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Seasonal fluctuation and coexistence of beet fly, *Pegomyia mixta* vill. with some sugar beet varieties at two locations

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Abstract
Variety resistance became important in beet breeding program strategies as an effective conventional alternative in pest control, where pests cause side effects of pollution and harmful impact on the plant, natural enemies and ambient environment. Whereas, variety resistance refer to the ability of some genotypes to give higher yields of good quality than susceptible ones at the same initial level of insect attack under similar environmental conditions. Therefore, this study was carried out under two geographical locations, Ismailia and Al-Fayoum Governorates in 2017/2018 and 2018/2019 seasons to determine the seasonal fluctuation in the population density of the sugar beet fly, *Pegomyia mixta* on eight sugar beet varieties (Florima, Gazelle, Tarbelli, Betamax, Sirona, Lilly, Hercule and Perikles) under natural infestation. Also, measuring the infestation effects on average root weight and sucrose percentage. The obtained results showed various noticeable signs of *Pegomya mixta* Vill. Infestation, expressed as population density (number of larvae), number of blotches, number of infested plants per 10 plants and infested leaf percentage were less in Ismailia area than those in Al-Fayoum, in both seasons. Further, Tarbelli and Lilly varieties exhibited the least resistance to beet fly infestation, which exhibited significant and the highest signs of infestation by beet fly, in both seasons and locations. On the other hand, Hercule and Sirona varieties recorded the highest resistance to beet fly infestation recording the lowest noticeable signs of infestation in both seasons and governorates.
Regarding seasonal fluctuation of beet fly, the obtained results illustrated that the beginning time of beet fly infestation differed significantly among the used varieties. Moreover, some varieties were free from infestation till 15 and 18 December, in both seasons and locations. Meantime, for all of the tested varieties, the beginning time of beet fly appearance was in January in both seasons and locations. Data also manifested that the number of peaks of noticeable signs of beet fly infestation varied among the used beet varieties, in both seasons and locations. As for the consistent and obvious relationships between the coexistence of beet fly insect and the evaluated varieties, the results clarified that may be, there is no option for the insect to attack any variety.
The obtained findings showed that whether in healthy or infested beets, root fresh weight and sucrose content were higher in Ismailia than those in Al-Fayoum. Data also cleared that the percent of reduction in average root weight and sucrose content resulting from infestation of plants by beet fly as compared to the healthy plants in Ismailia area were significantly less than those in Al-Fayoum area in both seasons. Meanwhile, the highest reduction of root weight and sucrose% were recorded by Tarbelli and Lilly varieties at Ismailia and Al-Fayoum Governorates. However, the lowest reduction in root weight was shown by Hercule variety, in Ismailia and Al-Fayoum, in the first season, and by Perikles and Sirona varieties, in the second one, due to the infestation by beet fly. Florima variety recorded the lowest reduction in sucrose content in both locations, in the first season. However, Sirona and Perikles varieties gave the lowest sucrose reduction, in the second one in both locations.

Keywords: beet fly seasonal fluctuation, coexistence, locations, sugar beet, varieties

Introduction
Sugar beet (*Beta vulgaris* var. saccharifera, L.) belongs to the family Chenopodiaceae. It is a biennial plant, where the root swells and accumulates sucrose in the first season. Sugar beet was grown commercially in Egypt in the northern Delta in 1982. Nowadays, its cultivation expanded to cover about 6.83 thousand feddan distributed over 21 Governorates, producing about 1.84 million tons of white sugar presented 67.7% of the total sugar production in 2021 season.
Every commercial beet crop is attacked by various insect pests during its growth stages. The most important and serious pest is the beet fly, *Pegomyia mixta* Vill., Diptera: Anthomyiidae [1- 6].
Being a favorite contract and profitable crop, in addition to the absence of crop rotaion, sugar beet is subjected to the attack of some general and specific insects along its growing season. Among these harmful insects, the beet fly *P. mixta* causes a great damage to sugar beet crop by feeding within the leaf between the upper and lower surfaces, producing large blotches or meandering tunnels, causing acute damage to sugar beet leaf chlorophyll content, and ultimately 20% of the foliage and 15% of root yield are lost [7- 12].
Research and development programs have provided farmers with several ways of minimizing the extent of yield loss resulting from pest attacks particularly by a number of pesticides.
Consideration is now given to the selection of beet varieties that have some physiological, morphological, biological and chemical constituents that gave some resistance to pest attack. In this connection, [11-13] reviewed the various internal and externals mechanisms involved in the sensitivity of resistance of cultivars to pest infestation.
This investigation aimed to determine the seasonal fluctuation in the population density of the sugar beet fly, *Pegomyia mixta* on eight sugar beet varieties under natural infestation, at two geographical locations, Ismailia and Al-

Fayoum Governorates. Also, measuring the infestation effects on average root weight and sucrose percentage.

Materials and Methods

Ecological studies were carried out at two geographical locations; Wadi El-Noran Farm, Al-Abtal Village, Ismailia Governorate, located in the northeastern part of Egypt (latitude of 30.18º N and longitude of 32.30º E and elevation of 13 m above sea level) and a private field at Demo, Al-Fayoum Governorate, located in the southwest part of Egypt (latitude of 29.17º N and longitude of 30.53º E and elevation of 23 m above sea level), in 2017/2018 and 2018/2019 seasons to determine the seasonal fluctuation in the population density of the sugar beet fly, *Pegomyia mixta* on eight sugar beet varieties under natural infestation. Also, measuring the infestation effects on average root weight and sucrose percentage.

The evaluated eight sugar beet varieties namely; Florima, Gazelle, Tarbelli, Betamax, Sirona, Lilly, Hercule and Perikles were obtained from Sugar Crops Research Institute, Agricultural Research Center. The varieties were planted during the last week of October in both locations and seasons. Randomized Complete Block Design with three replications was used. The experimental area was divided into plots each of 42 m^2 (1/100 fed.), each plot consisted of 10 ridges of 60 cm apart and 7 m long and 20 cm spacing within hills. Agricultural practices as including hoeing, thinning, fertilizers, irrigation…etc were carried out as recommended for sugar beet in each location. No insecticide was used for controlling the beet fly throughout the period of the study. A list of varieties and their country of origin is presented in Table (1). Monthly data of temperature and relative humidity of locations are presented in Table (2).

Table 1: Origin and type of the tested sugar beet varieties

Sugar beet variety	Type of seeds	Origin	
		Company	Country
Florima	Multigerm	Desprez	France
Gazelle	Multigerm	Maribo	Denmark
Tarbelli	Multigerm	Semences	France
Betamax	Multigerm	Semences	France
Sirona	Multigerm	Desprez	France
Lilly	Multigerm	Maribo	Denmark
Hercule	Multigerm	Sesvauderhave	Netherland
Perikles	Multigerm	Schreibers	Germany

Table 2: Monthly temperature and relative humidity percentage

Month	Al-Fayoum				Ismailia			
	Temperature ºC			Relative	Temperature ºC			Relative
	Max.	Min.	Aver.	Humidity %	Max.	Min.	Aver.	Humidity %
2017/2018								
Dec.	22.94	13.32	19.13	50.81	21.84	14.29	18.87	54.8
Jan.	19.81	10.16	16.23	53.87	18.45	11.52	15.87	59.48
Feb.	24.39	14.46	20.96	38.57	22.29	14.46	19.57	50.04
Mar.	29.03	16.68	25.16	30.87	26.61	15.74	22.87	42.83
Apr.	30.27	18.80	27.37	30.07	26.97	17.43	24.30	47.10
2018/2019								
Dec.	20.19	12.48	17.32	55.84	19.84	13.29	17.45	58.10
Jan.	19.35	11.55	15.94	38.97	18.16	10.94	15.13	43.71
Feb.	21.39	13.29	18.11	41.32	19.64	12.39	16.64	50.32
Mar.	24.13	14.61	20.35	39.32	21.52	13.90	18.42	53.19
Apr.	28.77	18.63	24.90	32.77	25.50	16.43	21.93	46.20

Source: Central lab. for Agricultural Climate, Agric. Res. Center, Egypt

Sampling started after about two months from sowing and was carefully examined bi-weekly from December up to harvesting in the two locations and seasons. Sugar beets were visually examined and the beet fly was counted and recorded on 30 guarded plants (10 plants/replicate), which were randomly collected from each variety to determine the number of larvae, number of blotches, number of infested plants and leaf damage percentage.

At harvesting, ten plants were taken at random from each plot/variety to determine average root weight (g), sucrose%, which was polarimetrically determined in a lead acetate extract of fresh minced root according to the method of [14].

Statistical Analysis

Data were transformed by Arc-sin units before statistical analysis. Statistical analysis was computed for each experiment in each location using the technique of analysis of variance (ANOVA) as published by [15], using the MSTAT statistical computer software package (MSTAT-C). Treatment means were compared using LSD values at a 5% level of probability.

Result and Discussion

Locations effect on beet fly (*P. mixta*) infestation

Average over eight sugar beet varieties through their growing seasons Tables (3-6) and Figs (1 and 2) indicated various noticeable signs of *Pegomya mixta* Vill. infestation expressed as population density (Number of larvae), number of blotches, number of infested plants per 10 plants and infested leaf percentage were less in Ismailia area than those in Al-Fayoum area in both seasons. Further, the four infestation noticeable signs studies were much higher in the first seasons than those in the second seasons. Such an effect may be due to the higher temperature prevailing during beet growth under Al-Fayoum Governorate where it works may be more favourable for the proliferation of insect pests. In this connection, [16-20] stated that the timing attacks of insect pest vary widely from region to region and from year to year because the rates at which insects complete their life cycles rapidly increase population size are primarily determined by temperature.

The sensitivity of some sugar beet varieties to infestation by beet fly (*P. mixta*)

Data Tables (3-6) and Fig. (1) indicated that the four noticeable signs studied in this work significantly differed among the eight sugar beet varieties in both seasons and locations. Under Ismailia area, Tarbelli is the least resistant variety to beet fly infestation which exhibited the highest and most significant infestation signs by beet fly in both seasons. Otherwise, Florima variety had the lowest sensitivity to *P. mixta* with respect to population density (number of larvae) and No. of blotches, while, Gazella and Betamax varieties recorded the lowest susceptibility to beet fly with respect to No. of infested plants and infested leaf %, respectively in the first season. Nevertheless, the Sirona variety recorded the highest resistance to beet fly infestation with regard to all noticeable signs except infested leaf percentage in the second sseason.

egarding Al-Fayoum area, Lilly variety exhibited the highest sensitivity to beet fly infestation signs in both seasons except Betamax in the first season only. On the other hand, Hercule and Sirona varieties exhibited the lowest noticeable signs of infestation by *P. mixta* such as population density, No. of blotches, No. of infested plants and percentage of the infested leaf in both seasons. Such effect give evidence that both varieties characterized by high resistant to beet fly. The variation among beet varieties in their sensitivity to *P. mixta* infestation are may be genetic causes. The obtained findings are in agreement with those studied by numerous researchers and recently by [11, 13].

Table 3: Effect of sugar beet varieties on the population density of beet fly, *Pegomya mixta* Vill. in two locations through growing

Varieties	Florima	Gazelle	Tarbelli	Betamax	Sirona	Lilly	Hercule	Perikles	Mean	Florima	Gazelle	Tarbelli	Betamax	Sirona	Lilly	Hercule	Perikles	Mean
Examined Date			2017/2018 season					Ismailia location				2018/2019 season						
December 1	0.00	3.33	3.00	0.00	0.00	3.33	0.00	0.00	1.21	9.33	11.00	8.67	8.33	10.00	5.67	8.67	7.33	8.63
15	0.00	10.67	15.33	0.00	14.67	9.00	0.00	10.00	8.71	11.67	13.33	19.00	10.00	17.00	15.00	19.00	13.67	14.83
January 1	3.67	8.33	7.00	5.67	4.00	8.33	3.00	8.67	6.08	10.67	8.67	7.33	9.67	8.33	7.67	12.33	8.00	9.08
15	7.67	7.00	8.67	13.00	2.00	6.67	8.67	5.00	7.34	11.00	7.67	14.33	9.00	11.67	10.33	6.33	8.67	9.88
February 1	14.33	13.00	35.00	30.33	26.00	26.00	19.33	30.33	24.29	13.33	15.00	12.00	20.00	18.00	24.00	10.00	12.33	15.58
15	21.00	21.67	30.67	24.67	21.33	30.00	32.67	41.67	27.96	19.33	15.67	10.67	19.33	15.33	19.33	15.00	16.00	16.33
March 1	25.33	19.33	32.00	34.00	35.00	27.33	40.00	38.00	31.37	16.00	18.33	24.00	16.00	20.00	12.00	21.67	12.00	17.50
15	28.00	44.00	46.00	31.00	42.00	33.00	27.67	21.67	34.17	22.00	24.67	27.00	22.67	12.67	27.33	29.00	20.00	23.17
April 1	18.00	31.00	24.00	20.33	28.33	20.67	18.33	33.33	24.25	17.00	22.00	18.33	13.33	16.00	18.00	20.67	19.33	18.08
15	15.67	12.00	16.33	17.00	17.67	16.00	15.00	19.67	16.17	5.67	14.33	21.67	19.67	0.00	15.33	15.33	12.67	13.08
Mean	14.37	17.03	21.80	17.60	19.10	18.03	16.47	20.83	18.15	13.60	15.07	16.30	14.80	12.90	15.47	15.80	13.00	14.62
								Al- Fayoum location										
December 4	9.00	0.00	7.67	0.00	0.00	13.33	0.00	6.67	4.58	0.00	0.00	4.67	0.00	0.00	11.00	0.00	0.00	1.96
18	12.67	0.00	10.00	15.67	0.00	14.00	13.00	11.33	9.58	0.00	14.67	12.00	11.33	0.00	15.33	0.00	10.67	8.00
January 4	3.67	7.33	4.33	10.67	5.67	12.00	8.33	9.00	7.63	9.33	10.00	9.33	8.33	5.67	7.67	10.00	8.00	8.54
18	6.33	13.00	6.00	12.33	8.33	9.67	7.67	7.67	8.88	11.67	11.33	11.00	5.67	6.00	10.00	7.00	6.33	8.63
February 4	22.00	32.67	12.33	28.00	19.00	26.67	22.00	25.00	23.46	22.00	25.33	22.67	19.00	27.33	24.00	21.33	20.00	22.71
18	29.33	27.33	19.67	34.33	28.67	33.67	13.67	32.00	27.33	28.67	34.00	31.00	28.33	19.67	20.67	29.00	28.33	27.46
March 4	25.00	38.00	31.00	30.67	40.00	29.33	24.33	29.33	30.96	27.00	28.67	28.33	24.67	17.00	29.33	35.00	24.00	26.75
18	23.67	34.67	27.00	40.00	36.33	35.33	32.00	22.67	31.46	33.33	25.00	23.67	22.00	30.33	32.00	31.67	21.67	27.46
April 4	37.00	42.67	41.33	45.33	31.67	40.00	28.67	37.00	37.96	28.00	34.00	36.33	31.00	26.00	43.00	28.33	30.67	32.17
18	29.33	36.00	30.67	36.67	37.00	34.33	24.00	31.33	32.42	25.00	27.67	30.00	20.67	34.67	31.00	32.00	26.33	28.42
Mean	19.80	23.17	19.00	25.37	20.67	24.83	17.37	21.20	21.43	18.50	21.07	20.90	17.10	16.67	22.43	19.43	17.60	19.21

LSD 0.05	Ismailia	Al-Fayoum	Ismailia	Al-Fayoum
Varieties (V)	0.15**	0.13**	0.12**	0.12**
Examination Date (D)	0.17**	0.15**	0.13**	0.14**
V X D	0.49**	0.41**	0.36**	0.39**

Table 4: Effect of sugar beet varieties on number of blotches/ 10 plants of beet fly, *Pegomya mixta* Vill. in two locations through growing seasons

Varieties	Florima	Gazelle	Tarbelli	Betamax	Sirona	Lilly	Hercule	Perikles	Mean	Florima	Gazelle	Tarbelli	Betamax	Sirona	Lilly	Hercule	Perikles	Mean
Examined Date			2017/2018 season					Ismailia location				2018/2019 season						
December 1	0.00	2.00	2.00	0.00	0.00	2.00	0.00	0.00	0.75	5.33	3.67	5.00	6.33	8.67	2.67	4.00	5.33	5.12
15	5.33	5.67	8.33	0.00	5.00	8.67	0.00	5.00	4.75	7.00	8.33	10.33	9.00	9.33	5.33	5.67	6.67	7.71
January 1	1.33	2.00	3.67	2.33	2.00	6.33	1.33	3.00	2.75	4.33	3.00	8.33	4.67	2.00	3.33	2.33	3.67	3.96
15	4.00	3.33	3.33	7.00	1.00	4.00	5.33	2.00	3.75	3.67	4.67	3.67	3.33	6.00	5.00	2.00	3.00	3.92
February 1	5.00	8.67	15.00	11.67	19.00	17.00	9.00	17.00	12.79	6.00	7.00	5.67	5.00	8.33	9.67	8.33	5.33	6.92
15	12.33	17.67	20.00	16.00	12.00	20.67	18.67	22.67	17.50	9.33	9.33	13.00	8.67	9.00	16.33	9.67	12.00	10.92
March 1	10.67	17.00	12.67	12.33	11.00	15.00	26.67	21.00	15.79	7.67	8.67	11.33	8.00	2.67	5.67	12.00	5.67	7.71
15	14.00	10.33	30.00	22.00	21.00	20.33	15.00	12.33	18.12	11.67	13.00	19.67	9.33	5.00	18.00	17.33	8.67	12.83
April 1	10.00	6.00	16.00	18.00	19.00	10.00	12.00	18.00	13.63	5.00	6.33	10.00	8.67	2.67	11.33	4.67	6.00	6.83
15	8.67	4.00	8.00	8.67	10.00	8.00	9.33	13.33	8.75	3.67	5.00	7.33	9.33	0.00	6.67	10.00	3.67	5.71
Mean	7.13	7.66	11.90	9.80	10.00	11.20	9.73	11.43	9.86	6.37	6.90	9.43	7.23	5.37	8.40	7.60	6.00	7.16
								Al-Fayoum location										
December 4	3.67	0.00	5.67	0.00	0.00	9.33	0.00	3.00	2.71	0.00	0.00	2.33	0.00	0.00	4.00	0.00	0.00	0.79

18	6.00	0.00	8.33	10.67	0.00	11.67	3.33	5.67	5.71	0.00	8.33	7.00	5.33	0.00	6.67	0.00	4.00	3.92
January 4	3.00	4.67	2.00	8.00	3.67	9.00	4.67	4.33	4.92	3.33	6.33	4.67	6.00	2.33	2.67	5.00	2.33	4.08
18	3.00	5.33	3.33	9.33	6.00	6.33	5.00	2.00	5.04	5.67	7.00	3.33	4.33	3.67	4.00	3.67	2.00	4.21
February 4	14.67	20.00	9.67	13.33	12.33	12.00	10.33	15.33	13.46	14.00	16.67	13.00	9.67	12.00	18.67	17.33	8.00	13.67
18	18.33	14.67	8.00	18.67	19.67	17.67	4.33	24.33	15.71	15.33	22.33	16.33	12.33	9.33	16.33	15.00	10.67	14.71
March 4	12.33	16.33	15.00	15.00	22.00	22.33	8.67	19.67	16.42	12.67	16.00	20.67	11.00	7.33	13.00	20.33	10.33	13.92
18	10.67	19.00	13.33	28.67	21.67	29.00	17.00	14.00	19.17	17.00	11.00	15.00	9.67	15.67	19.67	14.00	13.00	14.38
April 4	15.00	13.67	21.67	22.33	15.67	21.67	14.00	26.67	18.84	15.00	18.67	20.67	14.33	11.33	21.33	16.67	12.33	16.29
18	11.67	12.00	17.00	16.00	17.33	15.33	13.33	21.00	15.46	13.67	9.33	17.67	11.67	8.00	23.00	11.33	8.00	12.83
Mean	9.83	10.57	10.40	14.20	11.83	15.43	8.07	13.60	11.74	9.67	11.57	12.07	8.43	6.97	12.93	10.33	7.07	9.88

LSD 0.05	Ismailia	Al-Fayoum	Ismailia	Al-Fayoum
Varieties (V)	0.15**	0.14**	0.17**	0.15**
Examination Date (D)	0.17**	0.16**	0.19**	0.17**
V X D	0.49**	0.46**	0.53**	0.47**

Table 5: Effect of sugar beet varieties on number of infested plants/ 10 plants of beet fly, *Pegomya mixta* Vill. in two locations through growing seasons

Varieties	**Florima**	**Gazelle**	**Tarbelli**	**Betamax**	**Sirona**	**Lilly**	**Hercule**	**Perikles**	**Mean**	**Florima**	**Gazelle**	**Tarbelli**	**Betamax**	**Sirona**	**Lilly**	**Hercule**	**Perikles**	**Mean**
Examined Date			2017/2018 season					Ismailia location				2018/2019 season						
December 1	0.00	1.33	1.67	0.00	0.00	1.00	0.00	0.00	0.50	4.33	1.00	2.33	3.67	4.00	2.00	2.67	6.00	3.25
15	5.00	4.67	5.00	0.00	2.67	5.67	0.00	3.33	3.29	6.00	3.00	6.00	4.33	4.67	3.67	4.00	4.67	4.54
January 1	1.33	3.33	2.67	2.00	1.00	4.00	1.00	2.00	2.17	5.00	1.67	4.67	3.00	1.67	1.67	2.00	3.67	2.92
15	2.67	2.00	3.00	4.67	1.00	2.33	3.33	1.00	2.50	2.67	1.00	2.00	3.33	4.00	3.00	1.00	3.00	2.50
February 1	4.00	7.33	8.67	7.33	9.00	9.00	5.67	8.67	7.46	3.67	4.67	5.33	2.67	6.33	7.33	7.00	3.33	5.04
15	7.67	6.33	10.00	10.00	8.33	10.00	8.33	7.00	8.46	5.00	7.00	4.00	6.00	5.00	6.00	5.33	3.67	5.25
March 1	5.67	5.67	10.00	9.00	6.67	7.33	10.00	10.00	8.04	6.00	6.33	9.33	5.67	2.33	4.33	9.00	4.33	5.92
15	9.00	9.67	9.00	6.67	10.00	10.00	9.00	8.33	8.96	7.67	9.00	9.00	7.00	4.33	10.00	9.33	6.33	7.83
April 1	7.67	2.67	3.33	8.00	8.00	8.00	3.67	9.00	6.29	4.00	5.33	5.67	3.67	2.00	6.67	4.00	4.00	4.42
15	5.00	3.33	6.33	4.33	8.00	6.00	6.67	8.00	5.96	2.00	2.00	3.67	3.00	0.00	4.33	5.00	1.67	2.71
Mean	4.80	4.63	5.97	5.20	5.47	6.33	4.77	5.73	5.36	4.63	4.10	5.20	4.23	3.43	4.90	4.93	4.07	4.44
								Al-Fayoum location										
December 4	2.67	0.00	3.67	0.00	0.00	7.67	0.00	2.33	2.04	0.00	0.00	1.67	0.00	0.00	2.33	0.00	0.00	0.50
18	4.00	0.00	6.00	8.67	0.00	9.00	2.67	4.33	4.33	0.00	7.67	5.33	4.00	0.00	5.00	0.00	2.33	3.04
January 4	2.33	3.67	1.33	6.67	3.00	6.33	4.00	3.00	3.79	2.67	5.33	3.00	3.67	1.67	2.67	4.00	1.33	3.04
18	1.67	4.00	2.00	8.33	5.67	5.67	3.67	2.00	4.13	5.00	4.00	2.67	4.00	2.00	3.33	2.33	1.67	3.13
February 4	6.00	10.00	7.33	8.67	8.33	8.67	5.00	8.33	7.79	6.67	7.67	4.33	5.00	6.00	8.33	7.00	4.67	6.21
18	8.67	8.67	5.67	6.00	9.67	9.33	2.67	10.00	7.59	6.00	9.33	6.00	7.00	4.67	6.67	8.33	5.00	6.63
March 4	5.33	7.33	8.00	7.67	10.00	8.00	6.00	8.67	7.63	7.33	8.00	9.00	7.67	5.33	7.33	10.00	6.33	7.62
18	6.67	9.67	6.00	10.00	9.67	10.00	8.33	7.33	8.46	9.00	5.67	7.67	6.00	8.00	8.00	6.33	9.33	7.50
April 4	7.33	8.00	9.33	8.67	8.00	9.67	9.00	9.67	8.71	6.33	7.33	8.00	9.00	8.67	7.67	7.67	7.00	7.71
18	5.67	7.00	8.33	7.33	7.67	7.00	6.33	8.33	7.21	5.33	4.00	8.67	7.67	6.00	8.67	6.00	5.67	6.50
Mean	5.03	5.83	5.77	7.20	6.20	8.13	4.77	6.40	6.17	4.83	5.90	5.63	5.40	4.23	6.00	5.17	4.33	5.19

LSD 0.05	Ismailia	Al-Fayoum	Ismailia	Al-Fayoum
Varieties (V)	0.13**	0.12**	0.16**	0.12**
Examination Date (D)	0.14**	0.13**	0.18**	0.14**
V X D	0.40**	0.36**	0.50**	0.39**

Table (6): Effect of sugar beet varieties on infested leaf % of beet fly, *Pegomya mixta* Vill. in two locations through growing seasons

Varieties	Florima	Gazelle	Tarbelli	Betamax	Sirona	Lilly	Hercule	Perikles	Mean	Florima	Gazelle	Tarbelli	Betamax	Sirona	Lilly	Hercule	Perikles	Mean
Examined Date			2017/2018 season					Ismailia location				2018/2019 season						
December 1	0.00	2.73	4.97	0.00	0.00	3.54	0.00	0.00	1.41	4.19	3.88	4.62	2.42	2.90	4.14	3.71	4.16	3.75
15	5.13	6.23	6.17	0.00	5.85	6.30	0.00	5.58	4.41	4.48	4.15	6.28	3.05	5.00	5.79	4.53	5.12	4.80
January 1	4.44	5.70	5.20	4.20	4.73	4.69	5.03	5.06	4.88	3.05	4.74	5.15	2.43	2.61	3.91	4.02	4.46	3.80
15	4.27	4.99	5.52	4.68	2.83	5.92	4.74	4.70	4.71	4.24	4.69	6.64	3.18	4.93	5.33	3.11	5.02	4.64
February 1	6.18	6.07	6.66	4.40	6.17	6.68	5.91	6.64	6.09	5.35	4.96	7.82	3.45	3.62	5.93	4.77	4.36	5.03
15	6.23	6.55	7.43	6.25	7.82	7.06	5.85	7.87	6.88	4.31	5.60	5.11	3.10	5.27	6.38	4.42	5.91	5.01
March 1	7.37	7.60	6.71	5.84	6.52	6.48	6.52	7.32	6.80	6.43	4.74	7.15	4.37	7.17	4.33	5.82	7.53	5.82
15	6.61	6.00	8.15	7.08	7.78	7.20	7.26	9.06	7.39	5.14	5.04	6.88	5.29	6.91	5.98	6.17	4.66	5.65
April 1	5.71	5.72	7.58	5.27	6.83	6.39	7.98	7.03	6.56	4.12	4.51	6.71	4.41	4.00	5.56	4.63	4.35	4.60
15	4.72	4.39	5.26	5.00	5.07	5.08	5.67	6.19	5.17	3.22	3.45	4.95	2.75	0.00	4.31	3.19	3.44	3.59
Mean	5.07	5.60	6.37	4.27	5.36	5.93	4.90	5.95	5.43	4.45	4.58	6.13	3.45	4.24	5.17	4.44	4.90	4.67
								Al-Fayoum location										
December 4	5.15	0.00	5.29	0.00	0.00	5.31	0.00	5.78	2.69	0.00	0.00	5.16	0.00	0.00	5.58	0.00	0.00	1.34
18	6.31	0.00	6.00	9.76	0.00	7.54	4.34	7.04	5.12	0.00	4.21	6.42	4.28	0.00	5.84	0.00	4.15	3.11
January 4	3.58	7.58	3.52	7.42	5.78	4.42	4.71	5.32	5.29	4.72	3.96	5.10	3.33	5.28	4.23	5.79	3.77	4.52
18	4.04	8.03	4.77	7.87	5.87	4.13	5.51	4.65	5.61	4.97	6.01	4.29	4.00	4.59	4.71	4.67	2.93	4.52
February 4	6.40	9.63	7.69	8.65	8.73	9.61	5.97	8.46	8.14	6.15	6.74	6.08	6.95	5.96	7.39	7.15	5.61	6.50
18	7.77	7.10	5.23	7.98	9.62	10.28	3.89	9.80	7.71	7.64	8.55	6.38	7.17	4.74	6.80	6.47	6.66	6.80
March 4	7.02	5.51	7.04	9.80	10.32	8.90	6.15	7.63	7.80	5.79	5.83	8.13	5.64	4.48	5.95	7.90	5.97	6.21
18	5.49	8.72	4.36	10.93	9.80	11.19	6.58	6.87	7.99	8.31	6.42	7.27	4.72	6.91	8.96	6.67	6.13	6.92
April 4	6.08	7.54	7.93	9.41	7.61	10.47	6.26	9.13	8.05	7.46	7.49	8.02	7.44	5.65	9.88	7.64	4.40	7.25
18	4.35	6.55	6.10	7.13	6.90	9.82	5.52	7.68	6.76	5.20	5.68	6.86	5.26	4.80	9.81	5.88	4.31	5.98
Mean	5.62	6.07	5.79	7.90	6.46	8.17	4.89	7.24	6.52	5.02	5.49	6.37	4.88	4.24	6.92	5.21	4.39	5.32

LSD 0.05	Ismailia	Al-Fayoum	Ismailia	Al-Fayoum
Varieties (V)	0.01**	0.02**	0.02**	0.02**
Examination Date (D)	0.01**	0.02**	0.02**	0.02**
V X D	0.02**	0.06**	0.07**	0.07**

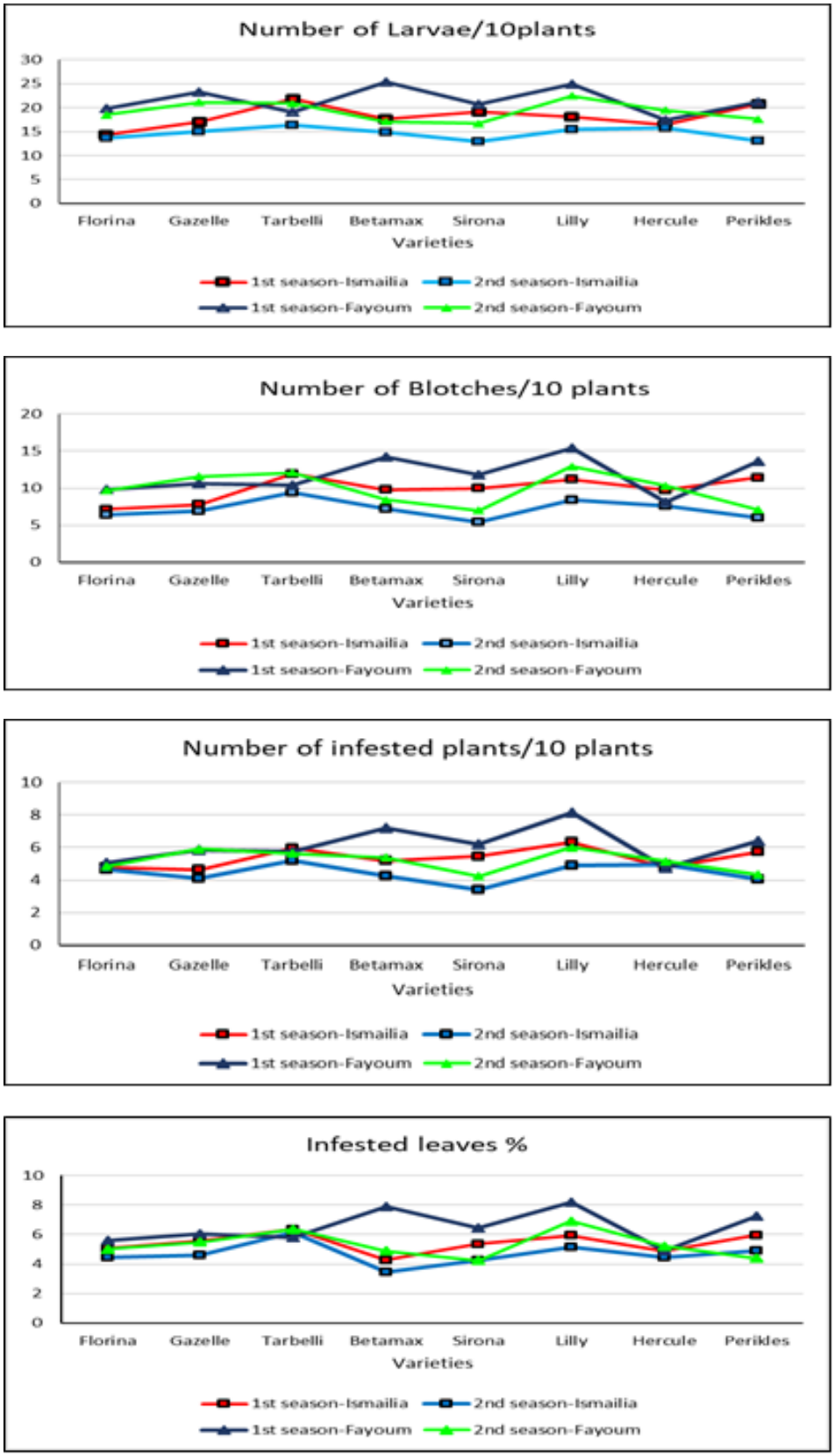


Fig 1: Effects of *Pegomya mixta* infestation on eight sugar beet varieties in Ismailia and Al-Fayoum locations during the 2017/2018 and 2018/2019 seasons

Seasonal fluctuation of beet fly (*P. mixta*)

The obtained data (Tables 3-6) and Fig. (2) illustrated that the beginning time of beet fly infestation differed significantly among the used varieties. Various noticeable signs of the infestations *i.e.* population density, No. of blotches, No. of infested plants and infested leaf percentage for some varieties were free from infestation till Dececember 15 and 18 in both seasons and locations except the second season in Ismailia area, where, all the used varieties were infested early on Dececember 1. Generally, data (Tables 3-6) clarified that the beginning time of beet fly was in January at both seasons and locations.

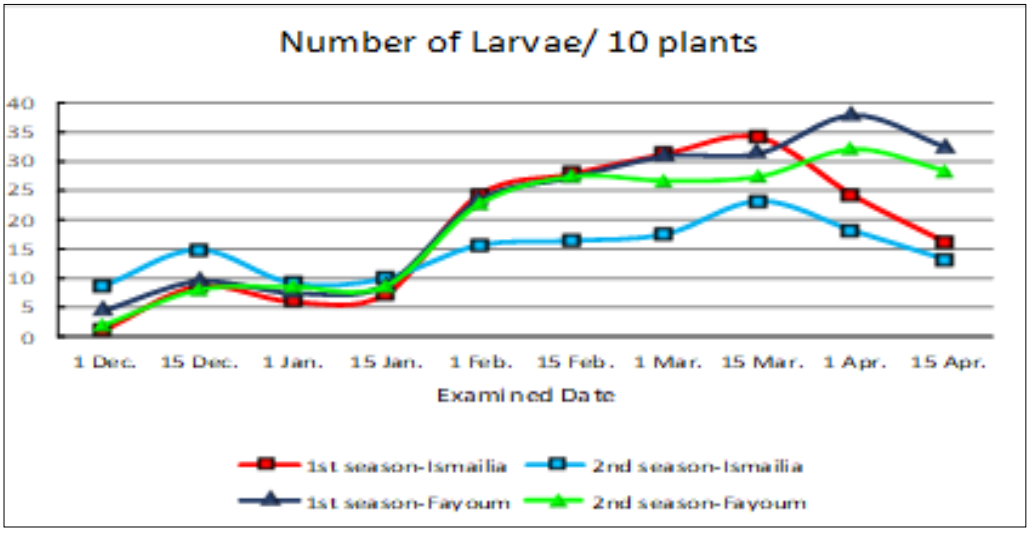
Data also mention that the number of peaks of noticeable signs of beet fly infestation varied among the used eight

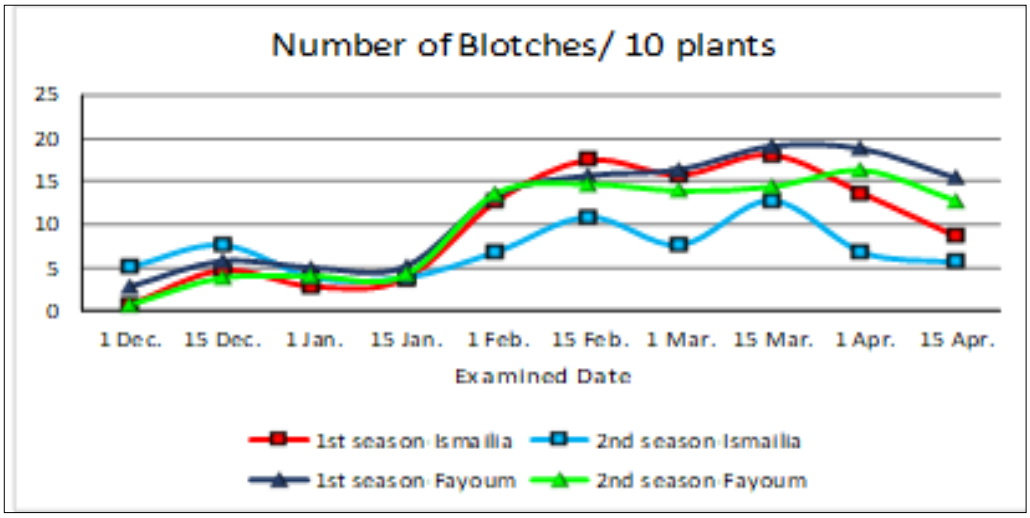
varieties in both seasons and locations (Table 3-6). In each season and location, the number of peaks ranging from one to four peaks was recorded for all varieties but most varieties showed three peaks. On the other hand, data also cleared that the infestation for the noticeable signs were increased gradually to reach the maximum on March 15 in Ismailia, area in both seasons and till April 4 in Al-Fayoum area in both seasons, also, thereafter gradually decreased for all infestation parameters until the end of the inspection dates (April 15 and 18) in two locations.

The interaction between the used varieties and inspection dates had a significant effect on the four infestation parameters cleared that the beginning of infestation was in Dececember and January in both seasons and locations and increased to reach its maximum in March in Ismailia area and in April in Al-Fayoum area as aforementioned. Such effect gives evidence to start controlling this insect in beet fields during March and April to prevent or reduce injury to a minimum and at the same time reduce crop damage (root yield and sugar content).

A similar study was conducted by [8] who demonstrated that beet fly larvae were observed on sugar beet plants in December and then increased progressively until reached their peak in March. According to [10], the population of *P. mixta* gradually increased until it reached its highest density in March and April. El-Khouly [21] showed that earlier beet fly infestation begins in November, with a steady increase towards the end of the season, generating distinct peaks in March and April.

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 at Kafr El-Sheikh Governorate [22]. Mohisen [23] stated that beet fly, *P. mixta* assaulted sugar beet fields from November to late February, and their greatest abundance in the spring, from March to May. Sherief [24] showed that the sugar beet fly *P. mixta* first appear in the plants on the first week of December, this insect was also discovered in high numbers in late February, late March, late April and late May. Three peaks were detected in late December, early February and mid-March in the first season, while, these three peaks were again documented in the second season in mid-December, late January and mid-March [19].





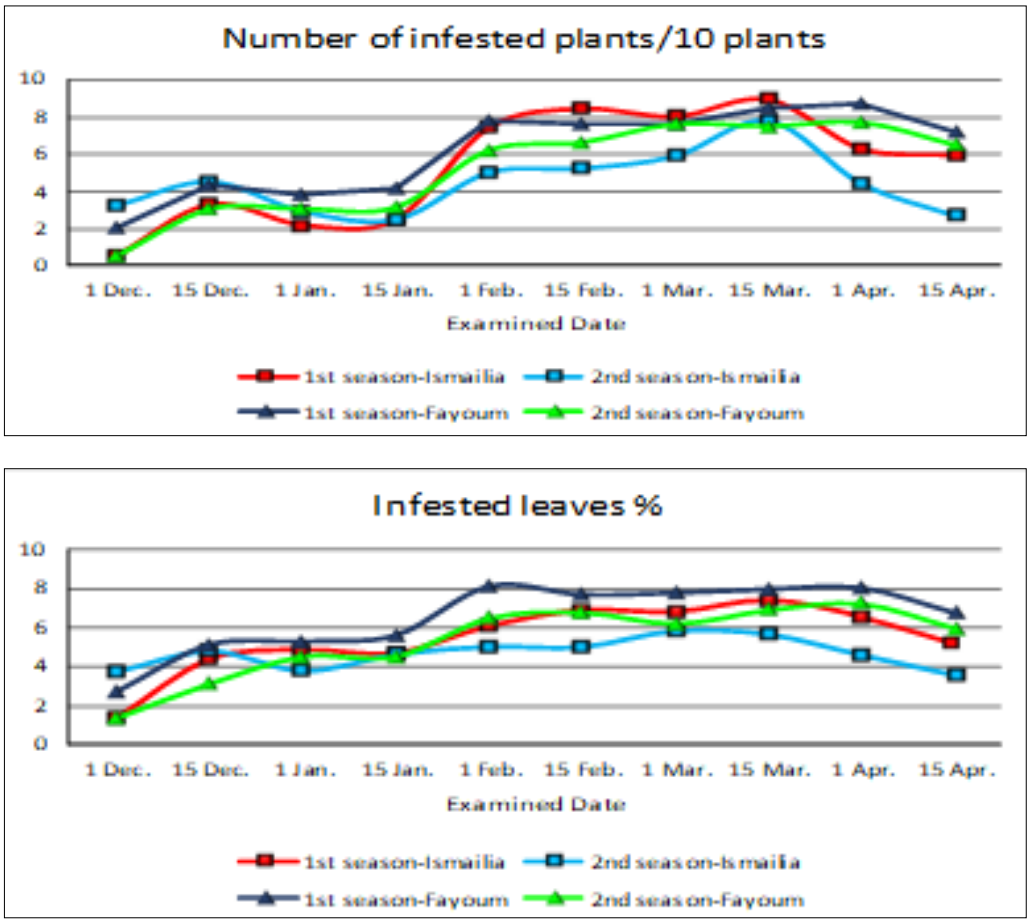


Fig 2: Seasonal fluctuation of *Pegomya mixta* infesting sugar beet plants in Ismailia and Al-Fayoum locations during the 2017/2018 and 2018/2019 seasons

Coexistence percentages of population density of beet fly, *Pegomya mixta*

The relationship between the preference of pests to attack a particular plant and the amount of injuries caused by the other plants is known as coexistence. Therefore, data Table (7) illustrated that Tarbelli variety gave the highest coexistence of beet fly during the two growing seasons under Ismailia area, meantime, the same trend has been recorded for Lilly variety underAl-Fayoum area. Otherwise, the lowest coexistence under Ismailia were Florima and Sirona varieties in the first and second seasons, respectively, while, Hercule and Perikles varieties were under Al-Fayoum area in both seasons.

Although, from these findings, it seems that consistent and obvious relationship between the coexistence of beet fly insect and the used varieties and may be there is no optional for the studies insect to attack any variety.

Table 7: Coexistence percentages of population density of beet fly, *Pegomya mixta* under two locations

Variety		Florima	Gazelle	Tarbelli	Betamax	Sirona	Lilly	Hercule	Perikles	Total
Seasons	Parameter				Ismailia location					
2017/2018	Av. No. of *P. mixta*	14.37	17.03	21.80	17.60	19.10	18.03	16.47	20.83	145.23
	% Coexistence	9.90	11.73	15.01	12.12	13.15	12.42	11.34	14.34	100
2018/2019	Av. No. of *P. mixta*	13.60	15.07	16.30	14.80	12.90	15.47	15.80	13.00	116.94
	% Coexistence	11.63	12.89	13.94	12.67	11.03	13.23	13.51	11.12	100
					Al-Fayoum location					
2017/2018	Av. No. of *P. mixta*	19.80	23.17	19.00	25.37	20.67	24.83	17.37	21.20	171.41
	% Coexistence	11.55	13.52	11.09	14.80	12.06	14.49	10.13	12.37	100
2018/2019	Av. No. of *P. mixta*	18.50	21.07	20.90	17.10	16.67	22.43	19.43	17.60	153.70
	% Coexistence	12.04	13.71	13.60	11.13	10.85	14.59	12.64	11.45	100

Effect of *P. mixta* infestation on average root weight and sucrose content

In general average root weight and sucrose content, data cleared that average over varieties and examination dates demonstrated that Ismailia area was less infested by beet fly, *P. mixta* as compared to Al-Fayoum area in both seasons (Tables 3-6)

Data of average root weight and sucrose content of eight sugar beet varieties (healthy and infested plants by beet fly *P. mixta*) grown in two seasons *i.e.* 2017/2018 and 2018/2019 and under two locations *i.e.* Ismailia and Al-Fayoum Governorates. Worth to mention that healthy and infested average root weight and sucrose content were higher in Ismailia compared to those in Al-Fayoum area (Table 8).

Table 8: Effect of *Pegomya mixta* Vill. infestation on average root weight and sucrose% of eight sugar beet varieties under two locations

Varieties	2017/2018 season						2018/2019 season					
	Average root weight (g) B			Sucrose % B			Average root weight (g) B			Sucrose % B		
	Healthy Plants	Infested Plants	Reduction (%)	Healthy Plants	Infested Plants	Reduction (%)	Healthy Plants	Infested Plants	Reduction (%)	Healthy Plants	Infested Plants	Reduction (%)
	Ismailia location											
Florima	1237	1221	1.29	18.74	18.33	2.19	1201	1184	1.42	18.76	18.33	2.29
Gazella	997	983	1.40	18.56	18.14	2.26	1003	983	1.99	18.71	18.29	2.25
Tarbelli	851	824	3.17	1 6.93	15.86	6.32	885	861	2.71	17.84	17.27	3.20
Betamax	982	969	1.32	17.89	17.19	3.91	1018	1007	1.08	18.45	17.93	2.82
Sirona	899	878	2.34	17.81	17.10	3.99	1257	1242	1.19	18.98	18.56	2.21
Lilly	957	939	1.88	17.15	16.33	4.78	997	972	2.51	18.13	17.63	2.76
Hercule	1199	1184	1.25	18.54	17.83	3.83	989	967	2.23	18.09	17.56	2.93
Perikles	915	903	1.31	17.56	16.50	6.04	1215	1202	1.07	18.81	18.39	2.23
Mean	1004.63	987.63	1.75	17.90	17.16	4.17	1070.63	1052.25	1.75	18.47	18.00	2.59
	Al-Fayoum location											
Florima	959	931	2.92	18.17	17.74	2.37	976	914	6.35	18.05	17.66	2.16
Gazella	935	904	3.32	17.93	17.20	4.07	935	902	3.53	17.89	17.18	3.97
Tarbelli	975	953	2.26	17.95	17.21	4.12	997	962	3.51	17.53	16.92	3.48
Betamax	915	884	3.39	16.85	15.76	6.47	1017	982	3.44	18.33	17.95	2.07
Sirona	991	968	2.32	17.78	17.03	4.22	1053	1024	2.75	18.46	18.10	1.95
Lilly	889	857	3.60	16.49	15.38	6.73	989	925	6.47	16.71	15.88	4.97
Hercule	1034	1014	1.93	18.24	17.71	2.91	915	864	5.57	17.69	17.02	3.79
Perikles	956	929	2.82	18.05	17.56	2.72	1005	966	3.88	18.35	18.00	1.91
Mean	956.75	930.00	2.82	17.68	16.70	4.20	985.88	942.38	4.44	17.88	17.34	3.04

LSD 0.05	Ismailia	Al-Fayoum	Ismailia	Al-Fayoum	Ismailia	Al-Fayoum	Ismailia	Al-Fayoum
Variety (A)	18.82	10.55	0.17	0.11	17.52	18.53	0.11	0.12
B	7.66	9.65	0.07	0.07	5.21	9.42	0.08	0.09
AB	NS	NS	0.21	0.21	NS	NS	NS	NS

Data Table (8) also cleared that the percent of the reduction in average root weight and sucrose content resulting from infested plants by beet fly as compared to the healthy plants using t-test between pairs values in both seasons. In Ismailia area the mentioned reduction was significantly less than Al-Fayoum area in both seasons, meantime, the highest reduction for average root weight and sucrose% were of Tarbelli and Lilly varieties in Ismailia and Al-Fayoum Governorates, respectively. However, the lowest reduction in Ismailia and Al-Fayoum
area for average root weight was for Hercule variety in the first season, whereas, Perikles and Sirona varieties in the second season recorded the lowest reduction due to the infestation by beet fly, meantime, Florima variety in the first season recorded the lowest reduction in sucrose content in both locations, however, Sirona and Perikles varieties gave the lowest sucrose reduction in the second season in both locations. The rest varieties were a relatively less affect by beet fly f both studied traits (Table 8). In this connection, the highest and lowest reduction in both studied traits was compatible with those insect infestation parameters previously discussed. The aforementioned data are in agreement with those obtained by [25, 26] who showed that the relationship between the yield of sugar beet and the infestation of sugar beet fly, *P.mixta* was negative, which is means that an increase in larvae numbers caused a decrease in roots yield and vice-versa.

Conclusion

The obtained findings in this study mentioned the importance of screening beet varieties which have some resistance to pest infestation and are considered as one of the substantial features of integrated pest management (IPM), however, results referred to some varieties have the lowest reduction in both average root weight and sucrose content due to infestation by beet fly, meantime, both traits
are as the main component of ultimate root and sugar yields, while, some varieties have vice versa behavour.

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