Journal of Phytopathology and Pest Management 5(2): 12-24, 2018
pISSN:2356-8577 eISSN: 2356-6507
Journal homepage: http://ppmj.net/

Monitoring the fluctuations of certain piercin sucking pests infesting cucumber plants at Sohag governorate, Egypt

M.M. Tantawy, S.H. Hammouda, F.K. Aly Marwa*, H.H. Mekhemer

Plant Protection Department, Faculty of Agriculture, Minia University, Minia, Egypt

Abstract

The population fluctuations of five piercingsucking pests; melon aphid, *Aphis gossypii* (Glover); cotton whitefly, *Bemisia tabaci* (Genn.); potato leafhopper, *Empoasca decipiens* (Paoli); onion thrips, *Thrips tabaci* (Lind.) and two-spotted spider mite, *Tetranychus urticae* (Koch) were investigated on Hail cucumber variety during autumn and spring plantation from 2014 to 2016 seasons. As a result in autumn plantation, population of aphid and whitefly had one peak during 2014 and 2015 seasons , meanwhile, thrips population recorded three peaks in the same seasons. Otherwise, in spring plantationin 2015 and 2016 seasons, the populations of aphid and thrips recorded three peaks and one peak, respectively. In the meantime, the whitefly's population showed three and two peaks, respectively. Leafhopper was the lowest sucking insect attacked cucumber during the two plantations throughout 2014, 2015 and 2016 growing seasons. The two-spotted spider mite only observed on spring plantation 2015 and 2016 and recorded one peak through the growing seasons. It could be concluded that planting date is effective on population fluctuations of piercing sucking pest and can be avoided by planting in late planting date.

Keywords: fluctuation, piercing- sucking pest, cucumber plants, autumn plantation, spring plantation.

* **Corresponding author:** F.K. Aly Marwa,
E-mail: dr.mero_83@yahoo.com

Introduction

Cucumber *Cucumis sativus* L. is one of the most important cucurbitaceous vegetable crops in Egypt, as it is grown under different environmental conditions, open fields and greenhouses for local consumption and exportation purposes. It is cultivated in many areas included the old and new reclaimed lands (Hanafy et al, 2014). In this interim, cucumber plants are attacked by many piercing-sucking arthropod pests such as the cotton aphid, *Aphis gossypii* (Glover); tomato whitefly, *Bemisia tabaci* (Genn.); onion thrips, *Thrips tabaci* (Lind.); potato leafhopper, *Empoasca decipiens* (Paoli) and the two-spotted spider mite, *Tetranychus urticae* (Koch). (Hussein et al., 2015; Oltean et al., 2012; Hanafy, 2004; Jan et al., 2003; Abdel-Hafiz, 2002; Higgins, 1992; Nozato, 1988; Coudriet et al., 1985). Further, these pests were mainly known as field crop pests in tropical and sub-tropical countries. They are broadly polyphagous causing both direct and indirect damage on cucumber plants for instance;excessive piercing removal, promoting the growth of sooty mold, vectoring plant viruses (Van Lenteren & Noldus, 1990; Cock, 1986; Perkins, 1983) and appreciable reduction in yield (Varma et al., 2013; El-Lakawah et al., 2011; Tomczyk & Pilko 1996; Kherebe et al., 1984). It could be observed that, the cucumber plants cultivated in the late planting date harboured a relatively higher number of piercing sucking pest as thrips (*T. tabaci*). Meanwhile, the plants of the early planting date harboured relatively lower numbers of the pest (Mohamed, 2012). Other researchers reported, the infestation rate of *T. tabaci* increased by delaying planting date (Abd El-Karim, 2010; Emam et al., 2006; Bairwa et al., 2005; Hanafy, 2004; ElRefai & Emam, 1994; Rizk et al., 1990). However, planting season is very important factor in the culture control, whereas many researchers pay attention to investigate the effect of planting season on population fluctuations of different piercing sucking pests all over the world. Otherwise, climate changes may affect population dynamics directly or indirectly through shifting survival, behaviour, and life cycles of insects (Boggs & Inouye, 2012). Whereas, increasing temperature could facilitate physiology and reproduction of insects at an individual level (Ullé et al. 2010). However, whether climate changes could affect pest damage and population dynamics at a community level is still largely unknown. Increasing temperature may positively affect development, longevity, and fecundity. Please here write the the effect on planting on population and used a references. The the relationship between the importance of peak population and IPM the weather condition especially the temperature as a main factor influencing the population dynamics. Then write the importance of your study in Sohag region, especially Sohag is one promised in vegetable production. Herein, the goal of this research is to study the population fluctuations of piercing sucking pests on cucumber varieties during autumn and spring cultivations to predict the outbreaks of these pests which could be a good point in case of piercing sucking pest control at Sohag region, especially Sohag is one of promised vegetable production in Egypt.

Materials and methods

Cucumber cultivations: The experiments were carried-out from September 2014 until February 2016 in a new private reclaimed farm at a Awlad-Azzaz village, about 18 kilometers West

of Sohag governorate, Egypt. How about the other traditional treatments like fertilization and irrigation and herbicides if used, all these factors affects the population dynamics. All the agriculture practices were done as recommended for recent reclaiming lands.

Autumn plantation: Cucumber variety Hail (PS 410832) was cultivated in area of 400 m^2, which divided to 4 replicates (plots) with a randomized complete block design (RCBD), each plot about 100 m^2. Seeds were sown on September13th and 15th during 2014 and 2015, respectively. This area was utilized for determination of the population fluctuations of piercing sucking pests.

$SV = (4/3)\ (\pi)\ (r^3)$

Spring plantation: To compare the population fluctuations of piercing sucking pests in spring plantation in the Hail (PS 410832) a cultivated area of 400 m^2 for each variety was divided into 4 replicates. Seeds were sown on February 14th and 16th during 2015 and 2016, respectively.

Sampling collection and data analysis: Leaf sampling was started on September 22nd, 2014 and 2015 for autumn cultivation, while for spring cultivation, leaves were started to be sampled on February 22nd, 2015 and 2016 with 3 days intervals until harvest or until the crop was discarded. Ten leaves were collected randomly that representing different stages of the canopy from each replicate. Samples were collected in the early morning in the field and the number of adults were counted, then kept in a paper bags after that and transferred to the laboratory to inspect the immature stages of piercing-sucking pests with the aid of light microscope. Direct count technique was done according to Southwood (1978) and Gusmao et al. (2006). Statistical analysis was conducted using ANOVA-one way, followed by LSD Test by using Co-stat 6.4 computer program according to Steel and Torrie (1981).

Results and Discussion

Population fluctuations of piercing sucking pests in autumn and spring plantations: Survey studies on cucumber plants cultivated in Sohag revealed that the *A.gossypii* , *B. tabaci* , *E. decipiens* , *T. tabaci* and *T. urticae* were the key of important piercing sucking pests that infesting Hail variety during autumn and spring plantations throughout three successive years of 2014, 2015 and 2016.

Autumn plantation of *A. gossypii*: Data indicated that (Figure 1a), the population density of *A. gossypii* had one peak during the 2014 and 2015 seasons. In 2014 season, the aphid infestation started early 7 days after sowing on September 22nd with mean numbers of 1.5 individuals /10 leaves). However, in 2015 season aphid infestation occurred late 12 days after sowing with mean numbers of 2.3 individuals /10 leaves on September 25th. Then aphids increased sharply to reach the maximum as 207.5 and 202.3 individuals 10 leaves on October 29th and 23rd, then, it decreased gradually to reach values of 150.3 and 97.5 individuals /10 leaves on November 17th and 13th the two successive seasons.

Spring plantation of *A. gossypii*: Data revealed that, *A. gossypii* appeared on February 22nd during 2015 and 2016 seasons and recorded 49.8 and 11.5 individuals/10 leaves. Then, the populations increased gradually to recoded three peaks in 2015 and one peak 2016 season. The mean numbers were 285.5, 139.3 and 93.8 individuals /10 leaves, which recorded as peaks on March, 27th and April, 3rd and 12th respectively, in the first season. However, the mean number was187.8 individuals /10 leaves that recorded as a peak on March 30th in the second season. After that, the population decreased gradually until the end of each season (Figure 1b).

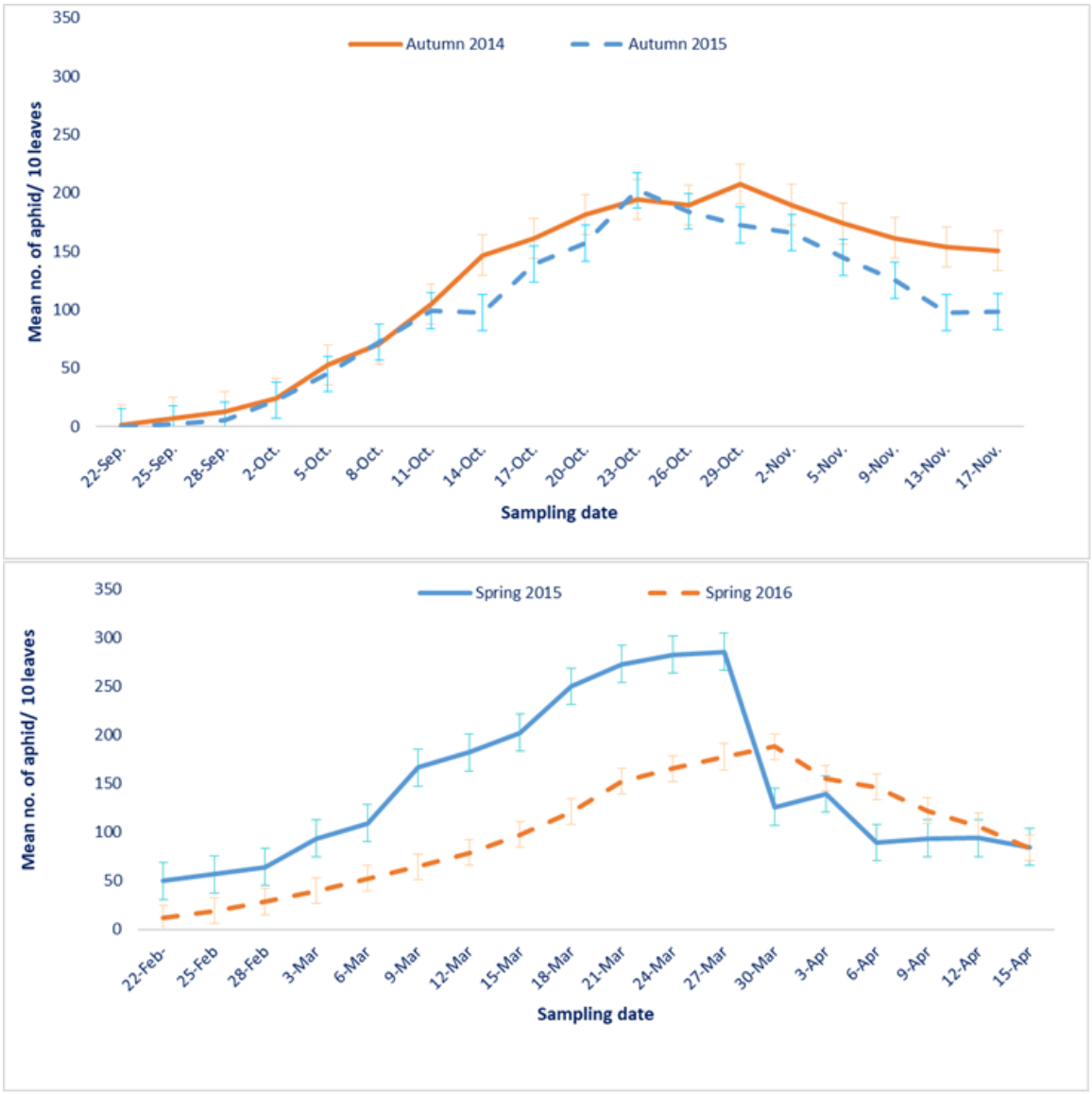

Figure 1: Population fluctuations of aphid infesting cucumber plants (Hail variety) during autumn plantation 2014 and 2015 seasons and spring plantation 2015 and 2016 seasons.

Autumn plantation of *B. tabaci*: Data presented in Figure (2) a showed that *B. tabaci* was recorded after one week from sowing for 2014 season, while in 2015 season it appeared in the second week. Whitefly population (nymphs and adults) increased gradually to reach the highest record (236 and 133.5 individuals /10 leaves) on October 26th and 23rd during 2014 and 2015 seasons, before the insect population dropped gradually to reach 157 and 113.8 individuals / 10 leaves on November17th and 15th through 2014 and 2015 seasons.

Spring plantation of *B. tabaci*: Data showed that the whitefly, *B. tabaci* was recorded on spring on cucumber throughout the first inspection in both seasons of the study with mean numbers of 36.8 and 10.0 individuals / 10 leaves (adults plus nymphs), (Figure 2b). In 2015 growing season, the peaks were observed on March 6th and 27th and April 12th with mean numbers of 92.5, 134.5 and 167.8 individuals / 10 leaves, respectively. While in 2016 season, two peaks were spotted on March 24th and April 18th with mean numbers of 206.3 and 206.5 individuals / 10 leaves, , before it decreased gradually to the end of 2015 season. In contrast, the population mean increased to reach its maximum by the end of 2016 season.

Figure 2: Population fluctuations of whitefly infesting cucumber plants (Hail variety) during autumn plantation 2014 and 2015 seasons and spring plantation 2015 and 2016 seasons.

Autumn plantation of *T. tabaci*: Cucumber leaves infestation started one week after sowing 2014 season and 9 days in 2015 season with mean numbers of 0.5 and 9.8 individuals/10 leaves, (Figure 3a). Three peaks were observed in both growing seasons of 2014 and 2015. The mean numbers were 12.5, 25 and 20.8 individuals /10 leaves which recorded as peaks on September 28th, October 11th and 20th, respectively during the first season. Meanwhile the mean numbers of 85, 63.3 and 43.3 individuals / 10 leaves were recorded as peaks on October 20th, 26th and November 8th, respectively during the 2015 season.

Spring plantation of *T. tabaci*: The onion thrips, *T. tabaci* began to attack leaves in the first inspection with mean numbers of 98.3 and 15.0 individuals / 10 leaves in both 2015 and 2016 seasons, (Figure 3b). The population of thrips demonstrated three peaks in first season, on February 28th, March 9th and April 9th with mean numbers of 110.5 m 256.3 and 91.8 individuals / 10 leaves, respectively. In 2016 season, the maximum number was recoded on March 27th with mean number of 261 individuals / 10 leaves. Then the population decreased gradually to the end of the season.

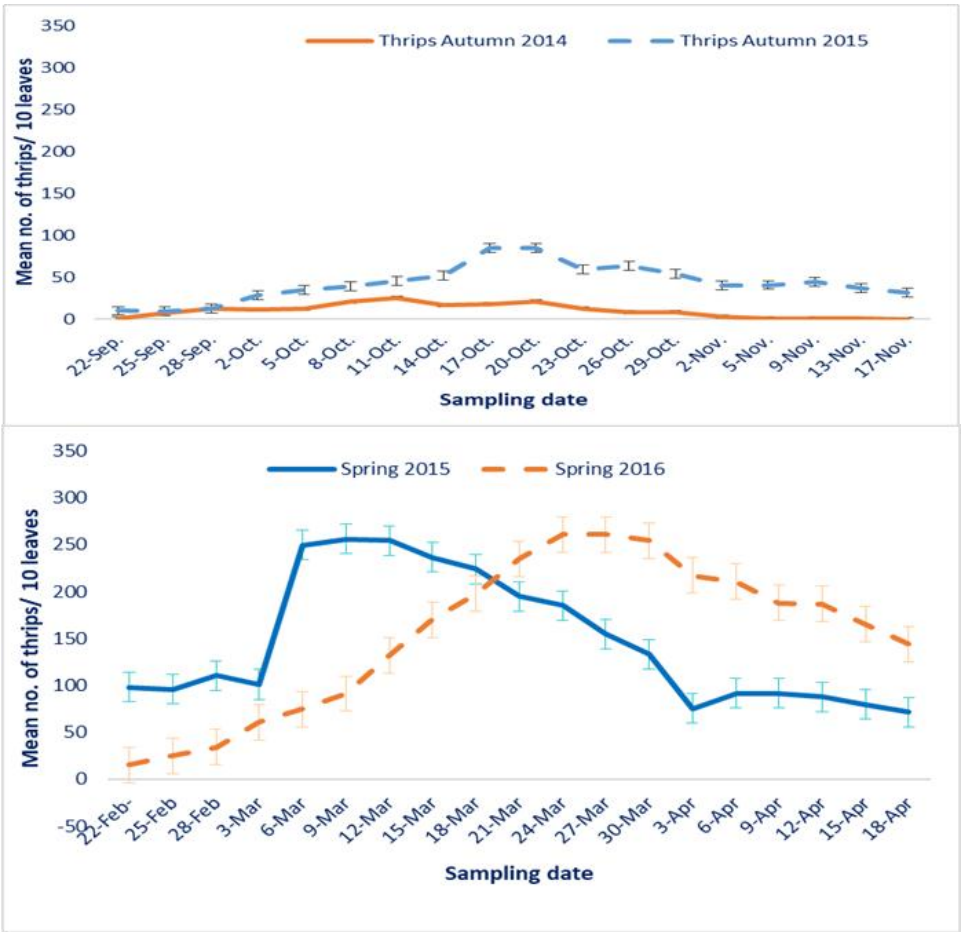

Figure 3: Population fluctuations of thrips infesting cucumber plants (Hail variety) during autumn plantation 2014 and 2015 seasons and spring plantation 2015 and 2016 seasons.

Autumn plantation of *E. decipiens*: Leaf hopper population was slightly abundant on cucumber plants. However, the first appearance was recorded on October 8th during 2014 and October 5th through 2015 season. The maximum leaf hopper numbers on October 29th was 5.8 individuals / 10 leaves during 2014 growing season compared with an average of 5.0 individuals / 10 leaves on November 11th during 2015 growing season (Figure 4a).

Spring plantation of *E. decipiens*: Regarding to the leafhopper, *E. decipiens* infestation started on March 12th and 3rd in 2015 and 2016 growing seasons, with mean numbers of 0.5 and 2.0 individuals / 10 leaves,. The maximum numbers of leaf hopper were recorded on March 27th and 24th (41.0 and 45.5 individuals / 10 leaves in 2015 and 2016 seasons,). It worth mentioned that, the last three sampling dates cleared completely from leaf hopper in the first season. Meanwhile, the population decreased gradually to the end of the second season. Furthermore, the population increased gradually and maximized one time in both seasons (Figure 4b).

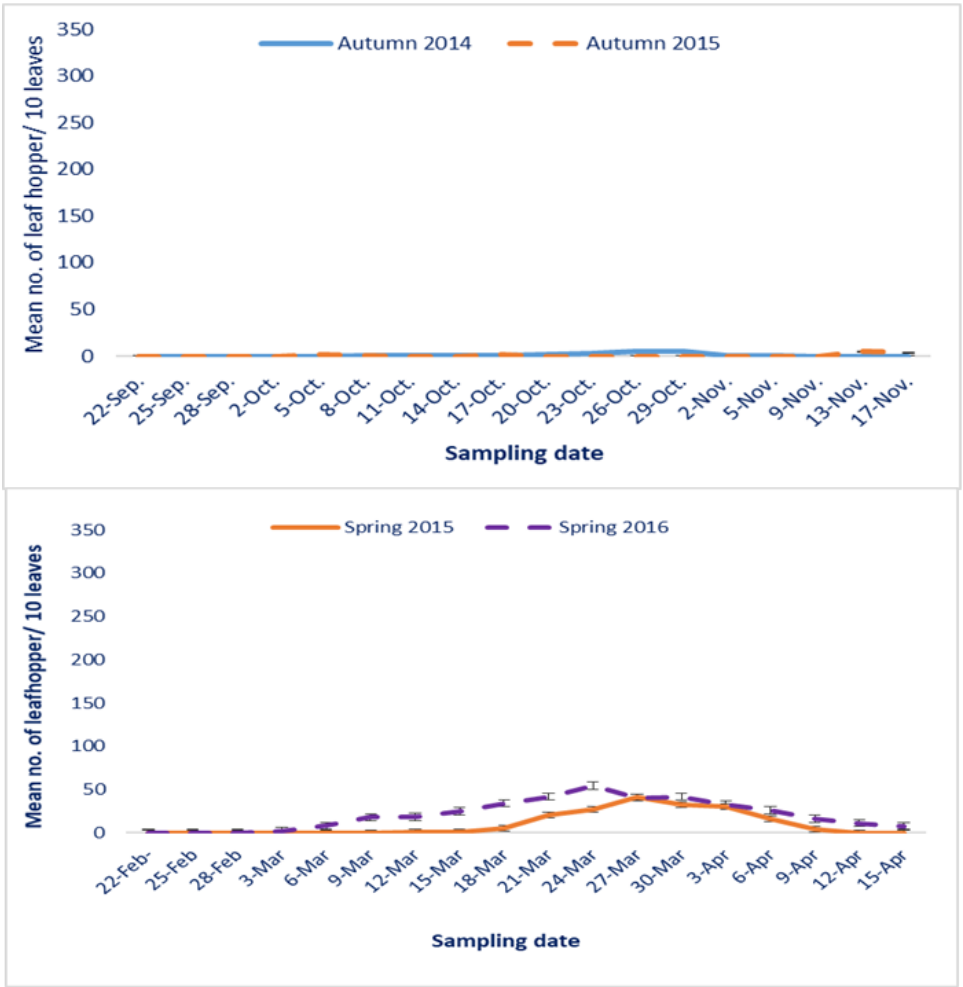

Figure 4: Population fluctuations of leaf hopper infesting cucumber plants (Hail variety) during autumn plantation 2014 and 2015 seasons and spring plantation 2015 and 2016 seasons.

Autumn plantation of *T. urticae*: Spider mite pest was not observed during autumn plantation for both seasons 2014 and 2015.

Spring plantation of *T. urticae*: The mite infestation began to appear on February 28th and 22nd with mean numbers of 28.5 and 7.8 individuals / 10 leaves in the both studied seasons, (Figure 5). It is evident that this pest was the dominant piercing sucking pest on cucumber in the spring plantation throughout both seasons. One peak was shown on April 18th of 2015 and 2016 seasons with mean numbers of 217 and 288.3 individuals / 10 leaves, Significantly, *B. tabaci* recorded the highest number on cucumber leaves followed by *A. gossypii* during 2014 season, 134.2 and 121.3 individuals/ 10 leaves, (Table 1). Otherwise, the aphid was the greatest through 2015 season followed by the whitefly (101.7 and 97.6 individuals/ 10 leaves,). Meanwhile, *T. tabaci* was the less abundant pest in both seasons (9.9 and 42.7 individuals/ 10 leaves). However, *E. decipiens* was the lowest sucking insect infesting cucumber in both studied growing seasons of 2014 and 2015 (1.1 and 0.7 individuals/ 10 leaves,).

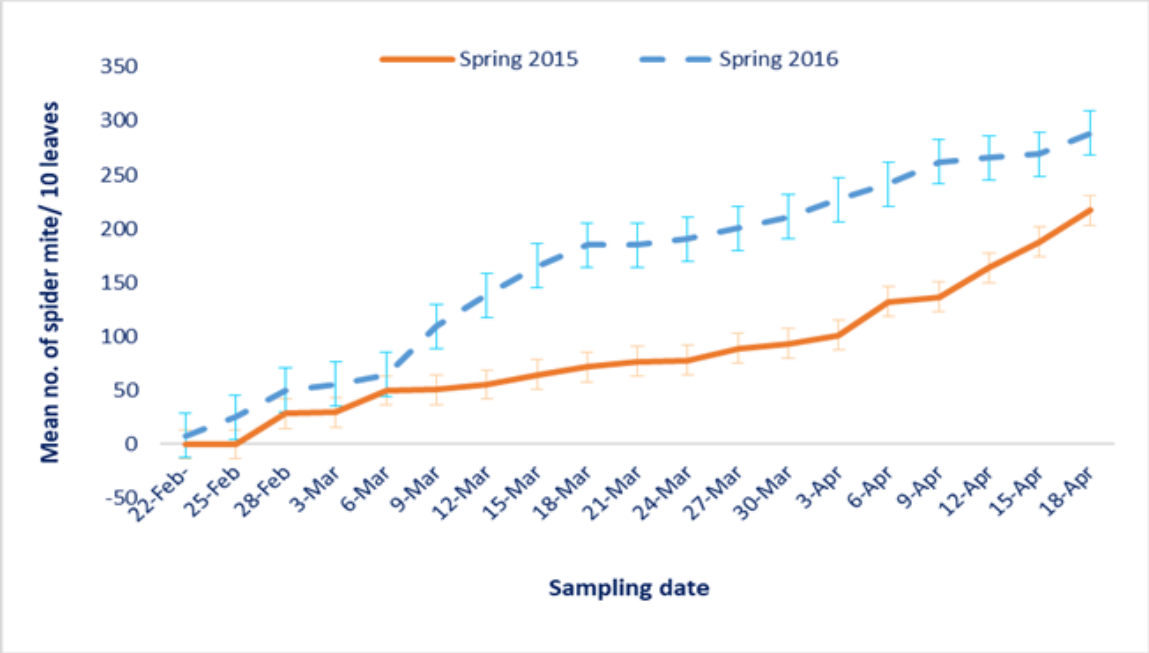

Figure 5: Population fluctuations of spider mite infesting cucumber plants (Hail variety) during spring plantation 2015 and 2016 seasons.

In this respect, Aly (1990) reported that, aphid and whitefly are considered as a main sucking pest infesting cucumber and other vegetables in Minia governorate, Egypt. Also, Abdel-Rahman et al. (2016) stated that, *B. tabaci* was the most abundant and seemed to be the major pest followed by *T. urticae*. They appended that, the piercing sucking insects such as *A. gossypii*; *T. tabaci* and *E. decipiens* were the most numerous pests infesting cantaloupe in Upper

Egypt. El-Khawalka et al. (1992) investigated the infestation level of vegetable crops by cotton aphid, *A. gossypii* in Egypt They found that the infestation levels were varied from high on cucumber moderate on summer squash and low on vegetable marrow. In addition, there was a positive correlation between the infestation rate by *A. gossypii* and plant stage. Additionally,

Table 1: Means of population fluctuations of piercing sucking pests during autumn and spring plantation during 2014 to 2016 seasons.

Piercing sucking pests	Significance	Autumn plantation		Spring plantation	
		2014	2015	2015	2016
A. gossypii	Mean*	121.3 b	101.7 a	143.4 b	98.9 d
	L.S.D. at 5%	10.3	6.8	10.03	7.37
Whitefly *B. tabaci*	Mean*	134.2 a	97.6 b	95.6 c	132.9 c
	L.S.D. at 5%	16.9	4.5	5.65	5.37
Thrips *T. tabaci*	Mean*	9.9 c	42.7 c	146.9 a	153.8 b
	L.S.D. at 5%	2.4	5.6	16.15	10.05
Leaf hopper *E. decipiens*	Mean*	1.1 d	0.7 d	9.3 e	19.9 e
	L.S.D. at 5%	1.2	0.8	4.92	6.29
Spider mite *T. urticae*	Mean*	-	-	85.6 d	165.3 a
	L.S.D. at 5%	-	-	7.45	11.13

*Means within a column followed by the same letter are not significantly different from each other

Abdel-Khalek (2005) inspected the population fluctuation of *B. tabaci* infesting cucumber plants in new reclaimed land and mentioned that whitefly population was low in early September and gradually increased to reach its maximum on October 16th before declined in the end of the season on December 18th. Our results for spring plantation are in agreement with El-Sayed et al. (1991), Fouda and Mohammed (1994), Abdel-Khalek (2005) and Mohamed (2012) where, they reported that the infestation rate of *B. tabaci* increased by delaying planting date. In contrast with our results, Farrag et al. (1982) recorded that, the highest population density of *T. urticae* occurred in summer plantation. While, our results showed that the two-spotted spider mite has not been observed in early planting dates of autumn plantation. Also, our results agreed with El-Khayat et al. (1994) who stated that, the highest whitefly population occurred during September in autumn plantation form one peak; meanwhile there were two peaks of whitefly population in June during summer plantation. In contrast with our results, Kim et al. (1996) who mentioned that *A. gossypii* population was higher during autumn plantation than it during spring plantation. Also, Adam et al. (1997) studied the population fluctuation of *B. tabaci* during autumn and spring. They recorded that the highest infestation level occurred during autumn plantation while, the low infestation level was in spring plantation.

El-Saad and Embarak (2009) found that, *T. urticae* exhibited one peak on cucumber in Egypt. El-Lakawah et al. (2011) revealed that, infestation of jassid started after 15 days of sowing and reached maximum at 22 days after sowing before it gradually decreased by the end of season. Results also indicated that the young plants had higher biological activity and more suitable for leafhopper reproduction than old ones. In addition, Kanika et al. (2013) recorded that, there was a peak of two-spotted spider mite during the second week of August 2011 and last week of May in 2012. It could be concluded that population fluctuation of piercing sucking pests were obvious in spring plantation more than autumn plantation. So we can recommend growers for earlier planting date (autumn plantation) to avoid high pest densities and their fluctuations.

Acknowledgments

We are grateful for Plant Protection Department, Faculty of Agriculture, Minia University and Sohag University, for funding research. Furthermore, we thank Professor Salah Hussein El-Roby for helping us in data analysis.

References

Abdel-Hafiz NA, 2002. Effect of certain cucumber varieties on the biology of *Aphis gossypii* (Homoptera: Aphididae). The Second International Conference for Plant Protection Research Institute, Plant Protection Research Institute, Giza, Egypt, Volume 1: 847- 849.

Abdel-Wali, M. Mustafa, T.2002. Effect of Pesticides on Emergence ,Survival , Longevity , and Fecundity of the Parasiroid Aphidius matricariae Haliday (Hytm. : Aphidiidae) from Mummified Myzus persicae Sulzer (Hom. Aphididae) . The Second International Conference for Plant Protection Research Institute . Giza – Egypt December 21 – 24 /2002. Integrated Pest Management in Relation to Safe Agricultural Products and Healthy Environment. Volume I.

Abd El-Karim HS, 2010. Studies on some arthropods inhabiting bean plants, *Phaseolus vulgaris* L. in Fayoum Governorate. Ph.D. Thesis, Faculty of Agriculture, Fayoum University, Egypt, 113 pp.

Abdel-Khalek AA, 2005. Population dynamics of the whitefly, *Bemisia tabaci* (Genn.) infesting cucumber plant in newly reclaimed land. Annals of Agricultural Sciences **50**: 719–728.

Abdel-Rahman MAA, Ali MMA, Awad AMA, Shafea AMH, Abdel-Rahem GH, 2016. CO-Existence of pests and their associated predators inhabiting cantaloupe plants, *Cucumis melo* L. in Assiut , Egypt. Assiut University Bulletin for Environmental Researches **19**(2): 1–9.

Adam MK, Bachatly MA, Doss SA, 1997. Populations of the whitefly *Bemisia tabaci* (Genn.) and its parasitoid *Eretmocerus mundus* (Mercet) in protected cucumber cultivations. Egyptian Journal of Agricultural Research **75**(4): 939–950.

Aly FK, 1990. Effect of some agricultural practice on the melon aphid and the whitefly infesting three cucurbit vegetables. Minia Journal of

Agricultural Research and Development **12**(2): 675–684.

Bairwa DK, Kanwat PM, Kumawat KC, 2005. Effect of dates of sowing on the incidence of jassids, whiteflies and shoot and fruit borer of the okra. Annals of Agricultural Sciences **26**(1): 110–112.

Boggs CL, Inouye DWA, 2012. Single climate driver has direct and indirect effects on insect population dynamics. Ecology Letters **15**: 502–508.

Cock MJW, 1986. Distribution. Bemisia tabaci-a literature survey. CAB International Institute of Biological Control. Chameleon Press, London, England, **2**: 13–17.

Coudriet DL, Prabhaker N, Kishaba AN, Meyerdirk DE, 1985. Variation in developmental rate on different hosts and overwintering of the sweet potato whitefly, *Bemisia tabaci* (Homoptera: Aleyrodidae). Environmental Entomology **14**(4): 516–519.

El-Khawalka MHM, Draz KAA, Samy MA, 1992. Studies on the population density of *Aphis gossypii* (Glover) on cucurbit crops at Kafr-El-Sheikh district [Egypt]. Mansoura Journal of Agricultural Science **17**(10): 3372–3376.

El-Khayat EF, El-Syed AM, Shalaby FF, Hady SA, 1994. Infestation rates with *Bemisia tabaci* (Genn.) to different summer and winter vegetable crop plants. Annals of Agricultural Science Moshtohor Journal **32**(1): 577–594.

El-Lakawah FA, Abd El-Wahab HA, Kattab MM, Azab MM, El-Ghanam MS, 2011. Population dynamics of some pests infesting nili cucumber plantations in relation to certain ecological factors. Egyptian Journal of Agricultural Research **89**(1): 137–153.

El-Refai SA, Emam AK, 1994. Some factors affecting cotton aphids, whitefly and bollworms infestation and cotton yield. Annals of Agricultural Sciences **39**(1): 431–439.

El-Saad AKA, Embarak MZ, 2009. Population fluctuation of *Tetranychus urticae* Koch and its predacious thrips, *Scolothrips longicornis* Priesner on cucumber and bean varieties, under green-house conditions. Alexandria Journal of Agricultural Research 54(3): 41–48.

El-Sayed AM, Shalaby FF, Abdel-Gawad AA, 1991. Ecological studies on *Bemisia tabaci* (Genn.) fluctuation and population density on different host plants. Egyptian Journal of Agricultural Research **69**(1): 193–207.

Emam AK, Hegab MFAH, Tantawy MAM, 2006. Effect of planting space and date on the population densities of certain insect pests infesting sweetpea plants at Qalyobia Governorate. Annals of Agricultural Science Moshtohor Journal **44**(1): 299–308.

Farrag AMI, Wahba ML, and Hafez A, 1982. Effect of planting date on the population fluctuations of *Tetranychus urticae* on some cucurbitaceous plants at Qualyobia provine (Egypt). Agricultural Research Review **60**(1): 107–116.

Fouda MS, Mohammed ABM, 1994. population dynamics of whitefly, *Bemisia tabaci* (Genn.) on certain vegetable crops in Egypt. Journal of Agricultural Science **19**(93): 1233–1243.

Gusmao R, Picanco MC, Guedes RNC, Galvan TL, 2006. Economic injury level

and sequential sampling plan for Bemisia tabaci in outdoor tomato. Journal of Applied Entomology **130**(3): 160–166.

Hanafy ARI, 2004. Studies on the most important cucumber pests in the open field and suitable control programs. PhD. Thesis, Faculty of Agriculture, Zagazig University - Benha Branch, Moshtohor, Egypt, 279 pp.

Hanafy ARI, Baiomy Fatina, Tantawy Maha AM, 2014. Comparison between the infestation rate of certain pests on cucumber and kidney bean and its relation with abiotic factors and anatomical characters. Egyptian Academic Journal of Biological Sciences **7**(2): 63–76.

Higgins CJ, 1992. Western flower thrips (Thysanoptera: Thripidae) in greenhouses: population dynamics, distribution on plants, and associations with predators. Journal of Economic Entomology **85**(5): 1891–1903.

Hussein SHA, Hanafy ARI, El-Sappagh IA, 2015. Impact of planting dates and some weather factors on population fluctuation and occurrence percentage of aphids and thrips on wheat crop in Egypt. Journal of Phytopathology and Pest Management **2**(3): 18–31.

Jan MT, Naeem M, Khan MI, Mahmood R, 2003. Leafhopper management on Autumn potato crop in Peshawar (Pakistan). Journal of Research (Science) **14**(1): 35–42.

Kanika T, Rachna G, Geroh M, 2013. Influence of abiotic stresses on population dynamics of two spotted spider mite *Tetranychus urticae* (Koch) in cucumber ecosystem. Annals of Plant Protection Sciences **21**(2): 242–246.

Kherebe AH, Mohamed SS, Bahaa El-Din SA, Radwan AA, 1984. Susceptibility of some cucumber and squash cultivars to aphids and spider mites infestation under natural conditions. Bulletin of Faculty of Agriculture, Cairo University **35**(3): 1727–1736.

Kim SH, Kim IT, Lee RS, 1996. Seasonal fluctuations of aphids and whiteflies in some vegetable crops. Korean Journal of Plant Protection **35**: 129–133.

Mohamed MA, 2012. Impact of planting dates, spaces and varieties on infestation of cucumber plants with whitefly, *Bemisia tabaci* (Genn.). The Journal of Basic and Applied Zoology, 65(1): 17-20.

Nozato K, 1988. Population growth of the melom aphid, *Aphis gossypii* Glover (Homoptera: Aphididae) during a year in the warmer Region of Japan. Research reports of the Kochi University **37**: 121–129.

Oltean I, Covaci AD, Florian T, Matei C, 2012. *Frankliniella occidentalis* (Thysanoptera: Thripidae) population dynamics on cucumber crop. Bulletin of the University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca **69**(1): 77–80.

Palomo LAT, Martinez NB, Johansen-Naime R, Napoles JR, Leon OS, Arroyo HS, Graziano JV, 2015. Population fluctuations of thrips (Thysanoptera) and their relationship to the phenology of vegetable crops in the central Region of Mexico. Florida entomologist **98**(2): 430–438.

Perkins HH, 1983. Identification and processing of honeydew contaminated cotton. Textile Research Journal **53**(8): 508–512.

Rizk GA, Moftah EA, Karaman GA, Abdel-Naby AA, 1990. Effectiveness of different planting dates on the population density of some sucking pests attacking soybean plants in Minia region. Assiut Journal of Agricultural Sciences **21**(3): 141–151.

Southwood TRE, 1978. Absolute Population Estimates using Marking Techniques. In: Ecological Methods. Springer, Dordrecht, Netherlands, 70–129 pp.

Steel GDR, Torrie HJ, 1981. Principles and procedures of statistics. McGraw-Hill College, Columbus, USA.

Tomczyk A, Pilko A, 1996. Prospects for integration of the defense abilities of the host plant and *Phytoseiulus persimilis* activity in spider mite control on cucumber. Bulletin OILB/SROP **19**(1): 175–178.

Ullé MD, Acier AC, Bankhead-Dronnet S, Harrington R. 2010. Aphids in the face of global changes Comptes Rendus Biologies **333**: 497–503.

Van Lenteren JCV, Noldus LPJJ, 1990. Whitefly-plant relationships: behavioural and ecological aspects. In: Whiteflies: their bionomics, pest status and management. Research output of Wageningen University, USA, 47-89.

Varma A, Mandal B, Singh MK, 2013. Emergence of begomoviruses: a major threat to vegetable production in Southeast Asia. Proceedings from the Regional Symposium on High Value Vegetables in Southeast Asia: Production, Supply and Demand, Chiang Mai, Thailand, 88–96 pp.