

EFFECT OF CROP ROTATION ON POPULATION DYNAMICS OF TWO SPOTTED SPIDER MITE, *TETRANYCHUS URTICAE*; LEAF MINER, *LIRIOMYZA SP*; AND PREDATORY MITE, *TYPHLODROMUS SWIRISKII*

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ABSTRACT: This study was carried out in Gemiza Agricultural Research Station, El-Gharbia governorate, Egypt to evaluate the influence of crop rotation on the susceptibility of plant cultivars : Faba bean, sugar beet , wheat, sunflower and maize to the infestation by sucking piercing pests under field conditions for two successive seasons (2012/2013 & 2013/2014) , and the population density of the predatory mite, *Typhlodromus swerskii*. Weekly leaf samples were collected from each crop and transferred to the laboratory for microscopic examination. The obtained results revealed that the population of the leaf minor, *Liriomyza sp* infested the tested crops was started early in first December, while the two spotted spider mite, *Tetranychus urticae* infesting faba bean plants was early started in late December. The numbers of the pest increased gradually form one peak on all cultivars in both seasons. It rerecorded by 680 in 27/ Jun and 678 individuals/ 10 faba bean leaflets, respectively. On the other hand, data recorded average number of different stage (eggs and moving stages of mite / leaf in faba bean and sugar cone fields. the numbers increased gradually to reach their peak in 6/April for faba bean and the sugar cone cultivars in 2013 season with average numbers of 12.5 and 14.5 individuals of eggs and moving stages of mite / leaf in faba bean and 8.2 and 10.3 individuals/ eggs and moving stages of mite in the sugar cone cultivars, respectively. Also data recorded that Sunflower crop (*Helianthus annus*) and Maize (*Rely crop*) cultivars after Faba bean, Sugar beet and Wheat, differed in their infestation by *T. urticae*. The high number of infestation were eggs and moving stages recorded on faba bean and rely crop cultivars flowed by faba bean.

Key words: Faba bean , Sunflower , Sugar beet , *Tetranychus* , *Liriomyza* , *Typhlodromus* .

INTRODUCTION

The two-spotted spider mite, *Tetranychus urticae* Koch, and the leaf miner, *Liriomyza sp.* are phytophagous feeding habitats and considered a serious pests against many field crops world-wide.

The divers of host plant species may have been result different effects on plant varieties. *T. urticae* infested most of cultivated crops in Egypt (Faba bean, Sugar beet , Wheat, Sunflower and Maize). These latter five plants are economic important crops, commercially produced all over of Egypt.

The importance of the *Tetranychus* mite is not only due to direct damage to cultivated plants including defoliation, leaf burning, and even in excessive outbreaks plant death, but also indirect damage to plants which decreases in photosynthesis and transpiration processes causing great loss in yield (Brandenburg and Kennedy, 1987 and Golam, 2002).

Host plants of spider mites differ in the degree of food quality, which either depend on the level of primary plant metabolites, or on the quantity and nature of secondary metabolites (Rosenthal and Berenbaum, 1991).

Sunflower plant (*Helianthus annus*) is widely cultivated in many parts of the world as major and strategy oil crop. Sunflower crop (*Helianthus annus*) is considered an important host to a huge number of insect pests (Charlet and Brewer, 1998); however there is a considerable variation in the respective importance of the different pests in different countries. In the meantime, productivity is rather limited due to many factors i.e. Variety ,

Faba bean (*Vicia faba*) attacked by serious pests reduces its quality and quantity, Ebadah *et al.* (2006). The major insect pests that attack the green parts of the bean in Egypt are the leaf miner, *Liriomyza trifolii* (Burgess) or *Liriomyza congesta* Becker, Abate and Ampofo (1996) and Ebadah *et al.* (2006).

The purpose of this study was to observe the effects of crop rotation (Relay planting) of faba bean, sugar beet and wheat cultivars followed by sun flower followed by maize, on the infestation with two pests, i.e. *Tetranychus urticae* , Koch. and leaf miner *Liriomyza* sp. and the predatory mite, *Typhlodromus swerskii*.

MATERIALS AND METHODS

The present study was conducted at the Experimental Farm of Gemiza Agricultural Research Station, El-Gharbia governorate, Egypt, during two successive seasons (2012/13 to 2013/14). An area of about one Feddan was divided into 100 plots of equal size (20 m²) where each plot was separated from each other by uncultivated area , and arranged in completely randomized blocks with three replicates for each planting.

Planting:

The experiments were carried out during two successive winter and summer seasons 2012- 2013 and 2013-2014. In each season, an area of about one feddan was prepared and divided into 9 plots of about 20 m² each.

Every plot was separated from other by uncultivated two rows. Seed varieties were obtained from Ministry of Agriculture. Seeds of faba bean, *Vicia faba*, sugar beet , *Beta vulgaris* and bread wheat , *Triticum aestivum* , were sown at November 21th and 23th for first and second seasons (2012/13 and 2013/14) . Seeds were planted (2-10 seeds/hill) at a distance of 20 cm between hills. Each crop was replicated in 3 plots. Experiments were arranged in complete randomized block design.

Five plants from each plot were randomly chosen where 15 leaves (leaflets) from different plant levels were biweekly collected as a composite sample for each plant variety, transferred to the laboratory for microscopic examination. The numbers of leaf miners and mites as well as any parasites and predators were recorded. The first sample for the examination process was conducted one month after planting time.

Regarding to the summer season sunflower, *Helianthus annus* seeds and maize, *Zea* maize were sown at May 14th on one side of the ridge at 20 cm spacing for first and second seasons.

A sample of 10 leaves were randomly selected biweekly from upper, middle and lower level of sunflower plants per each plot. Samples started after 15 days from sowing date then continued to harvesting. The selected samples were transferred to the laboratory for inspection with dissecting stereomicroscope to count the number of *Tetranychus urticae* and the leaf miner, *Liriomyza* sp. As well as the predatory mite, *Typhlodromus swerskii*.

The obtained data were analyzed using ANOVA with the computer program (SAS Institute, 1988) which runs under WIN to determine any significant difference between the means.

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RESULTS AND DISCUSSION

This study was carried out to evaluate the susceptibility of certain cultivars of faba bean, sugar beet, wheat, sunflower and maize to observe the infection by two piercing sucking pests: *Tetranychus urticae* Koch, and *Liriomyza* sp. (Paoli) (nymphs) under field conditions for two successive seasons (2012/13 – 2013/14) in Gharbia governorate, Egypt.

1) The leaf borer, *Liriomyza* sp:

The biweekly average numbers of *Liriomyza* sp population infested faba bean plants of 2012/13 and 2013/14 seasons was shown in Table (1).

Liriomyza sp individuals were recorded from the first date of inspection and continued to the end of the experiment along the two seasons. The numbers of the pest sharply increased to 680 in 27 January and 678 individuals/ 10 faba bean leaves, respectively, in 28 January, while these numbers were decreased gradually to 23 and 25 individuals/ 10 faba bean, respectively in 20 and 21 April in 2012 and 2013 seasons, respectively. Thus, the faba bean varieties could be arranged in descending order according to their susceptibility to infestation with leaf miners during the two seasons (2012-2013 and 2013-2014).

Table (1): Average numbers of the leaf minor stages infesting faba bean plants along two successive Winter seasons 2013 & 2014.

First season 2012/2013		Second season 2013/2014	
Sampling Date	Leaf minor/ 10 leaves	Sampling Date	Leaf minor/ 10 leaves
02/12/ 012	73	3/12/2013	82
16/ 12	155	17/12	166
30/12	566	31/12	560
Mean Dec.	264.66 d	Mean Dec.	269.33 d
13/1/2013	630	14/1/2014	640
27/1	680	28/1	678
Mean Jan.	655.0 a	Mean Jan.	659 a
10/2	622	11/2	610
24/2	504	25/2	520
Mean Feb.	563.0 b	Mean Feb.	565 b
9/3	373	10/3	320
23/3	369	24/3	288
Mean Mar.	371.0 c	Mean Mar.	304 c
6/4	160	7/4	130
20/4	23	21/4	25
Mean Apr.	91.5 e	Mean Apr.	77.5 d
Overall mean	389.0	Overall mean	375.0
LSD 5%	86.7	LSD 5%	80.3

Means in each column followed by the same letter(s) are not significantly different at $p < 0.05$ according to Duncan's multiple-range test.

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On the other hand the high mean numbers of *Liriomyza* sp. were recorded by 655 and 659 in June month and 563 & 565 individuals in February along the two seasons of study, respectively.

The statistical analysis of the obtained data revealed that there were significant differences in the numbers of leaf minor stages among the tested periods.

2) The two spotted spider mite, *Tetranychus urticae*:

Data in Table (2) show the average numbers of different stages (eggs and moving stages of mite / leaf in faba bean and sugar beet fields. *T. urticae* began to

take place in faba bean and sugar beet fields in 27 December 2012 and 7 February 2013 season, then the numbers increased gradually to reach their peak in 6 April for faba bean and the sugar beet cultivars in 2012 season with average numbers of 12.5 and 14.5 individuals of eggs and moving stages of mite / leaf in faba bean and 8.2 and 10.3 individuals/ eggs and moving stages of mite in the sugar beet cultivars, respectively. The statistical analysis of the obtained data revealed that there were significant differences in the numbers of *T. urticae* stages among the tested periods and crops.

Table (2): Average numbers of two spotted spider mite population, *T. urticae* infesting Faba bean, Sugar beet, Wheat plants along Winter season 2012 / 2013.

Sampling date	Average number of mite stages / leaf					
	Wheat		Sugar beet		Faba bean	
	Egg	Moving stages	Egg	Moving stages	Egg	Moving stages
13/12/2012	0	0	0	0	0	0
27/12	0	0	0	0	0.4	0.5
Mean Dec.	0	0	0 b	0 c	0.2 d	0.25 c
10/1/2013	0	0	0	0	1.2	0.8
24/1	0	0	0	0	1.4	0.9
Mean Jan.	0	0	0 b	0 c	1.3 d	0.85 c
7/2	0	0	0	0.5	2.1	1.9
21/2	0	0	1.6	1.2	5.6	3.4
Mean Feb.	0	0	0.8 b	0.9 c	3.9 c	2.7 b
7/3	0	0	4.2	3.1	9.2	7.5
21/3	0	0	5.2	4.1	11.1	9.9
Mean Mar.	0	0	4.7 a	3.6 b	10.2 a	8.7 a
5/4	0	0	10.3	8.2	14.5	12.5
19/4	0	0	1.1	1.3	1.2	4.1
Mean Apr.	0	0	5.7 a	4.8 a	7.9 b	8.3 a
Overall mean	0	0	2.30	1.89	4.92	4.32
LSD 5%	-	-	1.15	1.15	1.63	1.4

Means in each column followed by the same letter(s) are not significantly different at $p < 0.05$ according to Duncan's multiple-range test.

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Population of *T. urticae* Koch as influenced by the crop rotation of sun flower after faba bean, wheat and sugar beet:

The population dynamics of adults, immature and eggs of *T. urticae* during first season (2012/2013) are shown in Table (3). The infestation of the sun flower plants, which was planted after faba bean, wheat and sugar beet, by *T. urticae* was started in late April, then it gradually increased and reached their peaks in June 7 in sun flowers cultivars, crop and sun flower planting after wheat and sugar beet. The highest numbers of adults, immature and eggs of *T. urticae* averaged 17.4 & 32.1 immature and eggs of *T. urticae*, after

wheat, 22.2 & 38.1 immature and eggs of *T. urticae* after sugar beet and 17.5 & 33.0 immature and eggs of *T. urticae*, individuals /10 leaf, but when planting sun flower after faba bean the first peak was recorded in 24 May and estimated by 25.1 and 41.2 immature and eggs of *T. urticae*, respectively.

Generally, the results indicated that sun flower planted after faba bean (rely crop) was more susceptible to the infestation by *T. urticae* than all other cultivars along the two seasons of the study. The highest overall mean numbers of moving stages and eggs of *T. urticae* were 14.52 & 28.06 moving stages and eggs of *T. urticae*.

Table (3): Population fluctuation of the two spotted spider mite, *Tetranychus urticae* as influenced by the crop rotation: sun flower after faba bean, wheat and sugar beet

Sampling date (Planted 22/3/2012)	Sun flower		Faba bean		Wheat		Sugar beet	
	Average number of mite stages / leaf							
	Egg	moving stage	Egg	moving stage	Egg	moving stage	Egg	moving stage
22/4/2012	8.3	2.3	9.7	3.0	4.2	2.1	7.8	2.2
26/4	15.2	6.2	19.2	9.6	5.1	3.0	14.5	6.0
Mean Apr.	11.75b	4.25b	14.1c	6.3b	4.65b	2.55b	11.15c	4.1b
10/5	26.2	8.7	37.0	13.6	24.2	8.6	27.0	8.8
24/5	29.5	15.2	42.3	27.3	32.5	19.1	29.6	15.0
Mean May	27.85a	11.99a	39.7a	17.95a	28.4a	13.85a	28.3a	11.9a
7/6	32.1	17.4	41.2	25.1	38.1	22.2	33.0	17.5
21/6	15.1	5.3	19.2	10.2	12.0	8.2	14.4	6.0
Mean Jun.	23.6a	11.35a	30.2b	17.65a	25.1a	15.2a	23.7b	11.75a
LSD 5%	4.3	2.8	6.8	3.5	6.3	6.3	3.5	2.0
Overall mean	26.62	9.18	28.06	14.52	19.35	10.53	21.05	9.25

Means in each column followed by the same letter(s) are not significantly different at $p < 0.05$ according to Duncan's multiple-range test.

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The statistical analysis of the obtained data revealed that there were significant differences in the numbers of two spotted spider mite stages among the tested periods at all examined crops.

Population of *T. urticae* Koch as influenced by relay crop Maize after sun flower sugar cane, wheat, faba bean and maize.

Data in Table (4) recorded the average numbers of different stages (eggs and moving stages) of the spotted spider mite / leaf in maize planting after sun flower, sugar beet, wheat, faba bean and maize. The infestation by *T. urticae* during the season 2012 was started at 2nd week of Jun. in all tested cultivars. The number of immature and eggs were averaged by 13.1, 19.2 individuals / leaf, 16.5, 21.0 individuals / leaf on maize after planting in faba bean, 13.6, 19.0 individuals / leaf, respectively, on maize after planting in wheat crop 12.9 and 18.0 individuals / leaf on maize after planting in

sugar beet crop.

The statistical analysis of the obtained data revealed that there were significant differences in the numbers of two spotted spider mite stages among the tested periods.

Survey and population dynamics of predator *Typhlodromus swerskii* on faba beans:

Data recorded in Table (5) showed the influence level of *Typhlodromus swerskii* on faba beans along winter plantation. Afterwards, the population of predator disappeared completely in the first three weeks of December. As indicated in this study the predator mite started their activity by a few numbers in 4th week of December and increased slowly until the last week of April in the tow seasons, during these period recorded three peaks in 2012- 2013 and four peaks in 2013-2014 season.

Table (4): Population of *T. urticae* Koch as influenced by relay crop maize after sugar beet, wheat, faba bean and maize.

Sampling date (planted 15/5/2012)	Maize		Sugar beet		Wheat		Faba bean	
	Average number of mite stages / leaf							
	moving stage	egg	moving stage	egg	moving stage	egg	moving stage	Egg
10/6/2012	1.2	2.1	1.0	1.8	1.1	1.7	2.2	3.0
24/6	5.0	7.3	5.2	7.0	4.5	7.0	6.7	9.2
Mean Jun.	3.1 c	4.7c	3.1 c	4.4 b	2.8 c	4.35c	4.45c	6.1b
8/7	9.2	13.5	9.2	14.0	10.0	13.2	11.2	15.6
22/7	13.1	19.2	12.9	18.0	13.6	19.0	16.5	21.0
Mean Jul.	11.15a	16.35a	11.05a	16.0a	11.3 a	16.1a	13.85a	18.3a
5/8	11.1	12.0	12.1	8.5	10.2	9.5	16.3	11.0
19/8	5.3	4.2	3.1	5.2	5.1	5.1	2.3	4.0
Mean Aug.	8.2 b	8.1 b	7.6 b	6.85b	7.65 b	7.3 b	9.3 b	7.5 b
LSD 5%	2.0	2.8	2.0	2.8	2.0	2.0	2.0	2.0
Overall mean	7.48	9.71	7.25	9.08	7.36	9.25	9.2	11.74

Means in each column followed by the same letter(s) are not significantly different at p<0.05 according to Duncan's multiple-range test.

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Table (5): Population fluctuation of the predatory mite , *Typhlodromus swerskii* on faba bean plants along two successive Winter seasons.

2012/2013		2013/2014	
Sampling dates	Ave.number of <i>Typhlodromus swerskii</i> / leaf	Sampling dates	Ave.number of <i>Typhlodromus swerskii</i> / leaf
5/12/2012	0	5/12/2013	0
12/12	0	12/12	0
19/12	0	19/12	0
26/12	0.36	26/12	0.55
Mean Dec.	0.09 f	Mean Dec.	0.14 e
1/1/2013	0.29	1/1/2014	0.47
8/1	0.48	8/1	1.15
15/1	0.56	15/1	1.39
22/1	0.89	22/1	1.67
29/1	1.2	29/1	1.57
Mean Jan.	0.68 e	Mean Jan.	1.25 d
5/2/2013	1.05	5/2/2014	2.41
12/2	1.46	12/2	2.17
19/2	1.24	19/2	2.25
26/2	1.37	26/2	2.17
Mean Feb.	1.28 d	Mean Feb.	2.25 c
3/3/2013	1.38	3/3/2014	2.25
10/3	1.68	10/3	2.99
17/3	1.90	17/3	2.76
23/3	1.48	23/3	2.91
30/3	2.18	30/3	3.01
Mean Mar.	1.72 c	Mean Mar.	2.78 b
7/4/2013	2.30	7/4/2014	3.22
15/4	2.58	15/4	3.35
22/4	2.75	22/4	3.56
29/4	3.22	29/4	3.34
Mean Apr.	2.71 b	Mean Apr.	3.37 a
6/5	3.52 a	6/5	2.22 c
LSD 5%	0.26	LSD 5%	0.26
Grand mean	1.18	Grand mean	3.41

Means in each column followed by the same letter(s) are not significantly different at $p < 0.05$ according to Duncan's multiple-range test.

In 2012-2013 seasons the predator of *Typhlodromus swerskii* appeared in 26 December then reached their higher numbers in 5 February with average numbers of 1.54, 3.52 individuals/ leaves, in 22 April, respectively.

In case of 2013- 2014 seasons, *T. swerskii* also took place in faba bean plots from the fourth week of inspection, and increased gradually to four peaks in faba bean plots in 26 June, and 12, February, 3 March, and 15, April with average numbers of 2.41, 2.25, 2.99 and 3.56 individuals of *T. swerskii* / 10 faba bean leaves, respectively.

The statistical analysis of the obtained data revealed that there were significant differences in the numbers of the predatory mite among the tested periods.

From the obtained data it could be concluded that both of *T. urticae* and *Liriomyza sp* exhibited one peak on faba bean. Peaks of *T. urticae* and *Liriomyza sp* occurred on the 4th and 1st weeks of Jun and April in both seasons (2012/2013). The faba bean, sugar beet, wheat, sunflower and maize cultivars differed in their infestation by *T. urticae*. The highest numbers of infestation with moving stages and eggs of *T. urticae* were recorded on faba bean cultivated after sunflower, maize, followed by faba bean.

Generally, the results indicated that cultivar faba bean proved to be susceptible than all cultivars in the two seasons of the study, because it harbored significantly the highest average number of *T. urticae* individuals. This variance in infestation rate of piercing and sucking pests to faba bean reties may be due to the preference of host selection or the tendency of varieties tolerant and including, physical and chemical characters of the plants. The obtained results are in the agreement with those obtained by Waheeb (1998) who

recorded that the peak infestation by *T. urticae* on Soybean cultivar occurred at May population in Egypt, Mohamed and Omar (2007) studied the population fluctuations of *Tetranychus urticae* and its predators, *Amblyseius swirskii* & *A. cydnodactylon*. They recorded that the highest values for *T. urticae* and its predatory species appeared at the times of high temperature and R.H. through at end of the two seasons, Abd El-Karim (2010) who reported that the mite population gradually increased from mid April and reached the maximum at the end of May. In addition, Rizk *et al.* (2012) conducted survey and population dynamics of predators: Coccinellidae (*Coccinella undecimpunctata* L.), *Chrysoperla carnea* and *Typhlodromus swerskii* (Phytoseiidae) in addition to phytophagous mites. Results indicated that the spider mite started their activity by a few numbers in November and increased slowly until the mid of January then reach the maximum at the end of January. Recently, Romeih *et al.* (2013) showed that both of *T. urticae* and *S. longicornis* exhibited one peak on cucumber and beans. Peaks of *T. urticae* and *S. longicornis* occurred on the second and third weeks of April for bean and cucumber in both seasons (2007 and 2008).

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تأثير التتابع المحصولي على تذبذب التعداد لكل من أكاروس العنكبوت الاحمر وصناعات انفاق الاوراق والاكاروس المفترس تيفلودرومبس سواريسكاي

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^(٢) معهد بحوث وقاية النبات - محطة بحوث الجميزة - الغربية

الملخص العربى

أجريت هذه الدراسة لتقييم حساسية زراعات الفول البلدى وبنجر السكر والقمح وعباد الشمس والذرة لكل من أكاروس العنكبوت الأحمر وصناعات أنفاق الأوراق والمفترس الأكاروسى تيفلودروماس سواريسكاي. تم تقدير تعداد الافراد الحشرية لصناعة الاوراق *Liriomyza sp* وأكاروس العنكبوت الاحمر *Tetranychus urticae* والمفترس الأكاروسى *Typhlodromus swerskii* تحت الظروف الحقلية وذلك بأخذ عينات ورقية اسبوعية من المحاصيل تحت الدراسة لموسمين متتالين ٢٠١٢/٢٠١٣ ، ٢٠١٣/٢٠١٤ وذلك بمحطة الجميزة البحثية التابعة لمعهد بحوث وقاية النباتات - محافظه الغربية. أشارت النتائج أن تعداد صناعة انفاق الأوراق بدأ مبكرا فى الأول من ديسمبر ولكن إصابه الفول البلدى بالأكاروس كان مبكرا وبدأ فى أواخر ديسمبر من كل موسم. كما زاد تعداد الحشرات تدريجيا وبلغت الذروه على كلا الزراعات فى الموسمين فى شهر يناير. زادت الأعداد تدريجيا حتى بلغت الذروه فى ٦ ابريل لزراعات الفول وبنجر السكر فى موسم ٢٠١٣ بمتوسطات ١٢,٥ ، ٨,٢ ، ١٠,٣ فرد/بيضة او اطوار متحركة من الأكاروس فى زراعات البنجر على التوالي. كذلك سجلت النتائج إصابات محصولى عباد الشمس والذره (تعاقب الزراعات بعد الفول) البنجر والقمح كانت هناك إختلافات فى معدلات الإصابة بالعنكبوت الاحمر. أشارت النتائج الى ان معدل الاصابات العالية كانت للبيض والافراد الكاملة على الفول والزراعات المتتابة بعد الفول .