, that predation is the most important mortality factor determining to a great extent total mortality. This conclusion is supported by the relationship between total mortality and the population density of predators (Figure 4). The population of predators consisted mainly of species of Coccinelidae and Anthocoridae. Similar results were obtained in 1997. The action of predators is particularly evident in late May when the increase of

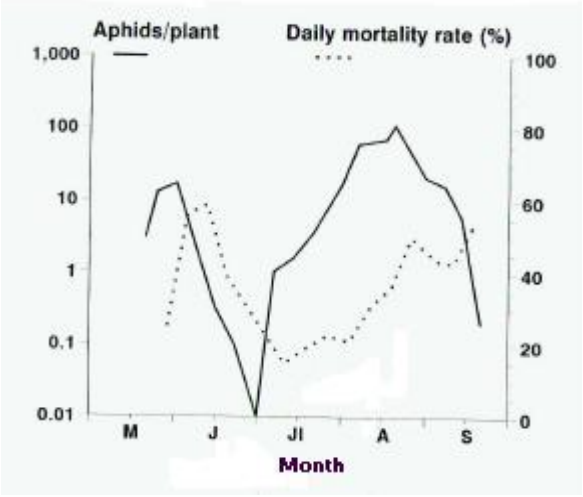
The reinfestation of the experimental fields by winged migrant aphids, estimated at weekly intervals during the growing season of 1993, indicate that the reinfestation of the experimental fields by winged migrant aphids was not negligible, compared to the total population density, particularly during August (Figure 5). It is possible that the population increase in August is partly due

to reinfestation by winged aphids that are produced in heavily infested cotton fields or other hosts where the conditions for the development of aphids become unfavourable. Similar results were obtained in the other years. In one of the experimental fields of 1996 in particular, a continuous reinfestation by winged migrant aphids, particularly during August, constituted the greater part of the aphid population estimated each week (Figure 6). These results are in agreement with other data (Lycouresis et al., 1997) that indicated high catches of winged *A. gossypii* adults in suction traps during August.

Conclusions

The population dynamics of *A. gossypii* in the experimental fields is explained to a great extent by changes in mortality. The most important mortality factor was probably predation, especially by species of Coccinelidae and Anthocoridae that were able to keep the aphid population down during most of the season when intensive insecticidal control was not applied. The experimental fields were almost continuously reinfested by winged migrant aphids. It is possible that the population increase during the period middle July - August was partly caused by winged migrant aphids which are produced in heavily infested cotton fields in which the action of predators was minimized by the insecticidal treatments against pink bollworm.

Figure 1. The population and mortality rate of *A. gossypii* estimated at weekly intervals during the growing season of 1993.



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Lycouresis, D.P., A.A. Parentis, D.X. Perdikis and X.A. Chalkia. (1997): Aphis on cotton and their natural enemies. 7th Hellenic Entomological Congress, Kavala, October 1997.

Figure 2. The population and mortality rate of *A. gossypii* estimated at weekly intervals during the growing season of 1995.

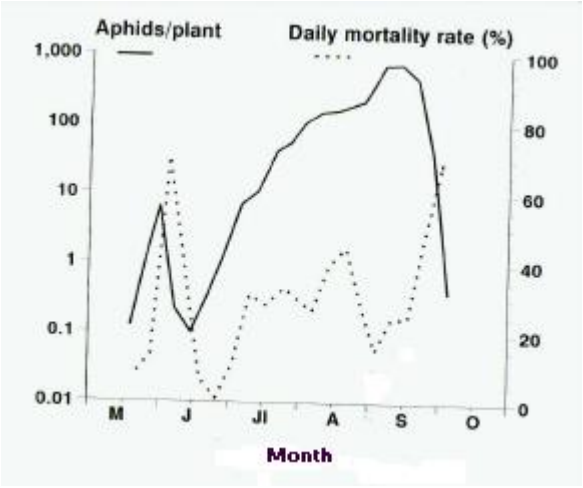

Figure 3. Total mortality rate and mortality rate caused by abiotic factors estimated at weekly intervals in 1996.

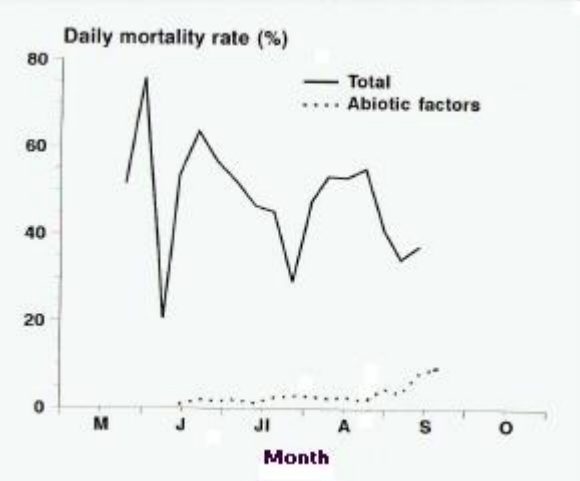

Figure 4. The relationship between mortality rate of *A. gossypii* and population density of predators in the growing season of 1996.

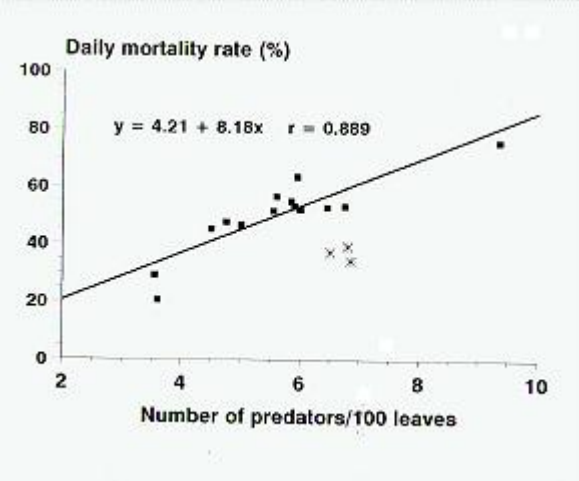

Figure 5. The total population density of aphids and that produced by winged migrant**s aphids, estimated at weekly interval in 1993.**

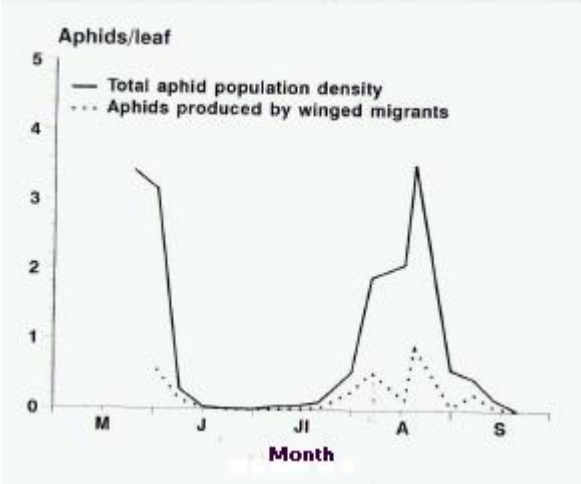

Figure 6. The total population density of aphids and that produced by winged migrant**s aphids, estimated at weekly interval in 1996.**