Egyptian Sugar Journal (2024), 23: 45 - 56
https://doi.org/ 10.21608/esugj.2025.342215.1073

RESEARCH ARTICLE

# Population activity of the endemic insect pests and its effect on the susceptibility of some sugar beet cultivars

**Alyaa E. Mohamed[1], Mohamed A.I. Ahamed[2], Salah Fatouh Abou-Elwafa[3] Tarek M. Abo-Elmaged[2]**

Received: 6 December 2024\ Revised: 6 January 2025\ Accepted: 15 January 2025\ Published online: 20 January 2025

## Abstract

Population activity of the main insect pests inhabiting sugar beet plants in Assiut Governorate was studied during two successive seasons of 2021/2022 and 2022/2023 at the Farm of the Faculty of Agriculture at Assiut University.

The results show that the sugar beet plants were harbored by three main insect species, i.e., Pegomya mixta Vill., Spodoptera littoralis (Boisduval) and Gryllotalpa gryllotalpa (Linnaeus).

Results revealed that the highest infestation levels of these insect pests occurred during December and January in both seasons.

The results also showed that the activity of the sugar beet fly, Pegomya mixta increased in the Salama and Oscarpoly cultivars during the two seasons.

By studying the major weather factors, temperature and relative humidity on the population activity of the major pests on sugar beet plants.

Results showed that the population densities of sugar beet fly, Pegomya mixta were relatively higher during the first season than the second one, and it has a higher density than Spodoptera littoralis and Gryllotalpa gryllotalpa in Salama and Oscarpoly cultivars in both seasons.

From the current study, we can conclude that Salama and Oscarpoly sugar beet cultivars were sensitive to the infestation with the sugar beet fly, Pegomya mixta, but the sensitivity varies from one cultivar to another.

**Keywords:** Beta vulgaris; Assiut governorate; Population activity; Crop sensitivity

[1]Science and Technology of the Sugar Industry Department, Faculty of Sugar and Integrated Industries Technology, Assiut University
[2]Department of Plant Protection, Faculty of Agriculture, Assiut University
[3]Department of Agronomy, Faculty of Agriculture, Assiut University

***Corresponding**:al.eltawel@gmail.com; tarek.adam@agr.aun.edu.eg

## Introduction

In the light of global warming and climate change, enhancing agricultural production without implying adverse environmental impacts has become an increasingly important issue (Al-Dhumri et al. 2023).

Intensive agricultural production that necessitates extensive application of fertilization and pesticides has substantial adverse effects on the environment, soil and human health (Schmidt Rivera et al. 2017).

Therefore, it is expected that the environmental effects on non-agricultural ecosystems will also continue to increase in response to increasing agricultural production (Spiertz 2010).

Sugar beet (Beta vulgaris L.) is an important crop for sugar production in Egypt and the world. It is considered one of the two main sugar crops in Upper Egypt (Alotaibi et al. 2023; Ahmed et al. 2023).

Sugar beet is the most important sugar crop that can be grown commercially in a wide variety of temperate regions (Galal et al. 2022a).

Recently, extensive efforts have been made to cultivate and adapt sugar beet in the tropical and subtropical countries such as Egypt (Galal et al. 2022b; Abou-Elwafa et al. 2020).

The sugar beet cultivated area in Egypt reached 550,000 feddan, producing about 12.8 million Mt of sugar beets with an average sucrose content of about 18% (www.fao.org 2023).

In the Egyptian ecosystem, sugar beet plants are attacked by many insect pests during their different growth stages (Abo-Aiana 1991; Amin et al. 2008; El-Dessouki et al. 2014; Arun Baitha et al. 2022).

The main insect pests of sugar beet are Pegomya mixta Villeneuve. (a synonym for P. cunicularia (Rondani), Cassida vittata Villers, Scrobipalpa ocellatella (Boyd), Ostrinia nubilalis (Hübner), Spodoptera littoralis (Boisd.) and Spodoptera exigua (Hübner) (Talha 2001; Shalaby et al. 2010; Khalifa 2017).

Sugar beet is cultivated in Upper Egypt, in three transplantations: August, September and October.
The early transplantation may suffer serious infestation by the cotton leafworm, S. littoralis and Agrotis ipsilon (Hufnagel) while the late one is subject to high infestations with C. vittata and S. ocellatella (Bazazo 2010; Al-Habshy 2018; Mohamed et al. 2019; Ekin and Çoruh 2022).

The sugar beet fly, Pegomya mixta is one of the most serious pests attacking sugar beet all over the world (Konig 1985; Sato et al. 1995; Abdel-Moniem et al. 2014; El-Fouly et al. 2024).

The pest is considered one of the serious insects attacking sugar beet in Egypt. The highest infestation was recorded in Fayoum, Kafr El-Sheikh, Dakahlia and Gharbia whereas the low infestation was observed in Upper Egypt (Ali et al. 1993; Mansour et al. 2021).

The present work was carried out to study the effect of sowing dates on the population density of insects on sugar beet cultivars and the susceptibility degree of sugar beet cultivars to pest infestation under field conditions in Assiut governorate.

## Materials and methods

## Field experiment

The current study was carried out at the Experimental Farm of the Faculty of Agriculture, Assiut University during two consecutive seasons in Assiut Governorate (2021/2022 and 2022/2023).

In each experiment, an area of about a quarter of feddan (1050 m2) was chosen and divided into plots (each ca. 3,0 x 3.5 m) Each experiment was set up in a factorial design, with two factors, sugar beet cultivars and planting dates.

Each treatment was replicated 4 times. Two sugar beet varieties were tested (Salama and Oscarpoly) and cultivated on two transplanting dates during the winter season. All the recommended agricultural practices were normally performed, and no chemical treatments were used during the study periods.

After three weeks of transplanting, weekly samples of 5 leaves/plot of each variety and using direct count. Pitfall traps were used and placed in the center of each plot. The trap was prepared by embedding a – wide-mouth ½ liter size glass jar in the soil and the top of the jars were even with the soil surface.

The jars were partially filled with crude commercial alcohol over which a thin layer of kerosene was poured to prevent evaporation, and 10 jars were used weekly (Khalil et al. 1975).

**Planting dates and calculating cultivars susceptibility**

In each season, the sugar beet was planted on planting dates, (winter transplantation). In winter transplantations, the seeds were sown in October 2021 and 2022. The collection of samples was carried out every week until the end of the growing season. Samples were collected on each sampling date, ideally from the same plot but never from the same plant. At every inspection date the steps of the direct count method are to count and record the number of species and individuals of each species in each sample.

In the second experiment, the degree of susceptibility of the two sugar beets cultivars (Oscarpoly and Salama) was investigated to their main insect pests.

Samples were taken by direct count method as previously mentioned. Numbers of P. mixta, S. littoralis and G. gryllotalpa were counted. Classification of the susceptibility degree of sugar beet cultivars was assessed according to Chiang and Talekar (1980) and Nosser (1996).

Results were statistically analyzed using the F-test as a factorial design. The means were compared according to LSD Test (Snedecor and Cochran 1971).

## Results and Discussion

The seasonal abundance of the main insect pests infested sugar beet plants was studied by taking weekly samples during two seasons of 2021/ 2022 and 2022/2023 in the Assiut Governorate.

The duration of the winter transplantation started from September to February.

The insect pest populations were studied using the direct count of sugar beet leaves method. Data in figures 1–6 show the appearance, incidence, and population density of insect species inhabiting sugar beet plants.

**Population density of insect pests**
**Season 2021/ 2022**

Population density of common insect pest species, P. mixta, S. littoralis and G. gryllotalpa infesting sugar beet plants was recorded by taking weekly samples during two studied seasons (2021/2022 and 2022/2023) at the Farm of the Faculty of Agricultural in Assiut University. Figures 1, 2, and 3 recorded the mean numbers of the insect pests on two sugar beet cultivars in the area of study.

In the 2021/ 2022 season, data in the corresponding Figure (1) show that the sugar beet fly, P. mixta began to appear from October 19 with relatively low numbers (25.00 and 15.00 individuals/leaf) in Salama and Oscarpoly cultivars respectively, at plant age of 26 day old and average temperature of 27.4°C and 47.00 % relative humidity (R.H.).

The population increased sharply to reach a maximum of (160.00 and 148.00 individuals/leaf) in Salama and Oscarpoly cultivars respectively on January 12 as correlated with an average temperature of 16.8°C and 21.00 % relative humidity (R.H.).

During the winter transplantation of 2021/ 2022, S. littoralis and G. gryllotalpa showed low values of population densities in all samples in both Salama and Oscarpoly cultivars (Figure 2 and Figure 3).

The high mean number of S. littoralis was 4.00 and 2.00 individuals/ leaf during Jan. 5 at plant age of 103 day and average temperature of 15.1ºC and 72 % R.H. in Salama and Oscarpoly cultivars, respectively, while the high mean number of G. gryllotalpa was 8.00 individuals/ leaf during Dec. 29 at plant age of 96 day and average temperature of 15.3ºC and 51 % R.H. in Salama cultivar, while the high mean number in Oscarpoly cultivar was 6.00 individuals/ leaf during Jan. 12 at plant age of 96 day and average temperature of 15.3ºC and 51 % R.H.

During the winter plantation of 2021/ 2022, it is clear that the sugar beet fly, P. mixta was the most common pest inhabiting sugar beet cultivars followed by G. gryllotalpa and then S. littoralis. However, the number of natural enemies was low in the studied area during this season.

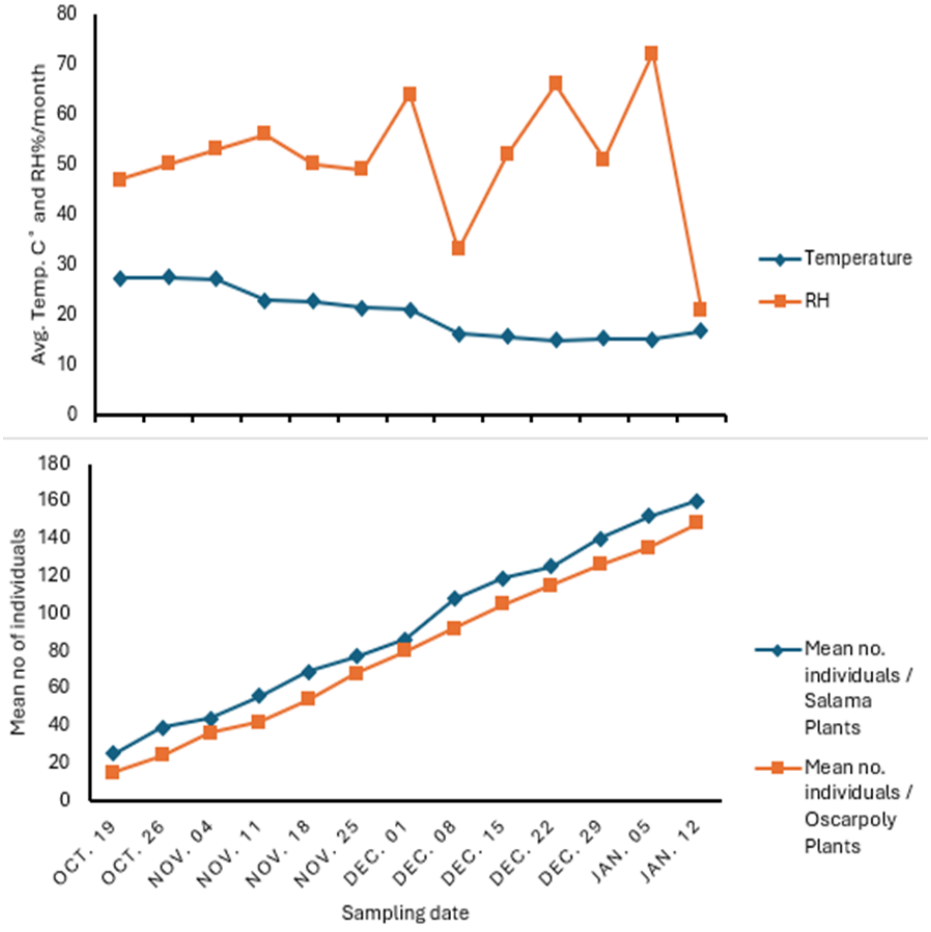


**Figure 1.** Population trend of *P. mixta* infesting sugar beet plants and its relation to temperature and relative humidity during the 2021-2022 growing season in Assiut region.

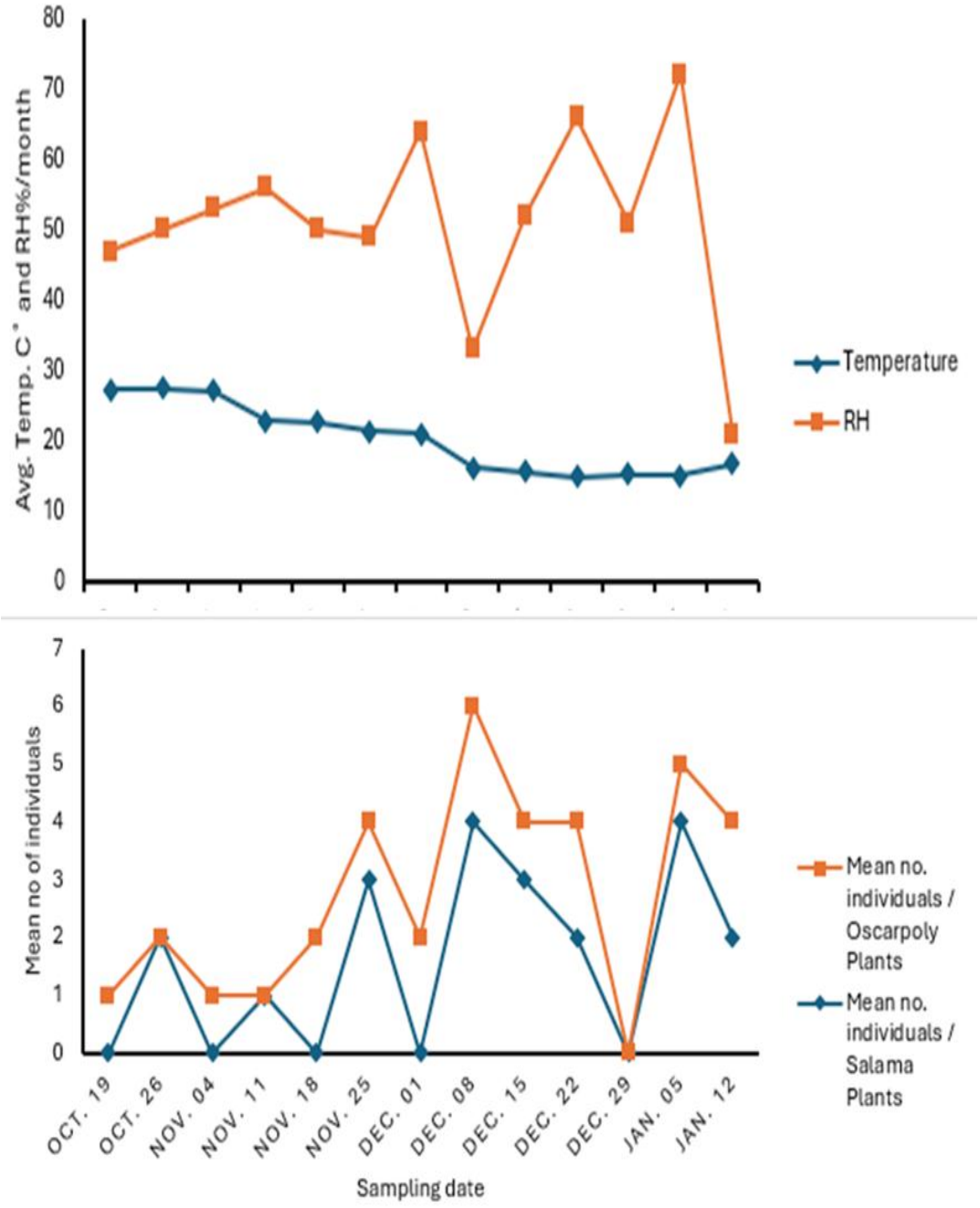


**Figure 2.** Population trend of *S. littoralis* infesting sugar beet plants and its relation to temperature and relative humidity during the 2021-2022 growing season in Assiut region.

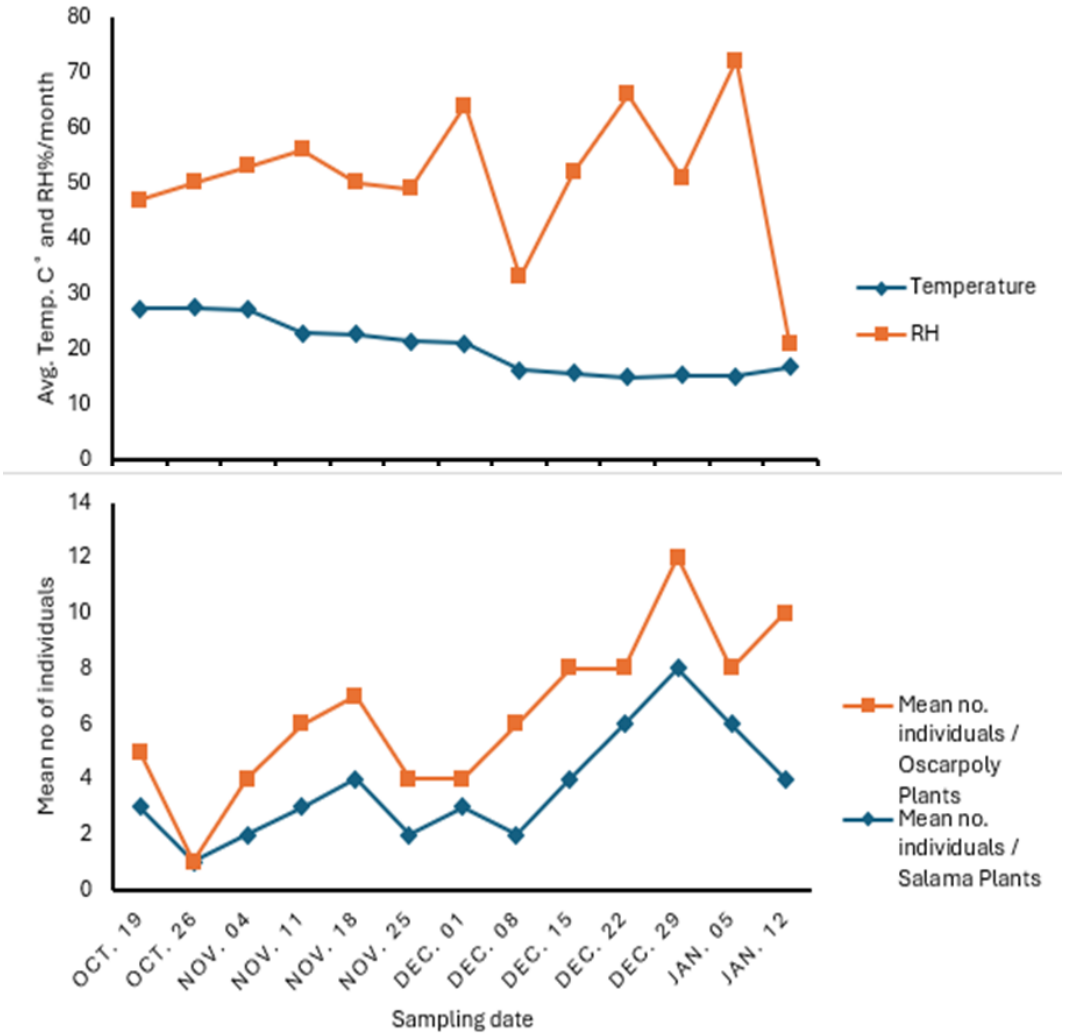


**Figure 3.** Population trend of *G. gryllotalpa* infesting sugar beet plants and its relation to temperature and relative humidity during the 2021-2022 growing season in Assiut region

.

## Season 2022/ 2023

Concerning the seasonal abundance of the insect pests during winter transplantation of 2022/ 2023 season, Figures 4,5 and 6 show that the sugar beet fly, P. mixta started first to appear from October 26th with relatively low numbers (15.00 and 20.00 individuals/leaf) in Salama and Oscarpoly cultivars respectively, at plant age of 33day old and average temperature of 24.4°C and 47.00 % R.H.

The population increased sharply to reach a maximum of 95.00 and 90.00 individuals/leaf during December 14 at a plant age of 82 day old and December 28 at a plant age of 96 day old as correlated with an average temperature of 20.7 and 17.4°C while 43.00 and 52.00 % R.H. in Salama and Oscarpoly, respectively (Fig.4).

Generally, in winter transplantation of 2022/ 2023, Spodopetra littoralis and Gryllotalpa gryllotalpa showed low values of population densities in all samples for both Salama and Oscarpoly cultivars (Figure 5 and Figure 6).

Spodopetra littoralis does not appear in many samples and the high mean number was 2.00 and 3.00 individuals/ leaf on December 7 and January 3 at plant age of 72 and 103 days and an average temperature of 18.9 and 15.9ºC and 63 and 59 % R.H. in Salama and Oscarpoly cultivars respectively, while the population of the high mean number of *Gryllotalpa gryllotalpa* was 8.00 and 4.00 individuals/ leaf during Jan. 17 at plant age of 117 days and average temperature of 19.6ºC and 52 % R.H. in Salama and Oscarpoly cultivars respectively.

In conclusion, the fly sugar beet, *Pegomya mixta* population during winter transplantation in the study fluctuated in relatively high densities during the whole season with a peak of abundance during the middle of December and early January with a plant age of 95 and 110 days.

The fly sugar beet is likely to increase in the coming seasons, causing damage to the sugar beet in Assiut Governorate.

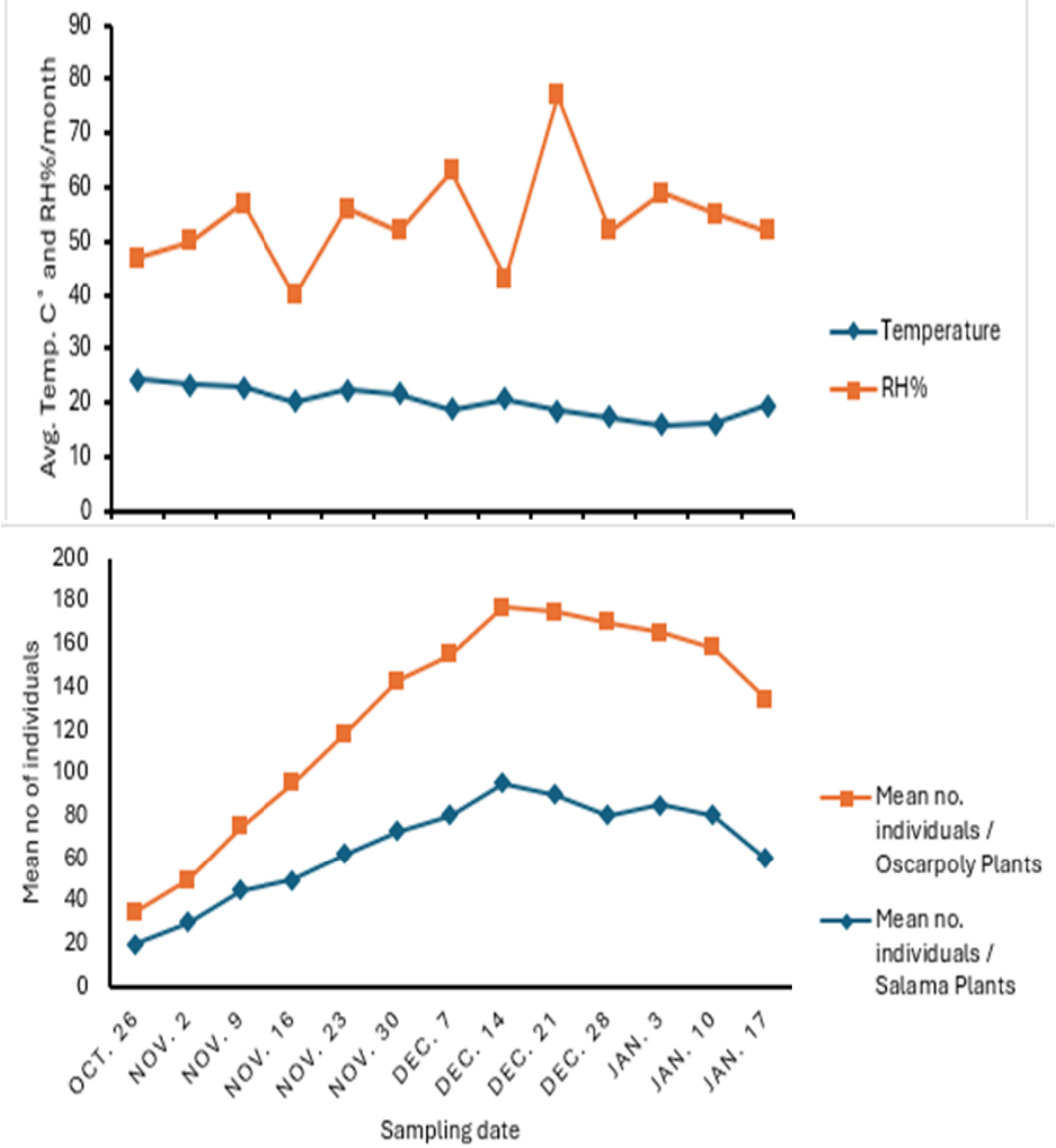


**Figure 4.** Population trend of *P. mixta* infesting sugar beet plants and its relation to temperature and relative humidity during the 2022-2023 growing season in Assiut region.

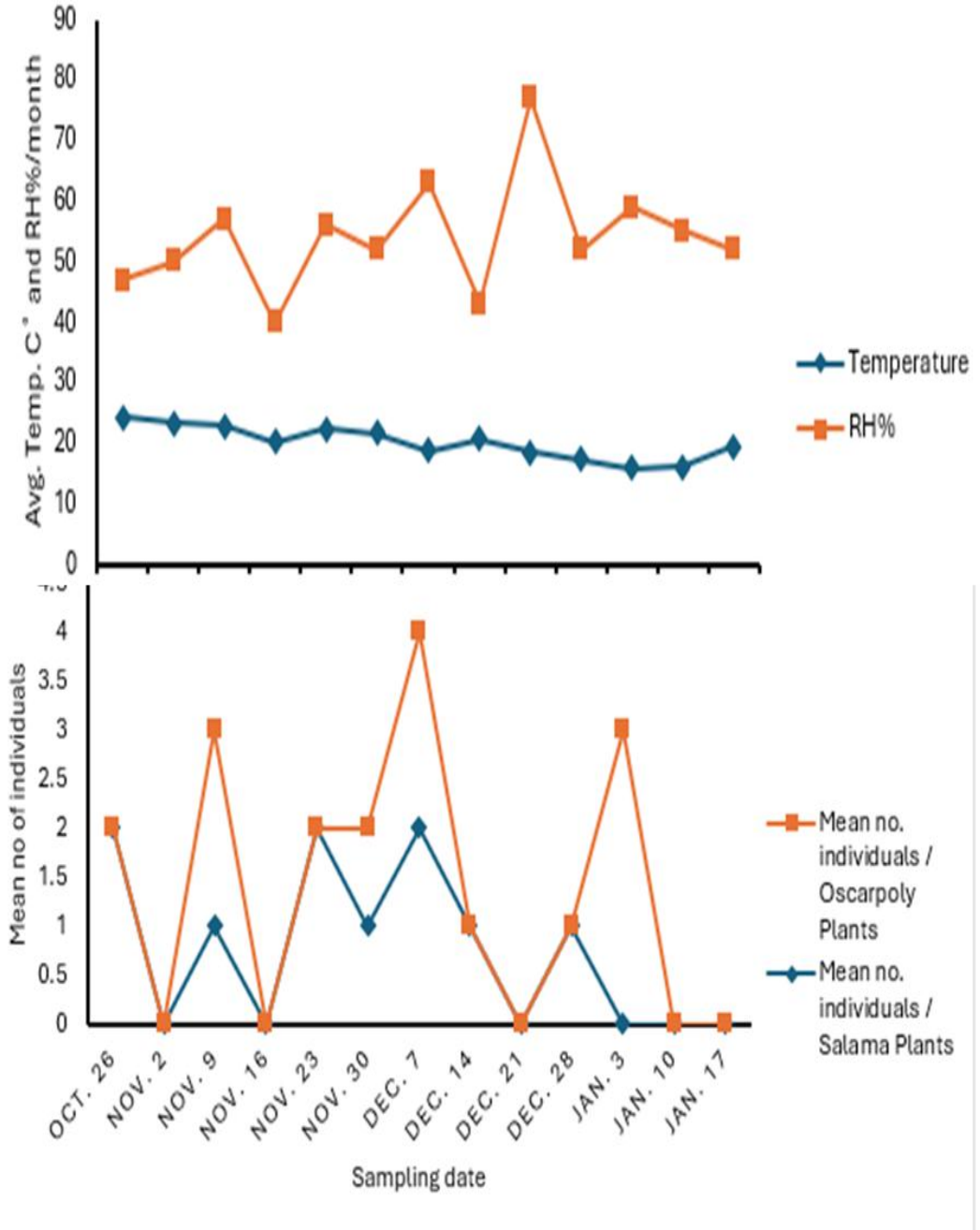


**Figure 5**. Population trend of *S. littoralis* infesting sugar beet plants and its relation to temperature and relative humidity during the 2022-2023 growing season in Assiut region.

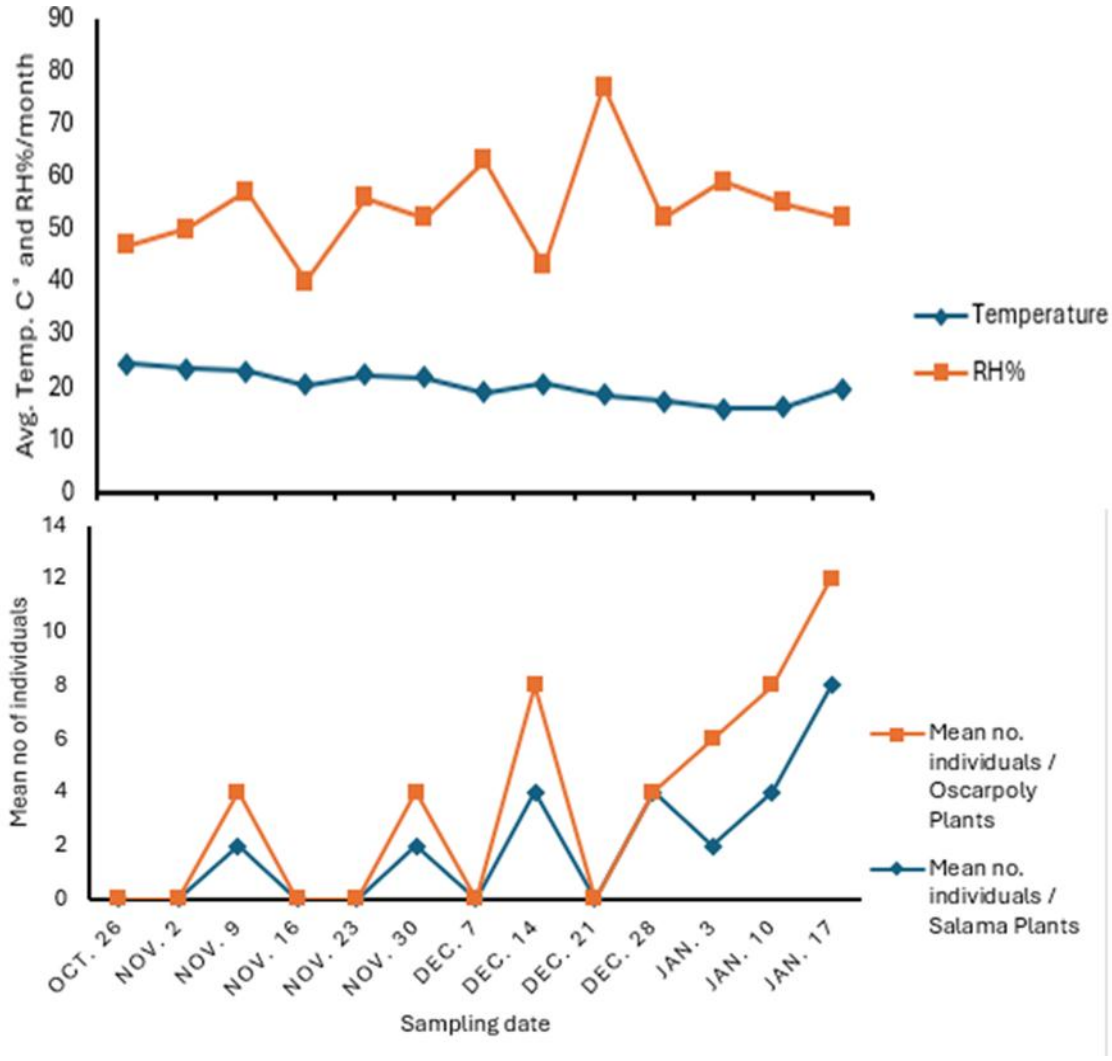


**Figure 6.** Population trend of *G. gryllotalpa* infesting sugar beet plants and its relation to temperature and relative humidity during the 2022-2023 growing season in Assiut region.

Generally, the data of the winter transplantation in this study revealed that the sugar beet plants harbored lower S. littoralis and G. gryllotalpa populations than the sugar beet fly, P. mixta population.

The population densities of the insect pests infesting sugar beet plants during the winter season was relatively at the same level during the 2021/2022 and 2022/ 2023 seasons.

These results may be related to the weather conditions in winter transplantation. However, the data also reveal that the population size of various insect pests on the sugar beet plants during winter transplantations in 2021/2022 and 2022/ 2023 could be arranged as follows: P. mixta, G. gryllotalpa and S. littoralis; these populations indicating that the sugar beet fly, P. mixta had the highest population size on sugar beet plants during winter season.

The results are in confirmation with Metwally et al. (1987); Volkmar et al. (2003) El-khouly (2006); El-Dessoukiet et al. (2014); Abdel-Moniem et al. (2014); Khalifa (2017); Sharma et al. (2017); Al-Habashy (2018); Kamel (2023) who recorded that the high numerical density of this insect pests during spring and winter transplantations on sugar beet.

The present results generally agree with Muresanu and Ciochia (2006); Shalaby and Samahy (2010); Sherief et al. (2013); Lemic et al. (2016); Awadalla et al. (2020); Mansour et al. (2021) who found that those were the most common insect species in the sugar beet plant and effect of sugar beet plantations on the pests.

Awadalla (1997) and Mohisen ( 2012) reported that the activity period of P. mixta extended from the end of November or December and continued to mid-June (Solouma 1989). While El-Fouly et al. (2024) studied the population fluctuations of the main insect pests on sugar beet plants and their relationship with temperature, relative humidity, precipitation, and mean numbers of leaves per plant in Egypt and found that P. mixta was a dominant insect pest species.

Identification of the degree of susceptibility of the two cultivars to the infestation with the insect pests

Data in Table 1 summarizes the susceptibility of the two sugar beet cultivars based on the average number of the insect pest population on the sugar beet plant for each cultivar in the Assiut region. During the first season (winter 2021/ 2022), the cultivars can be arranged in descending order based on their susceptibility to the insect pest infestation as follows Salama (92.38 ind./leaf) and Oscarpoly (80.00 ind./ leaf.). It is clear that the two tested sugar beet cultivars are susceptible (S) to the infestation with the sugar beet fly, P. mixta, while Salama showed high susceptible (S) on the Oscarpoly cultivar. Salama and Oscarpoly appeared as low resistance (LR) to the infestation with the S.littoralis and appeared as moderately resistant (MR) to the infestation with the G. gryllotalpa, respectively. In the second season (winter 2022/ 2023), Salama (65.38 ind./leaf) and Oscarpoly (61.53ind./ leaf.) remained the most susceptible (S) to the infestation with the sugar beet fly, P. mixta, while Salama and Oscarpoly gave low resistance (LR) or moderate resistance (MR) to the infestation with the S. littoralis and G. gryllotalpa, respectively (Table 2). In the first and second winter seasons in the Assiut region (Table 1 and 2), although the pest was present in very small numbers in the winter season during the two studied years, the susceptibility of the sugar beet was close to the season of development and activity of this pest.

This is, wholly and partially, in agreement with results obtained by Ebieda (1998); Ismail (2002); Ismail et al. (2002); Amro (2008); El-Rawy and Shalaby (2011); Ali (2014) who serve as ample guides to the current study.

Finally, it can be noted that the two sugar beet cultivars, whether tested in this study or studied by some of the scientists mentioned above, are susceptible to infestation with P. mixta, to a high degree, which causes severe damage to the crop. Therefore, it is necessary to encourage natural enemies (predatory insects) to reduce the number of pests and avoid using chemicals.

**Table 1.** General mean numbers and susceptibility degrees of sugar beet cultivars to main insect pests studied during the 2021-2022 growing season.

| pest | 2021-2022 | | | |
|---|---|---|---|---|
| | Salama Cultivar | | Oscarpoly Cultivar | |
| | Mean Number | Susceptibility degree | Mean Number | Susceptibility degree |
| *Pegomyia mixta* | 92.30769231 | S | 80 | S |
| *Spodopetra littoralis* | 1.615384615 | LR | 1.153846154 | LR |
| *Gryllotalpe gryllotalpa* | 3.692307692 | MR | 2.692307692 | MR |

S= Susceptible MR= Moderately resistant LR= Low resistance.

.

**Table 2.** General mean numbers and susceptibility degrees of sugar beet cultivars to main insect pests studied during the 2022-2023 growing season.

| pest | 2022-2023 | | | |
|---|---|---|---|---|
| | Salama Cultivar | | Oscarpoly Cultivar | |
| | Mean Number | Susceptibility degree | Mean Number | Susceptibility degree |
| *Pegomyia mixta* | 65.38461538 | S | 61.53846154 | S |
| *Spodoptera littoralis* | 0.77 | LR | 0.615384615 | LR |
| *Gryllotalpe gryllotalpa* | 2 | MR | 1.538461538 | MR |

S= Susceptible MR= Moderately resistant. LR= Low resistance.

## Conclusion

It was noted that sugar beet plants cultivated during the winter season are affected by a large number of insect pests. The sugar beet fly (Pegomya mixta) is present in large numbers on winter plants. In winter transplantations, the beginning of the activity season is in late November or early December. According to the current study, sugar beet plants are negatively impacted by the sugar beet fly and a few other predators, particularly during the winter months. To lessen the harm of this pest, it is vital to promote predatory insects during various seasons. Also, to control sugar beet pests, integrated pest management strategies might benefit from some of the knowledge this work provides.

## References

Abdel-Moniem ASH, Abdel-Raheem MA, and El-Khouly M Y (2014) Biological and ecological studies on the sugar beet fly Pegomyia mixta Vill. (Diptera: Anthomyiidae) on sugar beet in Egypt Arch Phytopathol and Plant Prot, 47(13): 1557–1562.

Abo-Aiana RAD (1991) Studies on pests of sugar beet in Kafr Sheikh, Egypt PhD Thesis, Fac. of Agric., Tanta Univ., Tanta, Egypt. 171 pp.

Abou-Elwafa SF, Amin AE-EA, Eujayl I (2020) Genetic diversity of sugar beet under heat stress and deficit irrigation. Agronomy Journal 112:3579-3590

Ahmed SY, Bekeet MA, Eissa MA, Hussien HA, Abou-Elwafa SF (2023) The application of bio-fertilizers improves sugar beet biofortification in clay loam soils and reduces sugar losses in beet sugar processing. Egyptian Sugar Journal 19: 60-70. https://doi.org/10.21608/esugj.2023.186339.1032

Al-Dhumri SA, Al Mosallam MS, Zhang W, Alharbi S, Abou-Elwafa SF (2023) Application of molasses as an eco-innovative approach substitutes mineral nitrogen fertilization and enhances sugar beet productivity. Waste Biomass Valor 14: 287–296. https://doi.org/10.1007/s12649-022-01873-z

Al-Habashy AZN (2018) Ecological studies on beet fly Pegomyia mixta Vill. infesting sugar beet plants and their associated predators in Sharkia Governorate, Egypt Acad J Biol Sci, 11(6): 51–55.

Ali S, Khan S, Akhtar K, Ali S, Ullah I, Ali A, Hussain S, Khan F, and Ali A (2014) The effect of population dynamics of insect pests on different varieties of sugar beet Glob J Sci Res, 2(3): 76–82.

Alotaibi NM, El-Darder AM, Alfurayji MA, Abou-Elwafa SF (2023) Green waste-derived compost (GWC) alleviates drought stress and promotes sugar beet productivity and biofortification. Plant Production Science 26(4): 391-401. https://doi.org/10.1080/1343943X.2023.2283942

Aly FA, El-Adl FE, Ibrahim SM, Samy MA, El-Khwalka MH, Gabr AM, Adam K M, Mahgoub MMA (1993) Survey and geographical distribution of sugar beet insect pests in Egypt J Agric Sci Mansoura Univ, 18(6): 1793–1804.

Amin AH, Helmi A, and El-Serwy S A (2008) Ecological studies on sugar beet insects at Kafr El-Sheikh Governorate, Egypt Egypt J Agric Res, 86(6): 2129–2139.

Amro MA RM (2008) Population fluctuation of certain arthropod pests inhabiting selected cucurbit cultivars and their resistance status to the main sap-sucking pests Egypt J Agric Res, 86(2): 697–709.

Awadalla SS (1997) Opius nitidulator (Nees) (Hymenoptera: Braconidae) as internal larval parasitoid on the sugar beet fly Pegomyia mixta Vill Proc 1st Nat Conf Appl Using of Natural Enemies for Cont Insect & Mite Pests, Mansoura Univ., 131–138.

Awadalla SS, Bayoumy MH, Abd Allah FA, Hawila HH (2020) Effect of different sugar beet plantations on the sugar beet moth Scrobipalpa ocellatella Boyd., and its insect parasitoids in Kafr El-Sheikh Governorate J Plant Prot and Path, Mansoura Univ., 11(11): 567–569.

Babushkina NG (1996) Natural regulators of beet leaf-miner fly numbers Zash Rast, Moskova, 1:14-15.

Baitha A, Singh MR, Roy S ( 2022).Identification of Insect-pests of Sugarcane and their Control Measures. In: Recent Approaches for Doubling Farmers Income in Sugarcane Based Cropping System [Shukla et al (Eds)]: 295-308pp.

Bazazo KGI (2010) Studies on some insect pests and natural enemies in sugar beet fields at Kafr El-Sheikh region PhD Thesis, Fac. Agric., Tanta Univ., 162 pp.

Chiang HS, and Talekar N S (1980) Identification of sources of resistance to the bean fly and two other Agromyzid flies on soybean and mung bean J Econ Entomol, 73(2): 197–199.

Galal AA, El-Noury MI, Essa MA, Abou El-Yazied A, Abou-Elwafa SF (2022) Response of sugar beet varieties to plant geometrical distribution. Egyptian Sugar Journal 18: 16-31. https://doi.org/10.21608/esugj.2022.125012.1004

Galal AA, El-Noury MI, Essa MA, Abou El-Yazied A, Abou-Elwafa SF (2022) Effect of algae extract foliar application and inter-row planting distances on the yield and quality of sugar beet. Egyptian Sugar Journal 18: 16-31. https://doi.org/10.21608/esugj.2022.125012.1004

Ebieda AM (1998) Studies on sugar beet pests. VI. Effect of beet fly Pegomya mixta Vill on sugar beet with special reference to the determination of its injury levels and economic threshold Egypt J Agric Res, 76(2): 681-692.

Ekin T, and Çoruh S (2022) Harmful and beneficial insect species determined in sugar beet areas in Cairoli District of Erzincan Province and short biology of Spodoptera exigua (Hbn.) (Lepidoptera: Noctuidae) J Tekirdag Agric, 19(3): 483–495.

El-Dessouki SA, El-Awady SM, El-Khawass KAM H, Mesbah AH, El-Dessouki WAA (2014) Population fluctuations of some insect pests infesting sugar beet and the associated predatory insects at Kafr El-Sheikh Governorate Annals Agric Sci, 59(1): 119–123.

El-Fouly SH, Heba A Ismail, Hassanein SSM, Shadia M Omara (2024) Influence of Certain Ecological Factors on Seasonal Abundance of Key Insect Species existing on Sugar Beet Plants J Plant Protection and Pathology, Mansoura Univ., 15(3): 81–86.

El-khouly MI (2006) Population fluctuations of the beet fly, Pegomyia mixta Vill. and the tortoise beetle, Cassida vittata Vill. in relation to certain associated natural enemies in sugar beet fields at Kafr El-Sheikh Governorate, Egypt Egyptian J Biol Pest Control, 16(1): 25–28.

El-Rawy AM, Shalaby GA (2011) Reaction of some sugar beet varieties to the infestation with some insects and final yield Egypt J Agric Res, 89(4): 1383–1390.

Ismail AMA (2002) Evaluation of some sugar beet varieties under different nitrogen levels at El-Fayoum Egypt J Appl Sci, 17(2): 75–85.

Ismail AMA, Aboushady Kh A, Allam SM (2002) Response of some sugar beet varieties to methods of potassium application Egypt J Appl Sci, 17(2): 86–101.

Kamel HM (2023) Population fluctuation of certain insect pests and its associated predators on Phaseolus vulgaris plants in Giza Governorate, Egypt Al-Azhar J Agric Res, (Special issue): 307–313.

Khalifa AA (2017) Population dynamics of insect pests and their associated predators at different plantations of sugar beet J Plant Prot and Path, Mansoura Univ., 8(12): 651–656.

Khalil FM, Negm AA, Ali AM (1975) Insecta and araneida recovered from pitfall traps in cotton fields at Assuit Ass J Agric Sci, 6: 169-174.

Konig K (1985) The beet fly Landtechnische Zeit, 4: 510.

Lemic D, Drmic´ Z, and Bažok R (2016) Population dynamics of noctuid moths and damage forecasting in sugar beet Agricultural and Forest Entomology, 18: 128–136.

Mansour MRK, Kandil RS, and Sadek AA (2021) Some ecological studies on sugar beet crop in Kafr El-Sheikh and Nubaria regions J Plant Prot and Path, Mansoura Univ., 12(8): 515–522.

Metwally S M, El-Sufty R, El-Hakhny N, and Bassiouny A (1987) Effect of infestation with certain insect pests on some sugar beet properties J Agric Res, Tanta Univ., 13(4): 1119–1128.

Mohamed HA, Alkordy MW, Atta AAAA (2019) Effect of host plants on biology of Spodopteralittoralis (Boisd.)- Egyptian Academic Journal of Biological Sciences. Entomology 12(6):65-73

Mohisen MAA (2012) Studies on some insects infesting sugar crops. M. Sc. Thesis, Fac. of Agric. Al-Azhar Univ. Cairo, Egypt, pp 211.

Muresanu F, and Ciochia V (2006) Flight dynamics of some lepidoptera species of sugar beet and possibilities for their control (Transylvania-Romania) Zbornik Matice Srpske za Prirodne Nauke/Proceedings of Natural Sciences, 110: 209–220.

Nosser MA (1996) Mechanism of resistance in bean and cowpea varieties to certain sucking insect infestations MSc Thesis, Fac. Agric., Cairo Univ.

Sato M, Tamayama A, Sugawara H, Shinsenji A, Kusuma T, Tamade T (1995) Application of a new insecticide "Imidacloprid" to control beet flea beetle, beet leaf miner and beet western yellow virus in Hokkaido Proc Japan Soc Sugar Beet Tech, 37: 103-113.

Schmidt RXC, Bacenetti J, Fusi A, Niero M (2017) The influence of fertiliser and pesticide emissions model on life cycle assessment of agricultural products: the case of Danish and Italian barley. Sci. Total Environ 592: 745–757. https://doi.org/10.1016/j.scitotenv.2016.11.183

Shalaby GA, El-Samahy MF (2010) Sugar beet plant stand in August cultivation as influenced by cotton leafworm infestation and role of arthropod predators in insect management J Plant Prot and Path, Mansoura Univ., 1(10): 807–813.

Shalaby GA, El-Samahy MF (2011) Seasonal abundance of braconid parasitoids on sugar beet moth and sugar beet fly and side effect of insecticides on the parasitoids Minufiya J Agric Res, 36(4): 1051–1062.

Shalaby NME, Osman AMH, AL Labbody AHSA (2011). Relative Performance Of sugar beet varieties under three plant densities in newly reclaimed soil, Egypt. J. Agric. Res., 89 (1)

SHARMA S, KOONER R, SANDHU S, ARORA R, KAUR T and KAUR S (2017). Seasonal dynamics of insect pests of sugar beet under sub-tropical conditions, Journal of Agrometeorology 19 (1): 81-83

Sherif EAH Said AAA , Shaheen FAH, Fouad HAM (2013).Population fluctuation of certain pests and their associated predator insects on sugar beet in Sharkia Governorate, Egypt. Egypt. J. Agric. Res., 91, 139- 150.

Snedecor GW, Cochran GW (1971). Statistical methods. Iowa State Univ. Press Ames, Iowa, USA.

Solouma A G (1989) Biological and ecological studies on some insect pests of sugar beet and their natural enemies PhD Thesis, Entomology Dept., Fac. Agric., Alexandria Univ., Egypt, pp. 203.

Spiertz H (2010) Food production, crops and sustainability: restoring confidence in science and technology. Curr. Opin. Environ. Sustain. 2:439–443. https://doi.org/10.1016/j.cosust.2010.10.006

Talha EAMM (2001) Integrated pest management of sugar-beet insects MSc Thesis, Fac. Agric, Mansoura Univ., 102 pp.

Volkmar C, Lübke-Al Hussein M, Jany D, Hunold I, Richter L, Kreuter T, and Wetzel T (2003) Ecological studies on epigeous arthropod populations of transgenic sugar beet at Friemar (Thuringia, Germany) Agriculture, Ecosystems and Environment, 95: 37–47.