Ecological studies on the cowpea aphid, *Aphis craccivora* Koch infesting broad bean crop with special references to its Hymenopters parasitoids in Assiut Governorate

By

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5- Summary

Faba bean (*V. faba* L.) is a species of bean family Fabaceae (Leguminosae), it is an economically important crop in Egypt.

The present study was undertaken at Refa village (27.0976° N, 31.2070° E), Assiut District (10 Kilometers south of Assiut City). It has long been planted to patches of alfalfa, faba bean, Egyptian clover, wheat, maize and vegetables. This study was oriented in the farmer fields during two successive growing seasons of 2017-2018 and 2018-2019.

Thus, the present study aimed to investigate:

1- Studying the population of aphids and their natural enemies with special references to hymenopterous parasitoids.
2- Studying factors affecting the population of the main pests infesting broad bean plants.
3- Examined certain agricultural tools as alternative methods of insecticides to control the key pests of bean.
4- Studying susceptibility of some broad bean varieties to natural infestation by aphids under field condition.
5- Studying some biological aspects of the cowpea aphid infesting broad bean cultivars.

The results could be summarized as follows:

5.1- Pests

The achieved results during the two successive seasons of the present study revealed that the cowpea aphid, *A. craccivora* Koch and the bean leafminer, *L. trifolii* (Burgess) are the most dominant insect pests infesting broad bean plants in Assiut. Immature and adults of these pests were commonly intermixed together at the same location on the plants in Assiut.

5.2- Some natural enemies (predators and parasitoids) recorded associated with broad bean plants in Assiut

Five species of natural enemies were identified as entomophagous. They are belonging to 4 orders (Coleoptera, Diptera, Neuroptera, and Heteroptera as well as some of the unidentified species of true spiders) and 5 families (Coccinellidae, Staphylinidae, Syrphidae, Chrysopidae, and Anthocoridae). The green lacewing, *Chrysoperla carnea* (Steph.), the hover fly, *Syrphus corolla* F. and the lady beetles, *Coccinella undecimpunctata* L., and some unidentified species of true spiders were the most abundant predators which recorded and identified. Species such as *Paederus alferii* Koch, and *Orius* sp. were collected occasionally in low numbers.

5.2.1- Parasitoids

Four species of primary parasitoids; *Aphidius colemani* Viereck**,** *Aphidus matricaria***,** *Diaretella rapae* (M'Intosh) and *Paraon necans* (Mackauer) were recorded and identified belonging to family Aphidiidae; in addition to two hyperparasitoid species belonging to two families, Cynipidae; *Alloxysta* sp.and Pteromalidae, *Oachyneuron* sp.

5.3- Dominance degrees of the predators and parasitoids inhabiting broad bean plants:

5.3.1- Predators

Generally, regardless of the growing seasons, data showed that *C. undecimpunctata* seems to be the most important economic predator on broad bean plants.

5.3.2- Parasitoids

The dominance degrees (%) of hymenopterous parasitoid species emerged from mummies of *A. craccivora* collected from broad bean plants during 2017-2018 and 2018-2019 growing seasons in Assiut. *Aphidius matricaira Diaretella rapae* had the most dominant degrees % (31.68 and 23.76% during 2017-2018) and (25.35 and 16.90% during 2018-2019) followed by *P. necans*, meanwhile, *A. colemani* had low values of dominance. For the secondary parasitoids, *Alloxysta* and *Oachyneuron* had the lowest dominance degrees (9.90, 7.93%, and 22.54, 8.45%) during 2017-2018 and 2018-2019, respectively.

5.4- Impact of hymenopterous parasitoids in regulating cowpea aphid in Assiut

Field and laboratory studies were conducted to determine the effect of hymenopterous parasitoids in relation to cowpea population during 2017-2018 and 2018-2019 growing seasons.

5.4.1- Mummification rate

5.4.1.1- 2017-2018 season

Data revealed that the mummified aphids appeared on faba bean plants during the period extended from the third week of November up to the end of March. The percentage of parasitism was relatively low generally <3% until the middle of January. Then the level of parasitism dramatically increased as the aphid population increased. Maximum parasitism (6.38%) was achieved during the end of February and the beginning of March.

5.4.1.2- 2018-2019 season

Data showed that the mummified aphids appeared on plants at the third week of November up to the end of March. The percentage of parasitism (%) was relatively low (0.15%) at the third week of November and increased with small number of forming a peak (7.44%) at the middle of March. Generally, the mummification rate in the first season more than those in the second season.

5.4.2- Parasitization rate

The present study was oriented under laboratory condition to estimate the rate of parasitism by hemeopterous parasitoids attacking cowpea aphid, *A. craccivora*. Live aphids (apterous forms) were collected weekly from faba bean field. In each date specimens were transferred to the laboratory and aphids were reared until formation of mummies.

5.4.2.1- 2017-2018

The present study indicated that the hymenopterous parasitoids are considered to be potentially important regulates of cowpea aphid in faba bean ecosystem.

5.5- Population studies

5.5.1- Aphids, *A. craccivora*

5.5.1.1- 2017-2018 Season

Data show that the *A. craccivors* began to appear in the field in relatively low numbers (0.10 individuals / plant) third week of November when the plants were in the seedling stage. This period coincided with a maximum temperature of 27.86ºC, a minimum temperature of 13.71ºC, a maximum RH of 72.57% and a minimum RH of 13.25%. Thereafter, the population density of the pest fluctuated in scarcely numbers to attain the peak (46.34 individuals / plant) during the second week of February (Feb. 10) when the plants were during the vegetative growth stage (end of flowering and beginning of ripening stages. The recorded weather factors in this period were 30.07ºC and 8.64ºC for max. and min., temperature and 70.71% and 9.43% for max. and min. RH, respectively. Then the number of aphids decreased gradually till the end of March, when the faba bean plants were in the ripening stages. The recorded weather factors were 30.57ºC and 11.43ºC for max. and min. temperature and 60.57% and 12.86% for max. and min. RH, respectively.

5.5.1.2- 2018-2019 season

The population trend was nearly similar as in 2017-2018 season. *A. craccivora* were first appeared in relatively high numbers during the third week of November after one month of sowing when the plants were in the seedling stage. Then, the number increased gradually forming the peak of 82.56 individuals / plant during the first week of February (the end of flowering and the beginning of ripening stages). The recorded max., min. temperatures were 23.50ºC; 4.71ºC and the max., min. RH were 80.57%, 25.43%, respectively. The population then decreased to its lowest level (2.23 individuals / plant). The recorded max., min. temperature were 27.71ºC, 7.14ºC and the max., min. RH were 77.14%, 15.14%, respectively.

5.5.1.3- Population age structure of cowpea aphid infesting faba bean

From the foregoing results the population development of *A. craccivor*a at Assiut area, in southern Egypt can be described by dividing this populations into five phases and calculated from the beginning of sowing (middel of October) as starting date as follows.

Its clear that the cowbea aphid, *A. craccivora* needed about 122.50 days (17 – 18 weeks) from the first appear on the plant to their disappearance (P1-P5). The highest population level could be expected after about 110.50 days (about 15 weeks).

5.5.1.4- Multi-correlation analysis of some factors affecting the infestation of faba bean plants by *A. craccivora*

The relationship between *A. craccivora* infestation and some variables was investigated. The studied variables were plant age and predators as biotic factors as well as some abiotic factors air temperatures and relative humidity.

5.5.1.4.1- Biotic factors

5.5.1.4.1.1- Plant age

The results shows that the rating sort of the plant age cams in number one and had significant positive correlation with plant age (r= +0.77).

5.5.1.4.1.2- Predators

Predators came in the rating sort in number three and seven and had positive correlation with predators (r= + 0.53).

5.5.1.4.1.3- Parasitoids

Predators came in the rating sort in number four and four and had significant positive correlation with parasitoids (r= + 0.62).

5.5.1.4.2- Abiotic factors

5.5.1.4.2.1- Air temperature and humidity

The rating sort of the maximum and minimum temperature came in number two and six of (2017-2018) and five and three of (2018-2019) and had significant positive correlation (r= + 0.59) and (r= + 0.66) respectively.

The maximum and minimum relative humidity came in number seven and five of (2017-2018) and six and two of (2018-2019) and had highly significant positive correlation (r= +0.71) and (r= + 0.68) respectively.

5.5.2- The leafminer, *L. trifolii* (Burgess)

Two characteristic parameters (i.e larval content and number of tunnels / plant) were used to determine the population of the leafminer infesting broad bean plants in the fields during 2017-2018 and 2018-2019 seasons.

5.5.2.1- 2017 - 2018 Season

Data show that the *L. trifolii* began to appear in the field of faba bean in relatively high numbers (0.15 / plant) after one month of planting during the third week of November when the plants were in the seedling stage. This period coincided with a maximum temperature of 21.86ºC, a minimum temperature of 13.71ºC, a maximum RH of 72.57% and a minimum RH of 13.25%. Thereafter, the population density of the pest fluctuated in scarcely numbers to attain the peak (39.08 / plant) during the third week of February when the plants were in the ripening stage and beginning of mature stage. The recorded weather factors in this period were 23.43ºC and 10.29ºC for max. and min., temperatures and 73.57 and 9.57% for max. and min. RH. Then the number of the pest decreased during the next two weeks. The recorded weather factors were 30.57ºC and 11.43ºC for max. and min. temperature and 60.57 and 12.86% for max. and min. RH,. From the present results it could be observed that, the faba bean plants mostly suffered from the attack with the leafminer at the period of flowering and ripening stages.

5.5.2.2- 2018 - 2019 season

The pest was appeared during the third week of November when the plants were in the seedling stage. Then, the number increased gradually forming the first peak of 28.80 / plant during the second half of February (the beginning of ripening stage). The recorded max. and min. temperatures were 23.50ºC; 4.71ºC and the max. and min. RH were 80.57% and 25.43%, respectively. A lowest level was recorded during the end week of March. The recorded max., min. temperature were 27.71ºC, 7.14ºC and the max., min. RH were 77.14% and 15.14, respectively.

From the present results it could be observed that, the faba bean plants mostly suffered from the attack with the leafminer (larvae and tunnel) at the period of flowering and ripening stages.

5.5.2.3- Population age structure of the leafminer on faba bean plants

The population of *L. trifolii* began to appear on faba bean plants after three weeks of planting during 2017-2018 and 2018-2019 seasons and developed up to last middle of February, and then the population decreased till the end of season. The maximum levels were attained for both seasons (2017-2018 and 2018-2019) during meddle of February.

From the foregoing results the population development of leafminer on faba bean plants in Assiut area, in southern Egypt can be described by dividing this populations into five phases and calculated from the beginning of transplanting (1st of November) as starting date.

Its clear that the pest needed about 128.50 days (18 – 19 weeks) from the first appear on the plant to their disappearance (P1-P5). The highest population level could be expected after about 110.50 days (about 17 weeks).

5.5.2.4- Multi-correlation analysis of some factors affecting the infestation of faba bean plants by the leafminer *L. trifolii*

In this time the he studied variables were plant age and predators as biotic factors as well as some abiotic factors air temperatures and relative humidity.

5.5.2.4.1- Biotic factors

5.5.2.4.1.1- Plant age

The rating sort of the plant age cams in number one and had significant positive correlation with plant age (r= + 0.69).

5.5.2.4.1.2- Predators

The rating sort in number six and two and had significant positive correlation with predators (r= + 0.58).

5.5.2.4.1.3- Air temperature and humidity

The rating sort of the maximum and minimum temperature came in number four and three of (2017-2018) and four and three of (2018-2019) and had significant positive correlation (r= + 0.73) and (r= + 0.56) respectively.

The maximum and minimum relative humidity came in number five and two of (2017-2018) and six and five of (2018-2019) and had highly significant positive correlation (r= + 0.68) and (r= + .057) respectively.

5.5.2.5- Agricultural practices

5.5.2.5.1- Effect of sowing dates and faba bean cultivars

From obtained results, it could be concluded that the early sowing of faba bean gives the plants the chance to escape from the heavy infestation of aphids, while the gradual late successive sowing dates increased the aphid populations to reach its maximum level on the delayed time. Consequently, the plants of the late sowing date suffering greatly from the aphid infestation affecting the plants of the early sowing dates (contrary to the aphid infestation).

Altering the sowing date of crops has been a recognized method of cultural control for many pests.

5.5.2.5.2- Effect of faba bean cultivars:

From the obtained data, it is obvious that the faba bean cultivar Misr 3 was harboured the lowest number of aphids with significant differences between this cultivar and the others. Sakha 1 came in the next grades. The cultivar Giza 843 was harboured the highest population of aphids during the two seasons of

study. It is clear from the results that all of the studied cultivars did not exhibit any resistance effect against aphid infestation.

5.5.2.5.3- Effect of nitrogen fertilization:

Data indicate that the population of aphids and leafminer increased significantly with the increase of nitrogen fertilizer. Significant differences were existed between the number of aphids and leafminer on plants received different rates of nitrogen fertilization.

5.6- Some biological aspects of the cowpea aphid infesting faba bean

5.6.1- Developmental time

5.6.1.1- Nymphal stage

Statistical analysis showed that the longest for nymphal development on three cultivars was recorded on Misr 3 while the shortest period was noticed on cultivar of Giza 843. On the other hand, the time needed for the development decreased development time by about 1.24 and 1.78 times. The cultivar Giza 843 had the lowest nymphal duration (4.65 days) followed by Sakha 1. Misr 3 had the highest.

Based on the obtained data, it may be concluded that cultivars of Giza 843 and Sakha 1 were the most suitable for the development of the pest.

Survival of nymphal instars and whole nymphal stage reared on three cultivars. The highest percentage of survival were observed at cultivar of Misr3 and Sakha1, respectively, whereas, the lowest (24%) was noticed on cultivar of Giza843.

5.6.1.2-Adult stage

Adult longevity was divided into pre-reproductive, reproductive and post-reproductive periods. The results indicate that reproductive periods varied from cultivar to others.

Adult apterous cowpea aphid numbers on Giza 843 was significantly higher than on Misr 3 and Sakha 1. In the detached-leaf biological assay, the cultivar Giza 843 had a longer pre-reproductive, reproductive, post-reproductive, and total longevity period as compared with Misr 3 and Sakha 1, whereas the number of progeny was lower as compared with Misr 3 and Sakha 1.

Finally the colony development study ranked the resistance level among cultivars as Giza 843>Sakha 1 and Misr3.