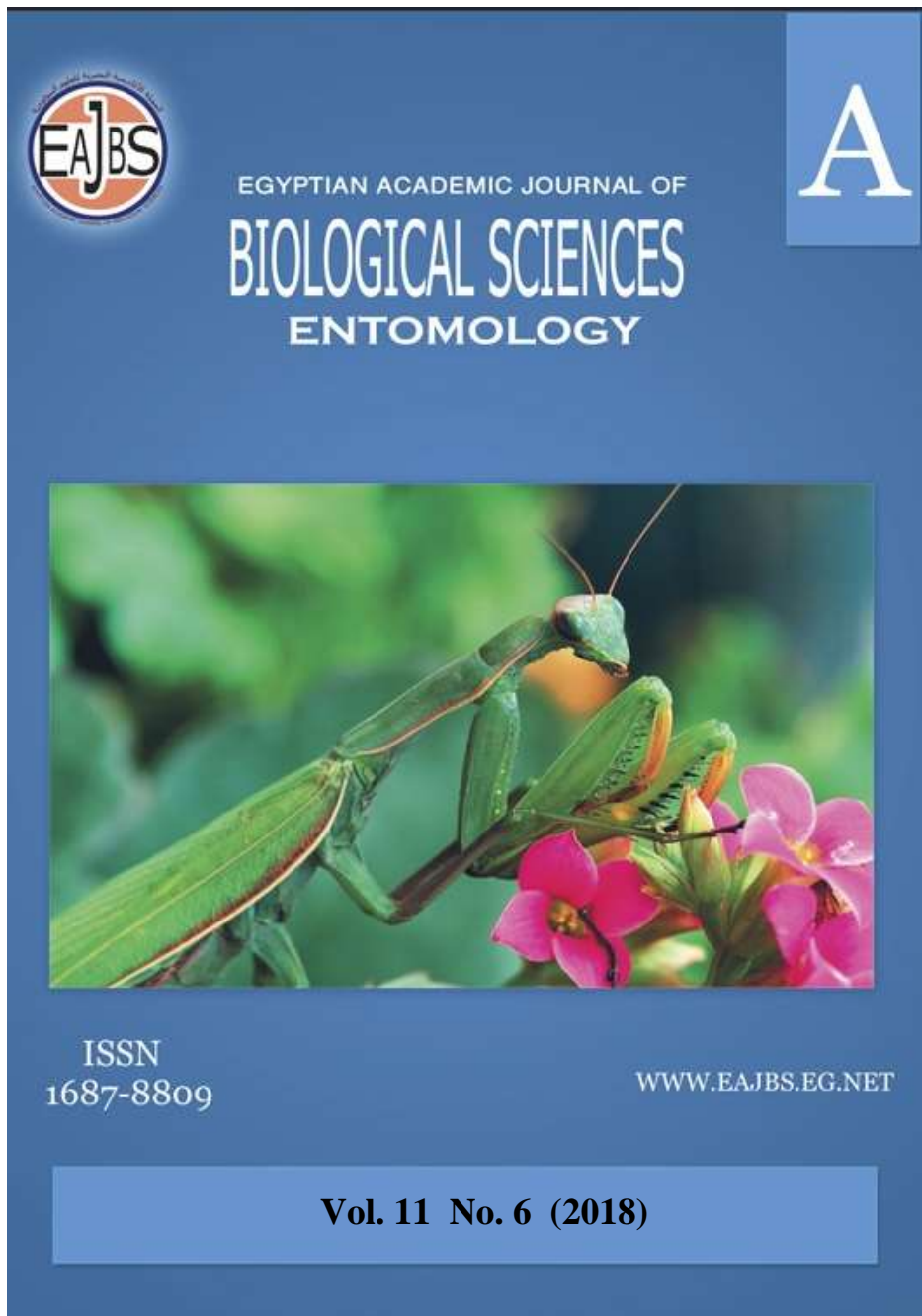


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Ecological Studies on Beet Fly *Pegomyia mixta* (Vill) Infesting Sugar Beet Plants and Their Associated Predators in Sharkia Governorate, Egypt

Aml Z. N. Al – Habshy

Plant Prot. Res. Inst., Agric. Res. Cent., Dokii, Giza, Egypt

E.Mail: dr_aml1970@yahoo.com

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ABSTRACT

The present work was carried out at Diarb- Nigm district, Sharkia Governorate, during the two sugar beet seasons 2015/2016 and 2016/2017, to study the seasonal fluctuation and number of generations of *Pegomyia mixta* (Vill) and seasonal fluctuation of the predators *Coccinella undecimpunctata* (L.), *Paederus alfieri* (Koch.), *Chrysoperla Carnea* (Stephens), *Scymnus sp.* and true spiders. The seasonal fluctuation of *P. mixta* (eggs and larvae) on sugar beet plants recorded two peaks during each season. Peaks of eggs were recorded in 22nd of February and 11th of April, in the first season, while the second season, these peaks were recorded in 27th of February and 17th of April. Peaks of larvae were recorded in 7th of March and 18th of April in the first season while the second season, it recorded in 13th of March and 24th of April. *P. mixta* eggs and larval were recorded were recorded three generations during each season. The peak of *C. undecimpunctata* and *P. alfieri* has occurred in 21th of March and 20th of March for the first and second seasons. The peak of *C. Carnea* was recorded in 14th of March and 13th of March for the two seasons. The peak of true spiders was recorded in 11th of April and 17th of April for the two seasons. The numbers of *Scymnus sp* was decreased for the two seasons.

INTRODUCTION

Sugar beet, *Beta vulgaris* L., growing for sugar production and it is considered as one of the two important sugar beet crops in the world and Egypt. The Egyptian government encourages sugar beet growers to increase the cultivated area with sugar beet for decreasing the gap between sugar production by sugar cane and consumption. Sugar beet quality is of great economic importance. Several numbers of insects attack this crop caused considerable damage in its yield. *Pegomyia mixta* (Vill) considered among the economic pests of sugar beet plants at present

In Egypt Ali *et al.*, (1993) recorded those three common predators on sugar beet plants were *Coccinella undecimpunctata*, *Paederus alfieri* and *Chrysoperla carnea*. Predator numbers recorded two summits, the first one occurred in December, while the other was in June. Bassyouny (1993) who showed that *P. mixta* larvae recorded on sugar beet plants in December then, increased gradually until reached its peak in March. Bassyouny and Bleih (1996) reported that the initial rate of infestation of *P. mixta* was low in September plantation, but high in October

and November ones. The population of that insect increased gradually and reached the maximum at the end of the season. Helal (2004) indicated that *P. mixta* population gradually increased until it reached its highest density in March and April. In this respect, El-khouly (2006) found that the reliable occurrence of *P. mixta* individuals occurred in November was gradually increased forming a distinct peak in March. The changes in the population densities of the predacious insects; *C. undecimpunctata*, *P. alfierii* and *C. carnea* coincided with the population densities of the tested pests *P. mixta*. Sherief (2013) showed that the sugar beet fly *P. mixta* started to appear on the plants on the 1st week of December. Two peaks of eggs and larvae were found on sugar beet plant.

The present study aimed to investigate seasonal fluctuation and generation's number of *P. mixta* and seasonal fluctuation of the associated predators *C. undecimpunctata*, *P. alfierii*, *C. Carnea*, *Scymnus* sp. and true spiders as well as the relationship between *P. mixta* and maximum, minimum temperature and mean RH.

MATERIALS AND METHODS

Experimental Design:

The experiment was carried out at Diarb- Nigm district, Sharkia Governorate, during two growing sugar beet seasons of 2015/2016 and 2016/2017 to study seasonal fluctuation and generation number of *P. mixta*. The experimental area 1050 m² was chosen and divided into three plots. The field was planted with sugar beet on October during two seasons. The normal agricultural practices were followed and no pesticides treatments were applied during the whole experimental period.

Sample Technique:

Direct count, Sampling started when the age of sugar beet plants reached one month after sowing and continued weekly throughout the growing seasons until 16th and 22nd of May in 2015/2016 and 2016/2017 seasons. The following procedures of sampling were adopted. 25 plants were taken randomly and the total number of existing of *P. mixta* (eggs and larvae) and predators on plants were recorded. For clearing the effect of certain weather factors such as temperature and atmospheric relative humidity on the population fluctuation of *P. mixta*, the daily mean of the two factors were provided by the Meteorological Central Laboratory for Agricultural Climate- Agricultural Research Center during the whole period of the two seasons (2015/2016 and 2016/2017).

Number of Generation:

The approximated number and duration of the annual field generation of *P. mixta* (eggs and larvae) were calculated according to Audemard and Milaire (1975) and by Jacob (1977). The data were plotted on semigaussion (Scale Gauss) and a regression line represented each generation.

RESULTS AND DISCUSSION

Seasonal Fluctuation of *P. mixta* on Sugar Beet Plants:

1) Eggs :

Results in Table (1 and 2) indicated that eggs of beet fly began to appear in 21th and 26th of December with few numbers 24 and 32 eggs / 25 plants during first and second seasons on sugar beet plants. The number of the eggs had two peaks during the two seasons. These peaks were recorded in 22nd of February and 11th of April represented by 293 and 220 eggs/ 25 plants, respectively, in the first season. In the second season, these peaks were noticed in 27th of February and 17th of April represented by 335 and 252 eggs/ 25 plants, respectively.

2) Larvae :

Results in Table (1 and 2) indicated that larvae began to appear in 28th of December and 2nd of January with few numbers 10 and 22 larvae / 25 plants during

first and second seasons on sugar beet plants. The number of the larvae had two peaks during the two seasons. These peaks were recorded in 7th of March and 18th of April represented by 217 and 189 larvae/25 plants, respectively, in the first season. In the second season, these peaks were noticed in 13th of March and 24th of April represented by 250 and 201 larvae /25 plants, respectively.

Table (1): Weekly number of beet fly *P. mixta* (eggs and larvae) infested sugar beet plants and accumulated during 2015/2016 season.

Date	Accumulated days	No. of eggs	Accumulated		No. of larvae	Accumulated		Temp.		R.H%
			No.	%		No.	%	. Min	. Max	
14\12	0	0	0	0.00	0	0	0.00	11.29	19.71	68.14
21\12	7	24	24	0.78	0	0	0.00	11.57	20.86	64.57
28\12	14	47	71	2.31	10	10	0.39	11.00	20.00	68.14
4\1	21	73	144	4.68	46	56	2.20	10.29	18.00	61.68
11\1	28	95	239	7.77	73	129	5.07	12.43	20.14	45.14
18\1	35	110	349	11.35	95	224	8.80	10.43	20.29	64.14
25\1	42	157	506	16.46	114	338	13.28	9.29	16.43	54.29
1\2	49	161	667	21.69	125	463	18.19	7.00	15.29	69.86
8\2	56	214	881	28.65	174	637	25.03	10.57	20.29	59.71
15\2	63	271	1152	37.46	169	806	31.67	11.14	20.86	50.43
22\2	70	293	1445	46.99	189	995	39.09	16.43	27.57	48.57
29\2	77	210	1655	53.82	210	1205	47.35	14.71	24.71	50.86
7\3	84	117	1772	57.63	217	1422	55.87	17.86	30.71	58.28
14\3	91	93	1865	60.65	174	1596	62.71	16.86	28.42	39.57
21\3	98	150	2015	65.53	99	1695	66.60	15.14	24.29	50.00
28\3	105	167	2182	70.96	114	1809	71.08	11.57	20.86	40.86
4\4	112	189	2371	77.11	125	1934	75.99	11.00	20.00	54.86
11\4	119	220	2591	84.26	126	2060	80.94	10.29	18.00	36.71
18\4	126	153	2744	89.24	189	2249	88.37	12.43	20.14	45.43
25\4	133	114	2858	92.94	122	2371	93.16	10.43	20.29	41.29
2\5	140	98	2956	96.13	76	2447	96.15	9.29	16.43	43.29
9\5	147	73	3029	98.50	63	2510	98.62	7.00	15.29	43.29
16\5	154	46	3075	100.00	35	2545	100.00	10.57	20.29	35.43

Table (2): Weekly number of beet fly *P. mixta* (eggs and larvae) infested sugar beet plants and accumulated during 2016/2017 season.

Date	Accumulated days	No. of eggs	Accumulated		No. of larvae	Accumulated		Temp.		R.H%
			No.	%		No.	%	. Min	Max.	
19\12	0	0	0	0	0	0	0	11.36	20.17	55.67
26\12	7	32	32	0.85	0	0		10.43	18.29	56.17
2\1	14	52	84	2.24	22	22	0.75	10.07	19.00	60.5
9\1	21	88	172	4.58	35	57	1.95	9.14	18.00	52.86
16\1	28	115	287	7.65	88	145	4.96	10.43	17.57	49.57
23\1	35	180	467	12.44	115	260	8.89	9.71	19.43	72.43
30\1	42	195	662	17.64	140	400	13.67	11.57	18.71	53.40
6\2	49	210	872	23.23	166	566	19.34	6.00	17.71	60.86
13\2	56	252	1124	29.95	188	754	25.77	11.71	21.71	55.43
20\2	63	295	1419	37.81	198	952	32.54	11.71	16.43	60.71
27\2	70	335	1754	46.74	211	1163	39.75	10.86	21.00	62.57
6\3	77	290	2044	54.46	233	1396	47.71	13.29	23.86	63.14
13\3	84	180	2224	59.26	250	1646	56.25	15.14	23.57	44.00
20\3	91	102	2326	61.98	190	1836	62.75	13.71	21.86	52.57
27\3	98	170	2496	66.51	101	1937	66.19	15.14	24.00	59.40
3\4	105	180	2676	71.3	108	2045	69.89	16.43	27.00	47.14
10\4	112	199	2875	76.61	130	2175	74.33	15.71	26.71	55.86
17\4	119	252	3127	83.32	185	2360	80.66	16.57	26.29	55.86
24\4	126	215	3342	89.05	201	2561	87.53	18.43	31.43	36.71
1\5	133	192	3534	94.42	144	2705	92.45	17.00	28.43	44.14
8\5	140	80	3614	96.29	88	2793	95.45	19.43	29.86	52.17
15\5	147	72	3686	98.21	71	2864	97.88	21.00	36.00	37.71
22\5	154	67	3753	100.00	62	2926	100.00	21.19	32.29	46.43

Number of Generation of *P. mixta* on Sugar Beet Plants:

1) Eggs:

The data in Figs.(1 and 2) and Table (3) recorded three generations of *P. mixta* eggs for 2015/2016 and 2016/2017 seasons on sugar beet plants. The first generation was started at 21th of December and 26th of December in both the two experimental seasons and continued to 8 weeks until the 8th of February and 13th of February during first and second seasons, respectively. The second generation was appeared at the 15th of February and 20th of February in both experimental seasons and continued to about 6 and 7 weeks until the 21th of March and 3rd of April during first and second seasons, respectively. The third generation was appeared at the 28th of March and 10th of April in both experimental seasons and continued to 6 weeks until the 2nd of May and 15th of May during first and second seasons, respectively.

Table (3):The sequence of the annual generation of *P. mixta* (eggs) in Sharkia governorate during 2015/2016 and 2016 /2017 seasons

Generation on number	2015/2016					2016/2017				
	Duration		Duration in weeks	Total Eggs		Duration		Duration in weeks	Total Eggs	
	From	To		number	%	From	To		number	%
1 st	21 th of December	8 th of February	8 weeks	881	28.65	26 th of December	13 th of February	8 weeks	1124	29.95
2 nd	15 th of February	21 th of March	6 weeks	1134	36.88	20 th of February	3 rd of April	7 weeks	1552	41.35
3 rd	28 th of March	2 nd of May	6 weeks	941	30.60	10 th of April	15 th of May	6 weeks	1010	26.91

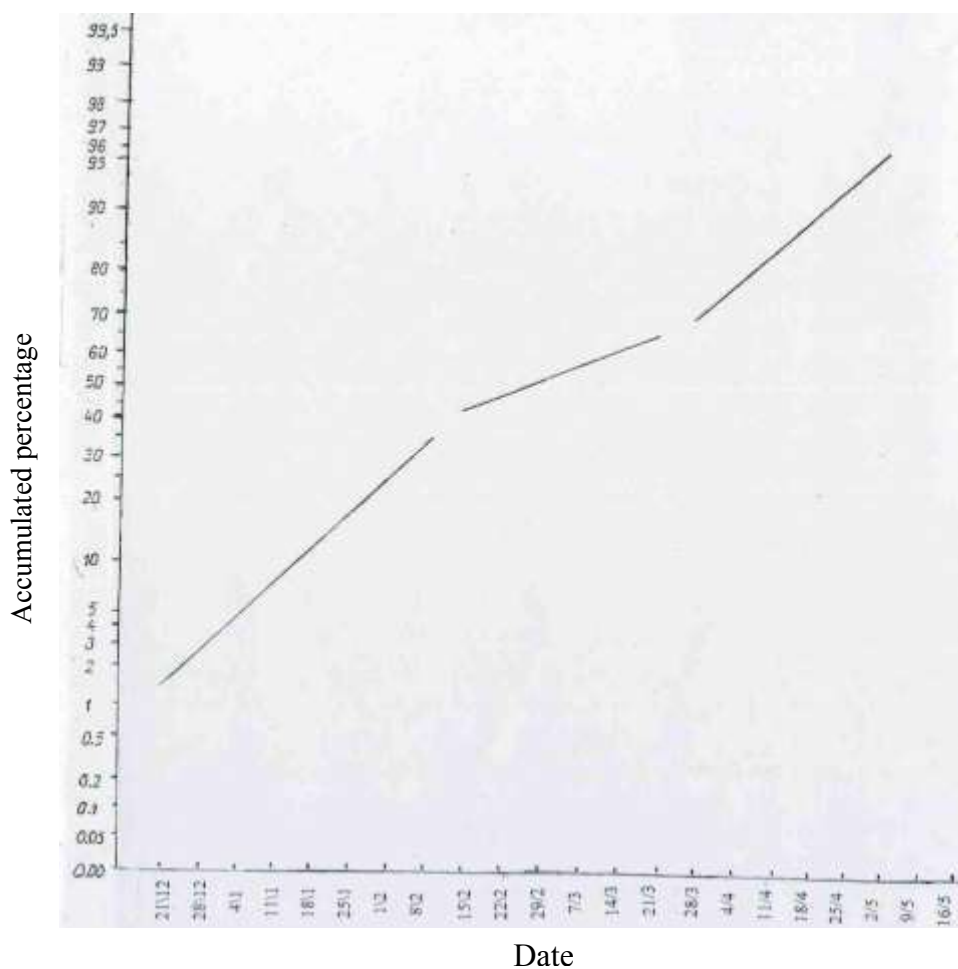


Fig. (1): Annual generation and duration of *P. mixta* (eggs) in Sharkia governorate during 2015/2016 season

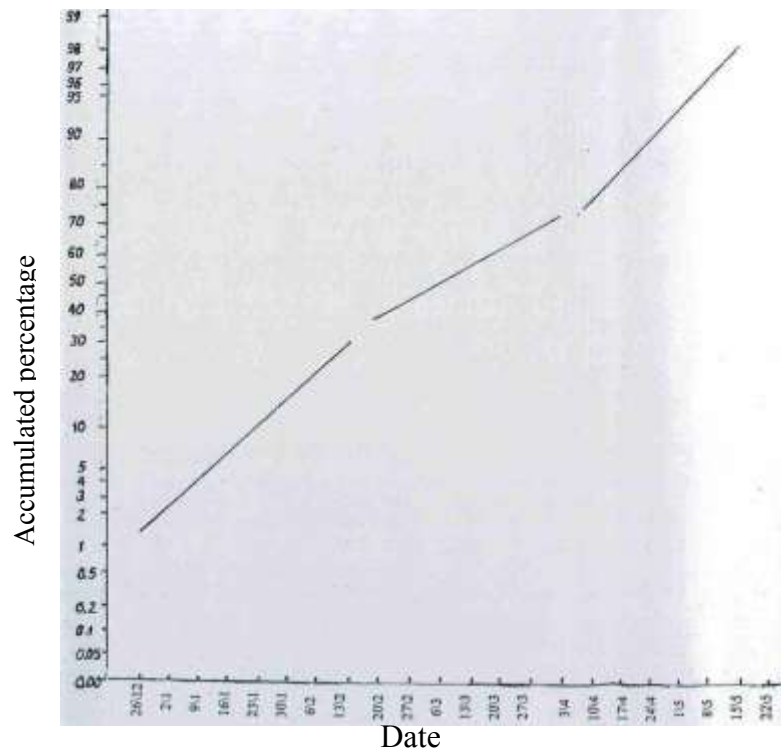


Fig. (2): Annual generation and duration of *P. mixta* (eggs) in Sharkia governorate during 2016 /2017 season

2) Larvae:

Data are given in Figs. (3 and 4) and Table (4) showed three generations of *P. mixta* larvae for 2015/2016 and 2016/2017 seasons on sugar beet plants. The first generation was started at 4th of January and 2nd of January in both experimented seasons and continued to 6 weeks until the 8th week of February and 6th of February during first and second seasons, respectively. The second generation was appeared at the 15th of February and 13th of February in both experimental seasons and continued to 7 weeks until the 28th of March and 27th of March during first and second seasons, respectively. The third generation was appeared at the 4th of April and 3rd of April in both experimental seasons and continued to about 6 and 7 weeks until the 9th and of May and 15th of May during first and second seasons, respectively.

Youssef (1994) revealed that the beet fly *P. mixta* appeared from November to June with three peaks of the population at Kafr El-Sheikh Governorate. Abou-Attia (1999) showed that *P. mixta* had three peaks of eggs on sugar beet plants during two seasons, while the larval population had two peaks of abundance in each season of the study. The highest numbers of eggs and larvae of *P. mixta* were observed during the end of April in both seasons. Amin *et al.*, (2008) indicated that the population density of *P. mixta* fluctuated and recorded two peaks; the first was in early March, while the second was in the first week of April under field conditions at Kafr El-Sheikh Governorate. Sherief (2013) showed that the sugar beet fly *P. mixta* started to appear on the plants on the 1st week of December. Two peaks of eggs and larvae were found on sugar beet plant. Abdel-Moniem (2014) reported that at the first season, eggs and the larvae of the *P. mixta* were observed on the first week of November. The population increases at end of November. This level continued more or less the same until the fourth week of April. The second season, the eggs and the larvae of *P. mixta* observed on the second week of November. The population increased in mid of December. This level continued more and less the same until the end of April.

Khalifa (2017) found that population density of *P. mixta* was low in all sugar beet plantations of both years of study, except in the third (October) plantation of the first season; the third plantation had the highest *P. mixta* population density during February and March. In the second season, the third plantation had a slight increase in the population density of the fly, by mid-March and throughout April.

Table (4): The sequence of the annual generation of *P. mixta* (larvae) in Sharkia governorate during 2015/2016 and 2016 /2017 seasons

Generation on number	2015/2016					2016/2017				
	Duration		Duration in weeks	Total larvae		Duration		Duration in weeks	Total larvae	
	From	To		number	%	From	To		number	%
1 st	4 th of January	8 th of February	6 weeks	627	24.64	2 nd of January	6 th of February	6 weeks	566	19.34
2 nd	15 th of February	28 th of March	7 weeks	1172	46.05	13 th of February	27 th of March	7 weeks	1371	46.86
3 rd	4 th of April	9 th of May	6 weeks	701	27.54	3 rd of April	15 th of May	7 weeks	927	31.68

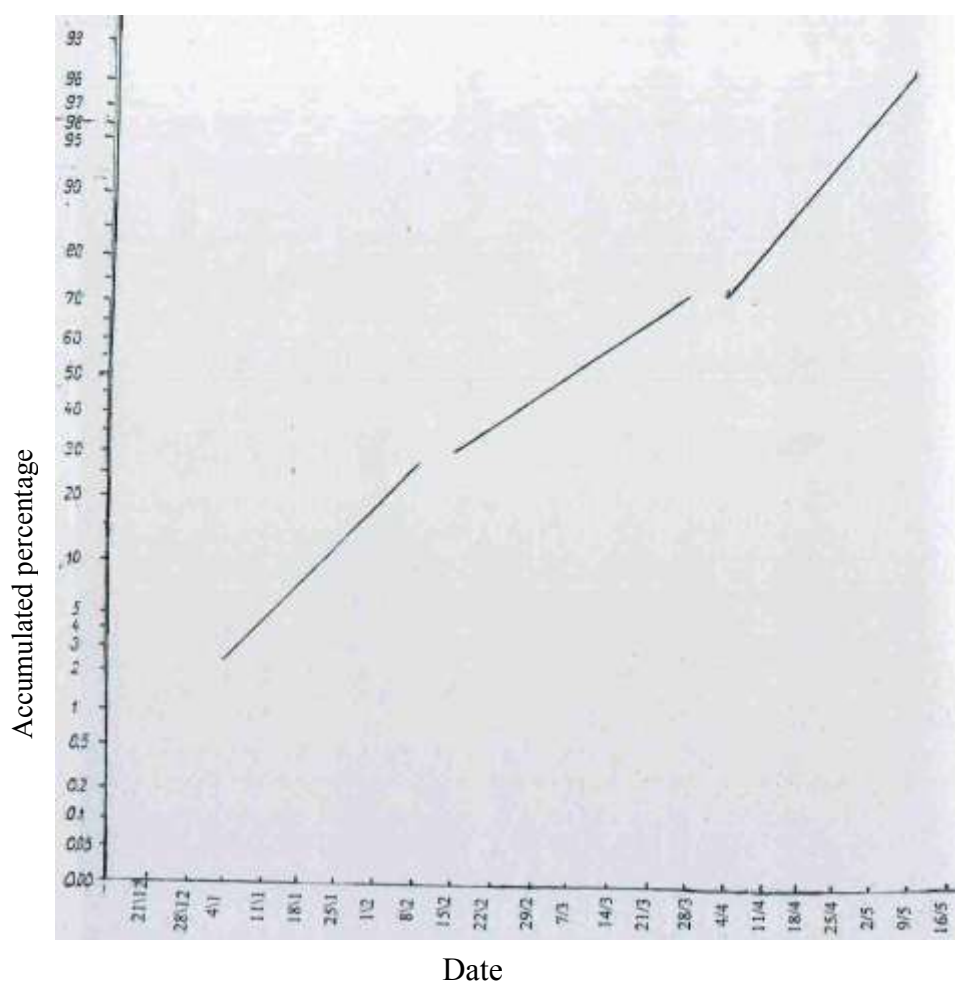


Fig. (3): Annual generation and duration of *P. mixta* (larvae) in Sharkia governorate during 2015/2016 season

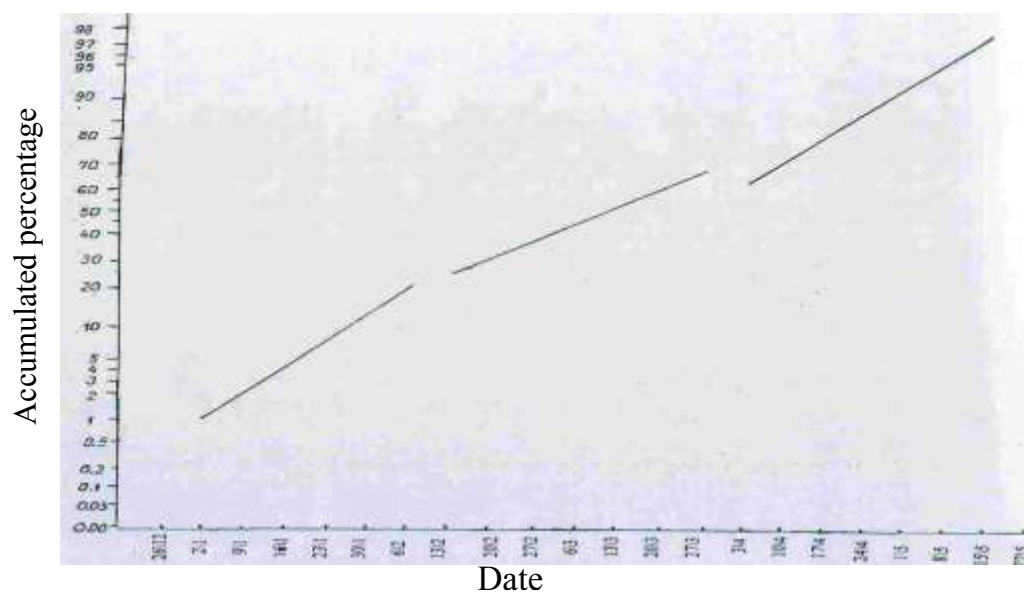


Fig. (4): Annual generation and duration of *P. mixta* (larvae) in Sharkia governorate during 2016 /2017 season

Seasonal Fluctuation of some the Associated Predators with *P. mixta*:

Results in Table (5 and 6) indicated that the numbers of *C. Carnea*, *Scymnus* sp. and true spiders appeared in 21th of December and 26th of December while *C. undecimpunctata* and *P. alfieri* appeared in 28th of December and 2nd of January during first and second seasons on sugar beet plants. The number of predator's insects (*C. carnea*, true spiders, *C. undecimpunctata* and *P. alfieri*) had one peak during the two seasons. The peak of *C. undecimpunctata* and *P. alfieri* (15 and 25 individual / 25 plants) was occurred in 21th of March and the total number (18 and 24 individual / 25 plants) has occurred in 20th of March for first and second seasons, respectively. The peak of *C. carnea* was recorded in 14th of March and 13th of March with a total numbers of 29 and 32 individual / 25 plants for the two seasons, respectively. While The peak of true spiders was recorded in 11th of April and 17th of April with a total numbers of 24 and 29 individual / 25 plants for the two seasons, respectively. The numbers of *Scymnus* sp was decreased for the two seasons.

Abo Saied Ahmed (1987) in Egypt recorded ten predators belonging to 5 orders and 6 families in sugar beet fields. He encountered *Coccinella* spp. from March to June while *Scymnus* sp., *C. v. nilotica* and *C. vicina isis* predators were encountered from November to June. Mesbah (1991) who found that the population of coccinellid predators started to increases in March and April. Youssef (1994) reported that three distinct peaks of *P. alfieri*, two peaks of coccinellid predators and two peaks of *Chrysopa carnea* were recorded in September. El-Agamy *et al* (1996) in Egypt found that the abundance of coccinellids, *P. alfieri* and *C. carnea* in sugar-beet fields reached their maximum populations during April in September plantation and throughout May-June in December plantation.

Shalaby (2001) observed that the population density of coccinellids was high during March, April and May; after that, he also found that population density of *C. carnea* was the highest in September plantation. El-Khouly (2006) found that the changes in the population densities of the predacious insects; *Coccinella undecimpunctata*, *Paederus alfieri* and *Chrysoperla carnea* coincided with the population densities of the tested pests *P. mixta*. Sherief (2013) showed that about natural enemies *C. undecimpunctata* and *C. carnea* appeared in November 2008 /2009 and 2009 /2010 but *P. alfieri* was observed

during January in both seasons The peaks of the studied predacious insects occurred in February, of the first season almost similar trend was obtained during the second season of study on the sugar beet

Khalifa (2017) reported the predatory coccinellids were more detected in the first plantation (3.44 – 7.08) and the second plantation (2.00 – 3.21 adults/25 sugar beet plants). Other than coccinellid predators *P. alferii*. and *Orius* sp. were surveyed.

Table (5): Weekly number of the predators associated with beet fly *P. mixta* infesting sugar beet plants at Sharkia Governorate during during 2015/2016 season.

Date	Number of predators/ 25 plants				
	<i>C. undecimpunctata</i>	<i>C. carnea</i>	<i>Scymnus sp.</i>	<i>P. alferii</i>	True spiders
14\12	0	0	0	0	0
21\12	0	1	4	0	6
28\12	1	2	6	2	2
4\1	1	1	0	3	4
11\1	2	2	2	4	6
18\1	0	0	2	7	5
25\1	3	5	0	4	9
1\2	1	4	3	3	10
8\2	1	6	3	6	5
15\2	3	7	5	11	7
22\2	3	5	2	9	5
29\2	8	6	2	8	5
7\3	7	12	3	9	6
14\3	10	29	0	20	10
21\3	15	10	0	25	9
28\3	9	8	2	12	10
4\4	3	5	1	11	11
11\4	2	1	1	4	24
18\4	1	2	0	3	9
25\4	0	1	2	6	6
2\5	2	4	2	0	5
9\5	1	2	0	5	1
16\5	0	1	0	2	3

Table (6): Weekly number of the predacious insects associated with beet fly *P. mixta* infesting sugar beet plants at Sharkia Governorate during 2016/2017 seasons.

Date	Number of predators/ 25 plants				
	<i>C. undecimpunctata</i>	<i>C. carnea</i>	<i>Scymnus sp.</i>	<i>P. alferii</i>	True spiders
19\12	0	0	0	0	0
26\12	0	4	1	0	4
2\1	2	0	0	4	5
9\1	1	2	2	2	4
16\1	3	2	1	3	5
23\1	1	7	2	1	4
30\1	2	3	0	3	3
6\2	0	8	2	4	8
13\2	4	13	3	6	8
20\2	6	11	1	5	5
27\2	6	14	5	10	7
6\3	8	17	2	11	7
13\3	9	32	3	22	6
20\3	18	12	0	24	5
27\3	12	11	2	11	14
3\4	8	6	1	8	10
10\4	5	3	3	6	11
17\4	4	4	3	7	29
24\4	3	5	7	5	16
1\5	4	4	9	6	9
8\5	5	0	4	3	5
15\5	0	2	2	0	3
22\5	3	3	0	1	3

Effect of Maximum, Minimum Temperature and Relative Humidity on the Number of *P. mixta* Infesting Sugar Beet Plants:

1) Eggs :

The results in Table (7) obtained that the correlation coefficient between eggs and maximum temperature was insignificant ($r_1 = -0.2170$ and -0.1773) in the two seasons, respectively. The number of eggs was an insignificant correlation with minimum temperature ($r_2 = -0.1941$ and -0.1803) in the two seasons, respectively. While, relative humidity was insignificant ($r_3 = 0.1143$ and -0.0148) in the two seasons, respectively.

2) Larvae:

The results in Table (7) obtained that the correlation coefficient between larvae and maximum temperature was insignificant ($r_1 = 0.2516$ and 0.2364) in the two seasons, respectively. The correlation coefficient between larvae and minimum temperature was insignificant ($r_2 = 0.2790$ and 0.2507) in the two seasons, respectively. While, relative humidity was insignificant ($r_3 = -0.2882$ and -0.1097) in the two seasons, respectively).

Table (7): Simple correlation coefficients and partial regression between the means of maximum temperature, minimum temperature and mean relative humidity and total numbers of *P. mixta* (eggs and larvae) infesting sugar beet plants during 2015/2016 and 2016/2017 seasons

<i>P. mixta</i>	Simple correlation coefficients						Explained variance % R^2	
	2015/2016			2016/2017			2015/2016	2016/2017
	r_1	r_2	r_3	r_1	r_2	r_3		
Eggs	-0.2170	-0.1941	-0.1143	-0.1773	-0.1803	-0.0148	19.84	4.91
Larvae	0.2516	0.2790	-0.2882	0.2364	0.2507	-0.1097	34.38	10.09

r_1 =correlation coefficient between max. temp. and number of *P. mixta*

r_2 =correlation coefficient between min. temp. and number of *P. mixta*

r_3 =correlation coefficient between R.H. and number of *P. mixta*

Combined Effects of Meteorological Factors on the Numbers of *P. mixta* (eggs and larvae):

The effect of (maximum and minimum) temperatures and mean relative humidity on *P. mixta* (eggs and larvae) numbers were estimated by calculating the partial regression analysis. E.V.% values Table (7) demonstrate that the eggs and larvae population of *P. mixta* in the two seasons more sensitive to changes in the considered weather factors (maximum and minimum) temperatures and mean relative humidity showed E.V. % values of 19.84 % and 4.91 % (eggs) and E.V.% values of 34.38 % and 10.09 % (larvae) for the two seasons, respectively.

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ARABIC SUMMERY

دراسات بيئية على ذبابة البنجر التي تصيب نباتات البنجر والمفترسات المصاحبة لها في محافظة الشرقية - مصر

أمل زكريا نورالدين الحبشى
جيزة - دقى - مركز البحوث الزراعية - معهد بحوث وقاية النباتات

أجريت هذه الدراسة خلال موسمين متتاليين ٢٠١٥ / ٢٠١٦ و ٢٠١٦ / ٢٠١٧ بهدف دراسة التقلبات الموسمية وعدد الاجيال لبيض ويرقات ذبابة البنجر التي تصيب نباتات البنجر المنزرعة في منطقة ديرب نجم ، محافظة الشرقية . وتم دراسة التقلبات الموسمية لبيض ويرقات ذبابة البنجر على البنجر وجد لبيض ذبابة البنجر قمتين نشاط ، القمة الاولى فى يوم ٢٢ من شهر فبراير بينما القمة الثانية فى يوم ١١ من شهر ابريل للموسم الاول وفى الموسم الثانى ظهرت القمة الاولى فى يوم ٢٧ من شهر فبراير بينما القمة الثانية فى يوم ١٧ من شهر ابريل. ووجد ليرقات ذبابة البنجر قمتين نشاط ، القمة الاولى فى يوم ٧ من شهر مارس بينما القمة الثانية فى يوم ١٨ من شهر ابريل للموسم الاول وفى الموسم الثانى ظهرت القمة الاولى فى يوم ١٣ من شهر مارس بينما القمة الثانية فى يوم ٢٤ من شهر ابريل. ولقد وجد ان لبيض ويرقات ذبابة البنجر ثلاث اجيال . وتم عمل حصر للأعداء الحيوية (أبو العيد وأسد المن والحشرة الرواعة والعناكب الحقيقية والاسكمنس) المصاحبة لذبابة البنجر. حيث كانت لهما قمة نشاط واحدة لهذه المفترسات فى يوم ٢١ من مارس وفى ٢٠ من مارس لآبو العيد و الرواعة خلال الموسمين وسجلت قمة نشاط واحدة لآسد المن فى يوم ١٤ من شهر مارس وفى يوم ١٣ من شهر مارس خلال الموسمين بينما سجلت قمة نشاط واحده للعنكبوت الحقيقى فى يوم ١١ من ابريل و فى يوم ١٧ من ابريل خلال الموسمين على التوالي. حشرات الاسكمنس كانت اقل تعداد خلال الموسمين. ومن دراسة تأثير كل من درجة الحرارة العظمى و الصغرى وكذلك الرطوبة النسبية على تعداد بيض ويرقات ذبابة البنجر كان لها تأثير على التعداد.