TIME OF FLIGHT ACTIVITY OF WINGED COWPEA APHID, *A. CRACCIVORA* KOCH AND THEIR EFFICIENCY AS VECTORS OF FABA BEAN NECROTIC YELLOWS VIRUS

EL-DEFRAWI, G. M.[1] AND M. K. EL-ANSARY[2]

1. *Plant Protection Res. Institute, ARC, Dokki, Egypt.*
2. *Plant Protection Dept., Fac. Agric. Al-Azhar University, Nasr City, Egypt.*

Abstract

Studies on daily flight activity of cowpea aphid, Aphis craccivora attacking cowpea and faba bean plants and their infectivity during the two successive seasons of 2007/08 and 2008/09 were carried out at Sids, ARC, Beni-Suef Governorate, Middle Egypt. Horizontal yellow water pan traps, filling fresh water were used to monitor aphid flights over fields of cowpeas (late-summer season) and faba beans (early winter season). Traps were operated for 17 weeks, from mid-August to mid-December 2007 and 2008. The transmission efficiencies of FBNYV were determined for the cowpea aphid species caught most frequently. During late summer season, and early winter season, the number of cowpea aphids trapped by the pan traps over cowpea and faba bean fields and as well over prevailing weeds were significantly affected by the daily time of alighting, and consisted of irregular fluctuations in sizes of collections

With regard to the hourly and intensity of cowpea aphid migration flights, traps also operated for four days: 1st. and 15th. September, 1st. and 15th. November within cowpea and faba bean fields, respectively, after sunrise at a.m. 7–12 and before sunset at 4–7 p.m. Catch winged aphids were counted every hour and transplanted on a number of healthy faba bean (cv. Giza 2), to test their infectivity. Data obtained indicated that the flight activity of winged forms of cowpea aphid over cowpea and faba bean was significantly fluctuated up and down after sunrise, mid-day and before sunset. Peak numbers of winged cowpea aphid flight over the cowpea plantation area before harvesting time being in 8-9 a.m., and 6–7 p.m., while on earlier planted faba bean at seedling stage attended after sunrise mainly in 7–8 a.m., followed by minimizing at time and again noticed re-active before sunset 1-2 hours.

Keywords: *Aphis craccivora Koch. (CA), Faba Bean Necrotic Yellows Virus (FBNYV), Tissue Blot Immunoassay (TBIA), Horizontal yellow water pan traps.*

INTRODUCTION

Aphids are important pests of faba bean crops in Egypt. They cause significant yield reductions through direct feeding and the transmission of several virus diseases (Bos and Makkouk, 1994, Franz *et al.*, 1997, Abeer, 1998, El-Defrawi *et al.*, 1998). The faba bean necrotic yellows virus (FBNYV), which is exclusively transmitted by aphids (Makkouk *et al.*, 1998 and El-Defrawi *et al.*, 2000), has been of particular concern in

different sites of Egypt because of increasing incidence in recent years (El-Defrawi *et al.*, 1994b, Rizkalla *et al.*, 1994, Abeer, 1998). Four aphid species in Egypt are capable of transmitting FBNYV, including the cowpea aphid (*Aphis craccivora* (Koch)) which has historically been considered the most important aphid pest on faba beans in Egypt (El-Defrawi, 1987) and elsewhere (Halbert *et al.*, 1981). It is the most common species found on faba beans and is considered the most efficient vector of FBNYV disease (El-Defrawi *et al.*, 1994b, Abeer, 1998 and Franz *et al.*, 1998). This aphid is an anholocyclic thelytokous species (El-Defrawi, 1987). Alatae and apterous viviparous females are more abundant during all year round when there is plenty of foliage in different districts of Egypt, where it is infested mainly faba bean and cowpea plants during winter and summer seasons, consecutively (Abdel-Alim, 1994, El-Mezaien, 1996 and El-Defrawi, 1997). It migrates to faba beans in the autumn where both winged and wingless aphids can spread virus into and throughout the legume and non-legume crops (Katual *et al.*, 1993, El-Defrawi, 1997 & 1999 and Franz *et al.*, 1997). The main sources of infection for FBNYV in Egypt appear to be volunteer cowpeas and wild hosts such as *Amaranthus angustifolius*, *Medicago hispida*, *Vicia sativa*, *Medicago sativia*, *Melilotus indica* (Makkouk and Vetten, 1997 El-Defrawi, 1999). Two other highly polyphagous species, the pea aphid (*Acyrthosiphon pisum* Harris.) and the black bean aphid (*Aphis fabae* Scopoli), are found on faba bean crops in Egypt in moderate numbers (El-Defrawi *et al.*, 1994a) and are also vectors of FBNYV.

In most cultivated legume areas in Egypt, peak aphid flights occur in early-spring and mid-autumn with little flight activity in mid-winter and mid-summer (El-Defrawi *et al.*, 1994b). In middle Egypt region (Beni-Suef, Fayoum, Minia and Assuit Governorates), late-autumn flights coincide with the main period of faba beans and major legume crops are planting and emergence and early-spring flights overlap with the end of the main period faba bean harvesting and cowpea planting (El-Defrawi *et al.*, 2002). However, data from 15 years of trapping carried out in Sids, ARC, Beni-Suef Governorate, indicate that late-autumn flight peaks of the four main FBNYV vectors (predominantly cowpea aphid) vary considerably between seasons and between years in their timing, magnitude and duration (El-Defrawi, 2006). Numerous reports indicate the importance of winged aphids in the spread of virus disease infect faba beans (Abeer, 1998, Bos and Makkouk, 1994 and Franz *et al.*, 1998). Aphid flight activity is measured in several countries, including the Bureau (Kennedy, *et al.*, 1962), U.S. of America (Landis, 1972), Columbia (Thomas, 1983), Scotland (Woodford, *et al.*, 1983), Egypt (El-Defrawi *et al.*, 1994b) and Malaysia (Idris and Mohamad 2002), to help indicate the need for aphid control.

El-Defrawi (2002) pointed out that up-to-date information on aphid flights could be valuable to growers for use yearly information in aphid/virus pest management in Egypt with potential benefits including increased faba bean yields and reduced control costs. El-Defrawi (2006) recommended the development of an aphid monitoring system and virus-vectors forecasting program to provide governor and growers, especially faba bean growers in middle Egypt, with timely information on aphid flights and potential virus risk. The authors felt a critical lack of knowledge concerning the times and period of maximum activity, occurrence, abundance of legume aphids (*A. craccivora*) and threating viral disease vector status during the day time on the host plants (El-Dafrawi *et al.,* 1994b). Moreover, recently In Egypt, such kind of important research has been neglected. Apart the work of El-Defrawi (2006), practically no other contribution has been done specifically on this problem.

The present work is an attempt to fill part of that gap, concerning the times of maximum activity, occurrence and abundance of cowpea aphids, *A. craccivora* and to clarify the relationship between aphid flight activity, and mostly FBNY virus disease incidence in hot spot area in middle Egypt region.

MATERIALS AND TECHNIQUES

Studies were conducted on flying cowpea aphid (*Aphis craccivora* Koch.) attacking plants of cowpea (*Vigna unguiculata*) and faba bean (*Vicia faba*) during summer and winter season consecutively in the two successive growing seasons of 2007/08 and 2008/09 at the Experimental Farm of Sids Research Station, Beni-Suef Governorate, middle Egypt.

To study the daily flight activity of *A. craccivora*, an area of about 2100 m^2 was divided into two equal divisions. The first division was planted conventionally by Fetriat cowpea variety on the first week of May (summer season) and the second one cultivated by Giza 429 variety in the first week of October (winter season) in every year. Cowpea aphid (*A. craccivora*) alighting on the open crops were monitored a 2-year period (2007/08 and 2008/09) in fields from mid-August to mid-December of 2007 and 2008. Horizontal yellow pan water traps (El-Defrawi *et al.*, 1994b), were used, is yellow color plastic dishes, 45 cm in diameter and 15 cm depth, distributed at the outer edges of the fields of cowpea and faba bean (8 traps/ feddan), arranged at three traps in each cardinal side. The traps were fitted on a small iron table, 120 cm high from the level of the soil. The yellow pans were washed and filled with fresh water each Sunday morning, and aphids were collected each day, counted, and sorted into species. Also, the captured alive winged aphids on the pan

traps and as well as those that had settled on the plants (wild hosts, late-cowpea and early faba beans) in the 7th. day intervals were collected and transferred to the laboratory on the same day, once every week, to test their infectivity.

Common practice in day-degree methods is to start daily seasonal data collection on 15 August. thus, in this study, following the method described by Kenneth (1983), daily seasonal data collection was performed by use of thermo hygrographs placed in cowpea and faba bean fields to investigate effective total thermal summation of critical flight activity of cowpea aphid. Heat data for all 2 seasons of the study were available only for the Sids, ARC, Beni-Suef location. The following formula was used to calculate heat units accumulated each day: temp max (°C) – temp min (°C)/2 – 4.64 (El-Defrawi, 2006).

To determine the timing and intensity of cowpea aphid migration flights. The yellow pan water traps were also operated for four days applied in 1st. and 15th. September within late-cowpeas and 1st. and 15th. November on early planted faba bean fields, after sunrise at a.m. 7–12 and before sunset at 4–7 p.m. The captured winged aphids were counted every hour and transplanted individually on a number of healthy faba bean cv. Giza 2 variety, to test their infectivity.

Assaying potential insect vectors FBNYV to determine if they are inoculative or not, is an important part of quantifying vector propensity (a single vector) (Raccah, 1983). Thus, the collected alive cowpea aphids were starved for 2 hours before testing those allowed to feed for two days (AFP) on healthy 15-day-old single seedlings of faba bean cv. Giza 2 variety (host indicator). The aphids were then removed and the plants kept in a greenhouse under screen cages (80 x 80 x 80 cm) at 20 ± 2 °C and 50 ± 5 % RH, with a daily 16:8 light/dark day cycle photoperiodic regime. Plants showing FBNYV disease symptoms were transferred to both the Entomological and Virology Laboratories at ARC, Giza, Egypt, to confirm the presence of the pathogen using an aphid inoculation test and Tissue Blot Immunoassay (TBIA), as described by Katual *et al* (1993). The antiserum monoclonal antibodies were used for detection Faba bean Necrotic Yellows Virus (FBNYV) provided by Dr. S.G. Kumari, ICARDA, Aleppo, Syria. Goat anti-rabbit- and goat anti-mouse-alkaline phosphate conjugates and enzyme substrates were obtained from Sigma Chemical Company, expiry date: 6-8 months and storage at 4-10 °C. The percentage of viruliferous aphids was estimated.

All calculations and statistical analysis were computerized by using "Costat and micro-Costat Programs".

RESULTS AND DISCUSSION

Field-oriented assays of aphids as vectors of a given plant virus often take the form of capturing "wild" specimens and placing them individually on test seedlings for the required period of time, so that, if any were inoculate, they would have the potential to transmit the virus. This technique has adopted particularly well within persistent transmitted plant viruses where the vector retains infectivity for a long period of time (El-Defrawi *et al.*, 1994b). Our approach has been to develop values for vector propensity (a single vector had acquired a virus by landing on an infected plant, and subsequently transmit the virus) that are independent of the amount of inoculum's present in a field. This means that once measuring in a given hot-spot locality, each species will have a constant value for vector propensity. This value can be multiplied by the probability that a given specimen of a given species will alight on an infected plant (a measure of the amount of inoculum's present and time of alighting activity), that will provide an estimate of percentage of flight aphid infectivity.

Vector Species Detected:

In addition to the cowpea aphid, *Aphis craccivora* Koch. (CA), one other known vector of FBNYV, *Acyrthosiphon pisum* Harris, was rarely captured in water traps. In the two successive years of 2007 and 2008, a total of 13 and 8 alatae were inconsequential trapped at the Sids experimental site in Beni-Suef Governorate, middle Egypt, respectively. No *A. pisum* apterae were seen in the field plots in a period extended from the 2nd. week of August to mid-November (late-summer cowpeas) or/and early October to mid-December (winter faba beans) at Beni-Suef when the field plots were monitoring weekly to determine aphid colonization and their infectivity.

Timing and Intensity of Cowpea Aphid Migration Flights:

1. Daily Flight Activity

Migratory flight activity of cowpea aphid (CA) peaked in the late summer (Fig. 1), and percentage infectivity (Figs. 2). Flying aphids rarely were collected in the interval between the spring and summer flight peaks but commonly were taken in the interval between the autumn and winter flights (Fig. 1). The fall flight, detected by yellow pan water traps for two years (2007 & 2008) at the most important district of the FBNYV disease assessment fields in Beni-Suef Governorate, middle Egypt, extended over a period of about 17 weeks from mid-August to mid-December (Table 1 & 2). Timing and intensity of the flight varied from year to year. Most cowpea aphids (52.3 and 23.8 aphids) were captured in the earliest flight within cowpea plantations during the

first week of September in the first and second year, respectively, while late autumn in the third week of November 2007 and 2008, flight aphids are vanished almost in all cowpea plantations, or activity flights nearly restricted between August and September, which began in the first week of October to decline in both 2007 and 2008 (Table 1 & 2).

The 2007 and 2008, cowpea aphid flights began 2 week later and produced 38.8 and 7.5 aphids/trap/day, respectively. By correlation analysis, there was a strong relationship (correlation coefficient = 0.98 & 0.96) and significant ($P < 0.05$) between accumulated heat units (degree days) on 15 August and total number of aphids captured each season. Accumulated heat units on the first day of the second week of August in which the last summer flight aphids were captured and approximately the same each year. Based on the data, timing of the autumn flight may be predicted to occur at a degree day ranges of 149–179 (To or lower = 4.64 and Tx or upper = 38.57 °c) at $P < 0.05$ (El-Defrawi, 2006).

Water traps, used to monitor cowpea aphid flights over weeds at a Sids, ARS, Beni-Suef Governorate, middle Egypt over a 17-week period, captured some but relatively few winter flight aphids, compared with fall flight aphids (Fig. 1). The late summer flight cowpea aphids were captured in the second week of August 2007 and 2008 over prevailing weed existing including, *Beta vulgaris* L. subsp. Maritima Thell, *Chenopodium ambrosoides* L., *Ch. murale* L., *Ch. Album* L., *Cichorium pumilum, Convolvulus arvensis* L., *Capsella bursa-pastoris* L., *Euphorbia peplus* L., *Portulaca oleracea* L., *Amaranthus angustifolius* L., *Urtica urens, Ammi majus* L., *Anagallis arvensis, Datura stramonium* L., (El-Defrawi, 1999 and Megahed, 2000). Within the 14 prevailing weeds, the flight CA activity began and extended the entire 17 weeks earlier (Table, 1 & 2) and intensity (winged aphids/trap/week) was more uniform throughout the flight period than over off-season cowpea and early faba bean plantations (Fig., 1). Flight intensity activity peaked during the first-third week of October 2007 (18.5-21.3 aphids/trap) and the first to fourth week of October 2008 (20.8-16.5 aphids) in Sids, ARS, Beni-Suef (Means of the 8 traps in each week).

The fall CA flight began late in October 2007 and 2008 over fields of faba bean plantations and before all farmers fields own plants well grown (at seedling establishment), and early November (Fig. 1). No apteroid cowpea aphids were observed in any of the experimental field sites in any year until after the late summer aphid flight began. In the other hand, it could noticed that all of the cultivated cowpeas contained CA apterae in early October onward in each of the two years when plants were ripening, but other aphid species were not found in these fields. There were no significant differences in numbers of CA between traps that contained initial

source of FBNYV inoculums and those that did not. Many CA alatae and apterae were observed on all winter annual weed and as well faba bean plants examined in late fall in each of the two years that counts were made, but no aphids were observed on the same plants in early spring (March onward), and no aphids were collected from these plants using the visual inspection and sampling technique (Hafez, 1964).

2. Relationship Between Aphid Flights and Virus Infection

Assaying potential vector FBNYV to determine if they are inoculative or not is an important part of quantifying vector propensity (single vector). Without a good knowledge of the species that are

Table 1. Percentage infectivity of cowpea aphids caught in a yellow water pan traps placed in a fields of late-cowpea, prevailed weeds, and early faba bean plantations during a period from the 2nd. week of August to the 2nd. week of December 2007 in Beni-Suef Governorate.

Inspection date	Cowpea fields		Among 14 common weeds		Faba bean fields		Average no. aphids /Trap	Mean % Infectivity
	Total aphids trapped	% infectivity	Total aphids trapped	% infectivity	Total aphids trapped	% infectivity		
2nd. w. Aug.	38.8	2.52	6.8	0.56	*	*	22.8	1.54
3rd. w. Aug.	42.8	3.97	4.8	2.63	*	*	23.8	3.30
4th. w. Aug.,	50.6	3.15	4.1	2.05	*	*	27.35	2.60
1st. w. Sept.	52.3	5.83	6.0	3.17	*	*	29.15	4.50
2nd. w. Sept.	44.4	5.35	6.3	2.00	*	*	25.35	3.68
3rd. w. Sept.	26.9	6.98	9.6	0.00	*	*	18.25	3.49
4th. w. Sept.	24.3	7.73	12.8	0.94	*	*	18.55	4.34
1st. w. Oct.	20.5	4.49	18.5	1.03	*	*	19.5	2.76
2nd. w. Oct.	14.1	1.19	14.1	1.77	0.0	0.00	9.40	0.99
3rd. w. Oct.	23.4	1.07	21.3	1.18	0.4	0.00	15.03	0.75
4th. w. Oct.	20.8	0.81	13.6	0.75	13.8	0.64	16.07	0.73
1st. w. Nov.	15.5	2.17	15.4	1.80	16.1	3.78	15.67	2.58
2nd. w. Nov.	14.9	0.64	11.5	1.39	19.1	1.72	15.17	1.25
3rd. w. Nov.	*	*	9.1	1.37	22.3	2.60	15.7	1.99
4th. w. Nov.	*	*	3.3	0.05	10.4	0.85	6.85	0.45
1st. w. Dec.	*	*	4.4	0.86	9.3	2.83	6.85	1.85
2nd. w. Dec.	*	*	7.3	1.45	3.6	1.43	5.45	1.44
Mean	29.95	3.53	9.94	1.35	10.56	1.54	17.14	2.25

* : The respective plants were not available.

Table 2. Percentage infectivity of cowpea aphids caught in a yellow water pan traps placed in a fields of late-cowpea, prevailed weeds, and early faba bean plantations during a period from the 2nd. week of August to the 2nd. week of December 2008 in Beni-Suef Governorate.

Inspection date	Cowpea fields		Among 14 common weeds		Faba bean fields		Average no. aphids /Trap	Mean % Infectivity
	Total aphids trapped	% infectivity	Total aphids trapped	% infectivity	Total aphids trapped	% infectivity		
2nd. w. Aug.	7.5	1.36	4.5	0.03	*	*	6.00	0.70
3rd. w. Aug.	11.3	1.29	3.1	0.15	*	*	7.20	0.72
4th. w. Aug.,	12.1	0.84	0.0	0.68	*	*	6.05	0.76
1st. w. Sept.	23.8	0.58	4.8	0.07	*	*	14.30	0.33
2nd. w. Sept.	23.4	0.60	7.8	0.09	*	*	15.60	0.35
3rd. w. Sept.	18.0	0.39	7.6	0.36	*	*	12.80	0.38
4th. w. Sept.	9.6	0.60	11.3	0.67	*	*	10.45	0.64
1st. w. Oct.	2.5	1.77	20.8	2.87	*	*	11.65	2.32
2nd. w. Oct.	0.1	0.06	18.8	1.71	*	*	9.45	0.89
3rd. w. Oct.	0.9	0.09	14.5	2.31	1.9	0.00	5.77	0.80
4th. w. Oct.	0.6	0.33	16.5	1.33	12.0	1.13	9.70	0.93
1st. w. Nov.	0.5	0.00	13.3	2.06	23.8	4.07	12.53	2.04
2nd. w. Nov.	*	*	14.4	3.67	28.5	4.12	21.45	3.90
3rd. w. Nov.	*	*	12.8	4.77	33.1	3.95	22.95	4.36
4th. w. Nov.	*	*	11.5	2.27	38.0	6.96	24.75	4.62
1st. w. Dec.	*	*	3.9	0.00	35.0	3.21	19.45	1.61
2nd. w. Dec.	*	*	3.1	0.00	20.8	2.81	11.95	1.41
Mean	9.19	0.66	9.92	1.36	24.14	3.28	13.06	1.57

: The respective plants were not available.

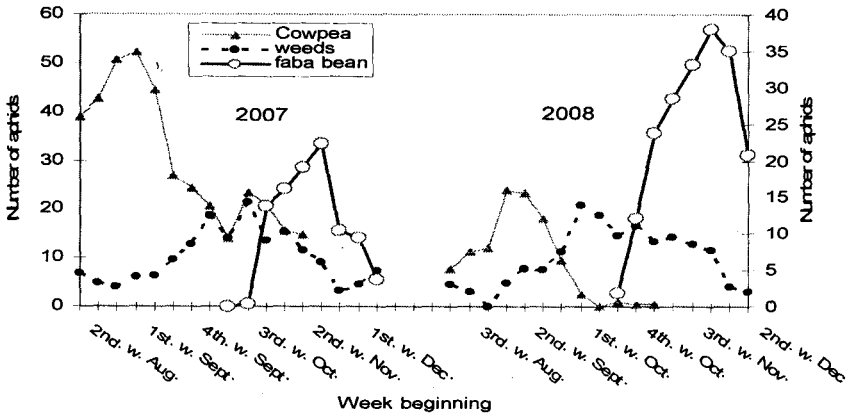

Fig. 1. Time, pattern, and intensity of fall flights of cowpea aphid *Aphis craccivora* within cowpea, weeds and faba bean fields. Mean number of CA's captured in eight yellow pan traps over a 7-day period in each week in two years 2007 and 2008.

potential vectors, given a large assemblage of aphid species, it is probably impossible to focus studies on the target vectors. The external symptoms of FBNYV-disease were observed during the experimental seasons of 2007/08 and 2008/09. The symptoms produced by the aphid inoculation tests in the greenhouse and confirmed by the Tissue Blot Immunoassay (TBIA) technique were quite similar to the natural symptoms. It was assumed, therefore, that the symptoms observed in the plant infested with individual aphid trapped (diagnostic host) were most probably due to a pathogen of FBNYV-disease mainly transmitted by the cowpea aphid, *A. craccivora*.

FBNYV distinct symptoms always began to appear in some fields adjusting a point source of inoculum's 2-3 weeks after the first viruliferous aphid alatae were trapped in yellow pans, and new symptoms were always present serialize in all faba bean fields 5 weeks after the first aphid individuals were landed within plantations. Thus, the earliest initial FBNYV infections began to appear in 2007 and 2008 when alatoid cowpea aphids were trapped earliest in the fourth week of October, 2007 and 2008, respectively (0.64 and 1.13 %), as shown in (Table, 1 & 2). It was appeared later by one week in both 2007 and 2008 when alatae arrived 1 or 2 weeks later, respectively (Fig. 2).

Data presented in Tables (1 & 2) shows that viruliferous winged aphid *A. craccivora* fluctuated widely and had two-three main periods of activity just over off-season cowpea and extended raised in faba bean plantations in the two tested seasons, respectively. Data obtained In the two investigated seasons, showed that the alatae CA occurred from the 2nd. week of August to the 2nd. week of December, and peaked numbers during the 1st. and 4th. week of September and the 1st. week of November 2007. In 2008, the viruliferous winged aphid trapped showed dominant in

two main periods, the first was noticed from 2nd. week of August to the 2nd. week of October, while the second period of activity started from the 3rd. week of October to the 2nd. week of December 2008.

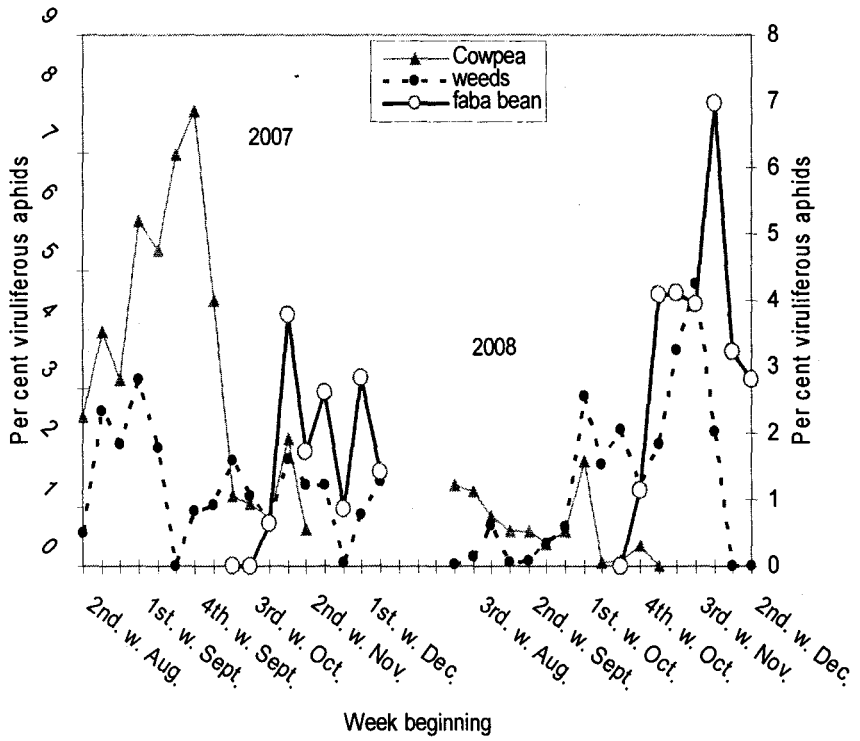

Fig.2. Time and percentage infectivity of cowpea aphids flight in a fields of late-cowpea, weeds and faba bean in Beni-Suef Govern. Mean % of total aphids captured in yellow pan traps each week from 2nd. week of August to 2nd. week of December 2007-2008.

The maximum percentage viruliferous cowpea aphids trapped were recorded in the 1st. week of October (2.32 %) and the 3rd. and 4th. week of November 2008 (4.36 & 4.62 %, respectively) in the two activity period intervals. Thus, viruliferous aphids bearing FBNYV occurs fly over late vegetative cowpea and as well in faba bean early planted at seedling and stem elongation growth stages with a few numbers of winged CA starting from the 1st. week of September onward.

Concerning the abundance and distribution of winged aphid *A. craccivora* emphasized serology inoculative with FBNYV existed among cowpeas, weeds and faba bean plantations. It was detected in the captured alight aphids based on the TBIA tested used monoclonal antibodies for faba bean necrotic yellows virus (FBNYV).

Based on our main achievements that refer the most important period for developing the cowpea aphid ability to spread the injurious virus agent namely FBNYV within the faba bean fields was detected mainly in the first and second week of November, which considered as the proper time for crop establishment. It means, the viruliferous aphids could be started early to inoculate the pathogen one month before at least possibly during the 2nd. week of October or before it.. This result indicate that dissemination of FBNYV depends almost exclusively on one aphid species, *A. craccivora,* that is dispersed seasonally in the distinct and common localities and highly predictable migratory flights in the Beni-Suef, middle Egypt. Thus, control strategies, either chemical or biological, may be targeted on this aphid species, on its dispersal flights, and on the sources of virus disseminated by this aphid.

Both the timing and intensity of the fall aphid flight appears to be strongly influenced by late summer temperatures and the Interspecific factors such as natural enemies (El-Defrawi, 2006). The earliest *A.*

craccivora flight occurred in the favored late-summer and the earliest in the coolest. In an earlier report (El-Defrawi *et al.*, 1994b), found that the autumn flight of the cowpea aphid was existed about 2-4 weeks before faba bean planting in middle Egypt, located about 120 Km. south of Cairo, and has a distinctly mild climate. The early winter flight was characterized by uniformity in starting date at any location of middle Egypt. Timing of the autumn flight of *A. craccivora* could be reliably ($P < 0.05$) predicted strongly on the basis of meteorological data, trapped aphid and it is infectivity by the method of detecting the virus disease that we used (Katul and Vetten, 1996).

The time required for symptoms to develop after the fall flight began was about the same as that required for new symptom development in field plots containing a source of infection after the winter flight arrived and approximately equal to the reported incubation period for FBNYV in faba beans (El-Defrawi, 2006). Volunteer faba beans and five winter annual weed species *Amaranthus angustifolius, Medicago hispida, Vicia sativa, Medicago sativia and Melilotus indica* (El-Defrawi, 1999) are the only known over summering hosts of FBNYV that could provide the virus introduced by the late-summer flight (El-Defrawi, 1997). Volunteer cowpeas were previously also (Franz *et al.*, 1997 and El-Defrawi *et al.,* 2002) implicated as a major source of virus disseminated by the late-summer and early autumn flights. Thus, the five weed species serve as sources of virus in the epidemiology of FBNYV. The information presented here on the introduction of FBNYV to faba bean fields by aphid

flights emphasizes the importance of controlling viruliferous aphids early on faba bean fields and indicates control strategies for FBNYV in the middle Egypt region must be need with rationalized use of insecticide. Season-long applications of insecticide are required to control FBNYV when infectious sources exist dominant in the fields.

3. Hourly and Intensity of Cowpea Aphid Migration Flights

The results given in Tables (3 & 4), indicate that the maximum number of winged cowpea aphid flight over the cowpea plantation area before harvest, occurred at 8 - 9 a.m., and again in 6 – 7 p.m. The average number of alatae CA caught in the four cardinal sites at 8, 9 and 10 a.m., was 29.75, 37.25 and 22.50 individuals on September 1, and 21.75, 19.75 and 17.50 on September 15. At 6 and 7 p.m., the intensity flight activity of cowpea aphid being 25.25 and 26.25 individuals /trap on September 1, while the maximum caught winged cowpea aphid was observed at 6 p.m. (18.50 winged aphids /trap), observed on September 15. At 4-5 p.m., the number of winged aphids' flight over cowpea plants at the different cardinal sites tended to minimize showing inactivity, reaching minimum levels on 4 p.m., with an average number of 5.50-8.25 individuals /trap. After 7 a.m., the alatae population began to increase progressively reaching a higher flight activity before sunset of 25.25-26.25 individuals (Table 3).

Data in Table (4) shows the day time activity of cowpea aphid fly on the earlier faba bean seedlings in 1st. and 15th. November 2008, that follows up and observed in high intensities after sunrise at 7–8

a.m., followed by minimizing in numbers and fluctuated it is activity widely. Before sunset 1-2 hours, the activity of alatae CA over faba bean plants could be followed the same trend as in cowpea.

Statistical analysis of the obtained results revealed a highly significantly different between the abundance of winged aphids caught in different sites of both cowpea and faba bean fields whereas "F" value was significant as shown in Tables (3 & 4). These results are in agreement with those obtained by (Milne,1971) who stated that the size of aphid populations on *Vicia faba* vary considerably from one year to another and from day to day during the growing season. This depends partly on the sequence of events in the non-crop environment and climatic conditions (Ofuya, 1988). El-Defrawi *et al.*, 1994b) reported that the daily flight activity of *Aphis craccivora* in faba bean plantations in Middle Egypt region varied considerably according to the time of sampling, Also, Hassanein *et al.* (1994) reached the same conclusion with certain leaf sap sucking insects *Empoasca decipiens* Paoli, *Myzus*

persicae Sulz. and *Thrips tabaci* Lind., invading potatoes, common bean and squash plants by using yellow sticky board and yellow pan water traps in capturing them throughout 1991 and 1992 in Gemmeza region-Egypt. Generally, the cowpea aphid alatae form population density was more pronounced abundant during sunrise and one-two hour before sunset compared to those flights in mid-day.

Table 3. Mean numbers of alatae cowpea aphid, Aphis craccivora caught in yellow water-pan trap placed on outer side cowpea fields during ten times of the day in late summer harvested season of 2008 (at one-hourly intervals) in Beni-Suef Governorate.

Sampling hour	Average no. aphids / trap 1st. September at indicated cardinal side				Mean no. aphids caught	% infectivity	Average no. aphids / trap 15th. September at indicated cardinal side				Mean no. aphids caught	% infectivity
	East	West	North	South			East	West	North	South		
7 a.m.	11	5	19	10	11.25	2.4	5	3	8	0	4.00	0.0
8 a.m.	48	19	45	7	29.75	4.4	14	19	33	21	21.75	2.3
9 a.m.	50	32	51	16	37.25	5.9	16	15	39	9	19.75	1.6
10 a.m.	19	7	46	18	22.50	1.1	22	12	34	2	17.50	1.3
11 a.m.	34	8	18	8	17.00	5.4	14	3	11	2	7.50	0.0
12 non	13	5	30	23	17.75	2.8	6	7	30	20	15.75	0.0
4 p.m.	5	0	11	6	5.50	0.0	8	4	4	16	8.00	0.0
5 p.m.	5	3	11	14	8.25	0.0	3	11	14	11	9.75	0.0
6 p.m.	27	16	33	25	25.25	5.9	11	13	40	10	18.50	0.0
7 p.m.	24	6	70	5	26.25	2.9	6	5	22	2	8.75	0.0
Mean	23.6	10.1	33.4	13.2	20.08	3.08	10.5	9.2	23.5	9.3	1.31	0.52

"F" values

Between cardinal side 8.73 ($P = 0.1$ %)

Between sampling hour 3.13 ($P = 5$ %)

"F" values

Between cardinal side 9.32 ($P = 0.1$ %)

Between sampling hour 2.95 ($P = 5$ %)

Table 4. Mean numbers of alatae cowpea aphid, Aphis craccivora caught in yellow water-pan trap placed on outer side Faba bean fields during ten times of the day in early winter seedling establishment 2008/09 season (at one-hourly intervals) in Beni-Suef Governorate.

Sampling hour	Average no. aphids / trap 1st. November at indicated cardinal side				Mean no. aphids caught	% infectivity	Average no. aphids / trap 15th. November at indicated cardinal side				Mean no. aphids caught	% infectivity
	East	West	North	South			East	West	North	South		
7 a.m.	64	11	70	14	39.75	1.8	10	43	18	7	19.50	0.0
8 a.m.	39	3	61	7	27.50	0.7	33	28	13	5	19.75	0.9
9 a.m.	32	3	55	8	24.50	2.1	8	10	11	10	9.75	0.0
10 a.m.	13	9	48	8	19.50	0.0	22	0	17	7	11.50	0.0
11 a.m.	19	8	10	14	12.75	0.0	28	3	7	3	10.25	0.0
12 non	28	7	3	5	10.75	0.0	15	2	11	2	7.50	0.8
4 p.m.	28	20	25	3	19.00	0.5	17	1	13	2	8.25	0.4
5 p.m.	12	8	44	9	18.25	1.1	14	1	8	16	9.75	0.0
6 p.m.	43	10	26	2	20.25	0.7	15	7	15	4	10.25	0.0
7 p.m.	27	10	47	11	23.75	0.8	20	1	9	5	8.75	0.0
Mean	30.5	8.9	38.9	8.1	21.60	0.8	18.2	9.6	12.2	6.1	11.53	0.2

"F" values		"F" values	
Between cardinal side	14.29 (P = 0.1 %)	Between cardinal side	4.36 (P = 5 %)
Between sampling hour	1.60 (P = 5 %)	Between sampling hour	1.59 (n.s.)

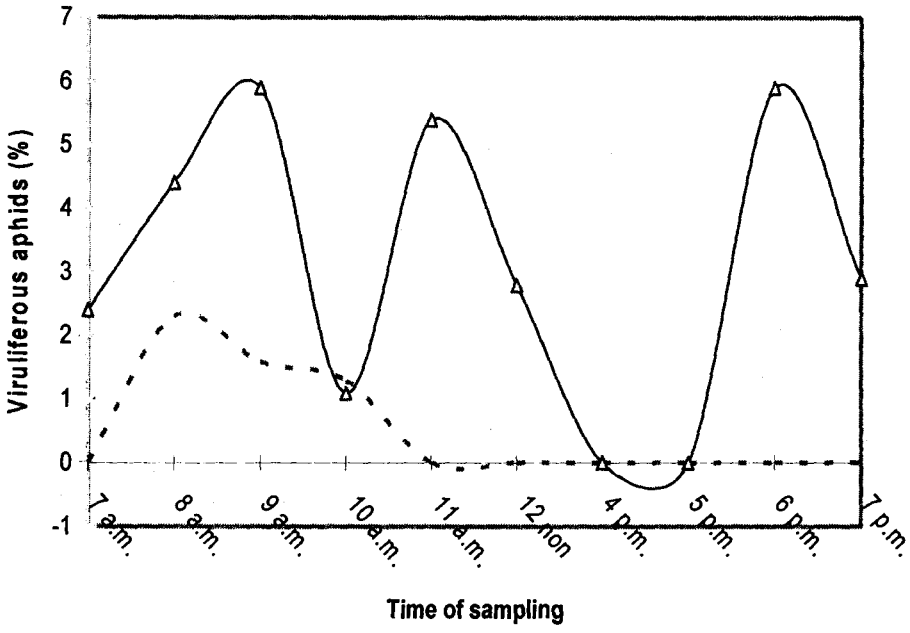

Fig. (3).Day time changes in percentages of viruliferous cowpea aphid captured over cowpea field plants in Beni-Suef Governorate during 1st. and 15th. September 2008

External symptoms of FBNYV disease as being described by Katul *et al.*, 1993 and El-Defrawi *et al.*, 1994b, were observed in diagnostic faba bean plants variety Giza 2. Obtained data showed that, more viruliferous cowpea aphids were detected between 8-11 a.m. and in 6 a.m. over faba bean plants (Fig., 3). Over faba bean plants at an early stage, the percentage of viruliferous cowpea aphid caught in pan traps recorded between 7-9 a,m, and just before sunset by 3 hrs at 4-7 p.m. as clearly shown in (Fig., 4).

Many experiments and observations shown the absence of relationships between the number of wingless aphids in the fields and the spread of non-persistent viruses such as PVY and Soybean mosaic virus (Hille Ris Lambers, 1972 and Halbert *et al.*, 1981) but correlations have been found between the number of winged aphids flight above a field and the spread of persistent virus within it (El-Defrawi, 1987)

It has been found that the catch cowpea aphid never appears bearing FBNYV during late harvested cowpea plants during a day time 1-7 p.m. (Table, 3) and the same on 15th. November 2008 over faba bean plants (Table, 4). The highest percentage of viruliferous cowpea aphids existing over leguminous fields before cultivation by 1-1.5 month at least. These variations imply that it was due to plant color attraction and light reflection. A'Brook (1973), stated that alatae migrating to

specific summer or winter hosts may, if light, temperature, pressure, relative humidity and wind are suitable. During the flight activity period, aphids such as *Aphis fabae, Myzus persicae* can make a primary distinction between ground and sky on the basis of wavelength (above or below 500 nm, respectively). and possible secondary distinction between the soil and plants (Kennedy *et al.*, 1961 &1962).

The present study results are in harmony with those obtained by many authors (El-Sharkawy, 1989 and Hander *et al.*, 1993) who reported that yellow pan water could be more efficient tool for detect migratory sucking insects bearing pathogenic virus diseases.

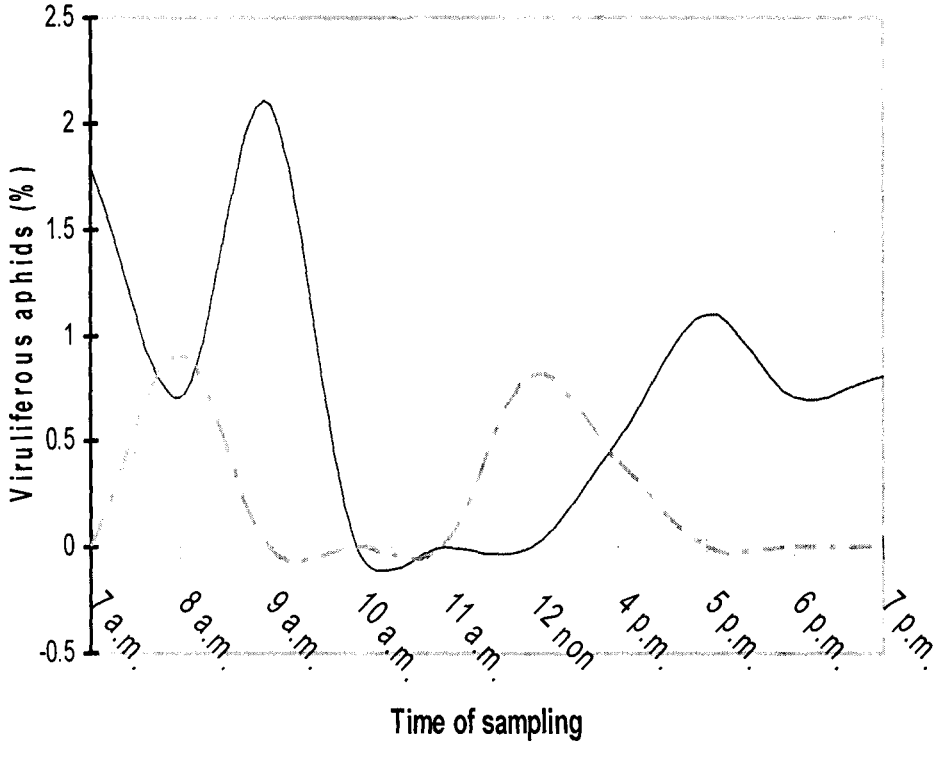

Fig. (4).Day time changes in percentages of viruliferous cowpea aphid captured over faba bean field plants in Beni-Suef Governorate during 1st. and 15th. November 2008

——— 1st. November

– – – 15th. November

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دراسة وقت نشاط الطيران لحشرات من اللوبيا المجنحة وكفاءتها في نقل مرض اصفرار وموت الفول البلدي

جودة محمد الدفراوى[1] ، محمد كمال الدين الانصارى[2]

١. معهد بحوث وقاية النباتات – مركز البحوث الزراعية – الدقي – جيزة
٢. قسم وقاية النباتات – كلية الزراعة – جامعة الأزهر – مدينة نصر – القاهرة.

أجريت هذه الدراسة في محطة سدس للبحوث والتجارب الزراعية – محافظة بنى سويف – إقليم مصر الوسطي بهدف دراسة النشاط البومى لطيران حشرة من اللوبيا التي تصيب نباتات اللوبيا صيفا والفول البلدي شتاء وكذلك قدرتها في نشر مرض اصفرار وموت الفول البلدي الفيروسي وذلك خلال موسمين متعاقبين ٢٠٠٧/٢٠٠٨ و ٢٠٠٨/٢٠٠٩.

استخدم لهذا الغرض مصائد مائية صفراء ممتلئة بالماء النظيف يتم تغيرها يوميا وبحيث توضع أفقيا على حامل أعلى مستوى النباتات للتعرف على النشاط اليومي للمهجرات المنتقلة من داخل حقول اللوبيا قبيل فترة تمام النضج و المجنحات الآتية من خارج حدود حقول محصول القول البلدي للهبوط داخل الحقل لتصيب النباتات وبداية نشرالمسبب الممرض الفيروسي FBNYV في الفترات الأولى للنمو (طور البادرة والاستطالة). حيث تم تشغيل هذه المصائد (٨ مصائد في الحدود الخارجية للحقل) ولمدة ١٧ أسبوعا من منتصف شهر أغسطس إلى منتصف شهر ديسمبر في كل عام ٢٠٠٧ و ٢٠٠٨. أيضا تم اختبار وتحديد ما إذا كانت هذه المهجرات حاملات لفيروس FBNYV من عدمة باستخدام طرق قياس بيولوجية للقدرة على النشر وطرق سيرولوجية للتعرف الدقيق على نوعية المرض المحمول داخل المهجرات التي تم اصطيادها. ولقد أظهرت النتائج المتحصل عليها أن إعداد ونشاط المجنحات لحشرة من اللوبيا التي تم جمعها من المصائد المائية الموجودة في حقول اللوبيا – الفول البلدي والحشائش المنتشرة قد تأثرت معنويا بالنشاط اليومي الذي أجريت فية عملية الصيد وتذبذبت الأعداد المصطادة يوميا بصورة غير منتظمة خلال الفترة من منتصف أغسطس إلى منتصف شهر ديسمبر.

أما بالنسبة للتغير في نشاط وتعداد الطور المجنح (المهجرات) لحشرة من اللوبيا *A. craccivora* خلال ساعات اليوم.

تم تثبيت وتشغيل هذه المصائد المائية خلال فترة ما قبل حصاد محصول اللوبيا الصيفي (يومي ١ و ١٥ سبتمبر) وبداية موسم نمو محصول الفول البلدي الشتوي (يومي ١ و ١٥ نوفمبر) من الساعة السادسة صباحا وحتى منصف اليوم في الساعة الثانية عشر ظهرا، ثم من الساعة الرابعة عصرا إلى السابعة مساء.

وخلال فترات الاصطياد (مدة كل منها ساعة واحدة)، حيث تم جمع العينات من الحشرات الطائرة مباشرة بعد سقوطها على سطح الماء للفحص وتسجيل أعدادها في كل مدة ونقلها إلى الصوبة

مباشرة وتوزيعها على عدد من النباتات السليمة لبادرات الفول البلدي صنف جيزة ٢، بمعدل حشرة على البادرة الواحدة لأجراء اختبارات حمل المسببات المرضية الفيروسية لمرض FBNYV وتحديد النسب المؤوية لقدرتها على نشر المرض.

أوضحت الدراسة أيضا أن نشاط طيران حشرة من اللوبيا أعلى نباتات اللوبيا خلال فترة نهاية موسم النمو وحتى بداية موسم نمو الفول البلدي تذبذبت بالزيادة والنقصان في الإعداد خلال ساعات اليوم وخاصة في الفترة من بعد بزوغ الشمس ووسط النهار وفترة ما قبل غروب الشمس ما بين الساعة ٦ – ٧ مساء. كانت أعلى متوسطات لأعداد حشرات من اللوبيا المجنحة المصطادة بالمصايد المائية المتواجدة على الحافة الخارجية لحقل اللوبيا ظهرت في الساعة الثامنة و التاسعة صباحا و من الساعة ٦–٧ مساء، بينما كانت أعلى تعداد ظهرت في الفترة من الساعة السابعة إلى الثامنة صباحا سجلت بالمصائد المائية المتواجدة على الحافة الخارجية لحقول الفول البلدي، ثم ما لبثت أن الإعداد الطائرة المصطادة تناقصت بشكل ملفت لتسجل اقل أعداد لها خلال منتصف اليوم ثم عاودت النشاط مرة أخرى بصورة ملحوظة في الفترة من الساعة السادسة إلى السابعة مساء أثناء فترة ما قبل غروب الشمس ١–٢ ساعة.