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Effect of Some Ecological Studies on *Tetranychus urticae* Koch and Its Predator *Neoseiulus californicus* on Two Medicinal and Aromatic Plants.

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ABSTRACT

The two investigated plants, sweet marjoram (*Origanum majorana* L.) and sweet basil (*Ocimum basilicum* L.) plants are considered the most important medicinal and aromatic plants. They are infested with many mites specially, the *Tetranychus urticae* Koch during growing season which cause considerable damage in the crop under Egyptian conditions. The present study was conducted during 2014 & 2015 seasons for sweet marjoram and sweet basil plant species at Giza governorate to survey the mite infesting these two crops at both governorates, the population fluctuations of the most important key mite and their relation to the a biotic factors (Mean temperatures & mean relative humidity as well as their associated predator, *Neoseiulus californicus* as biotic factor. Survey of mite species *T. urticae* (larvae, nymphs & adults) and predator species were recorded on sweet marjoram and sweet basil at Giza governorate. These factors gave different correlations with the population activity at Giza governorate and both host plants.

We present the results of a two-year study on the population dynamics of *T. urticae*, as well as the association between weather parameters and the seasonal population trends of *T. urticae*. The objective of the present study was to find out the cause of mite outbreaks under the different climate condition and its predator effect as biotic agent.

INTRODUCTION

Temperature can influence the rate of development and reproduction of both biological control agents and mites. For example, the predatory mite, *Phytoseiulus persimilis* is most effective at temperatures between 20 and 30°C because at this temperature range, the development time of *Phytoseiulus persimilis* is shorter than the two spotted spider mite (*Tetranychus urticae*). The optimal temperature for foraging, development and reproduction is 25 to 30°C However, searching activity decreases when temperatures are greater than 30°C. Furthermore, at temperatures greater than 30°C the development time of the twospotted spider mite is shorter than *Phytoseiulus persimilis*.

A relative humidity less than 40 percent may affect egg survival, adult longevity and female reproduction of the predatory mite (Stenseth, 1979).

A critical factor that may affect the effectiveness of biological control agents in regulating mite populations is the environmental conditions such as temperature, relative humidity, and day length (photoperiod) and light intensity. These environmental parameters, if not appropriate for the specific biological control agent, can influence reproduction, foraging behavior and survival. The predatory behaviour of *Stethorus punctillum* was studied on the two-spotted spider mite (*Tetranychus urticae*), in order to assess how it responded to temperatures and relative humidities. The results show that activity of *S. punctillum* significantly increased at higher temperatures. Host plant species also strongly influenced the performance of the predator, which was most active on pepper and tomato and least active on aubergine. Relative humidity had no significant influence. Rott and Ponsonby (2000).

Effect of temperature on developmental duration and demographic parameters of *Tetranychus urticae* Koch were investigated at five constant temperatures the intrinsic rate of increase for *T. urticae* ranged from 0.08 at 15°C to 0.321 at 30°C. Temperature increases reproduction, as well as, the developmental rate of several tetranychid mites, such as found to *T. bastosi* (Bounfour & Tanigoshi, 2001).

Barber *et al.*, (2003) revealed that the predatory mite *Neoseiulus californicus* (McGregor) prefers Tetranychid mites as food, but will also consume other mite species, small insects, such as thrips, and even pollen when the primary prey is unavailable and it is often used to control the two spotted spider mite, *Tetranychus urticae* Koch, and other phytophagous mites on various crops in temperate and subtropical regions around the world.

Neoseiulus californicus was first described by McGregor from lemon in California as *Typhlodromus californicus*. *Neoseiulus californicus* is used commercially around the world to control the twospotted spider mite and several other economically important mites on avocado, citrus, dwarf hops, grapes, raspberries, roses and other ornamentals, strawberries, and several vegetable crops. It has been shown to effectively control the twospotted spider mite *Neoseiulus californicus* has been used successfully to control twospotted spider mites on field grown strawberries in southern California and Florida. *Neoseiulus californicus* has also been used to control the two spotted spider mite on dwarf A predator in first technique, where *Neoseiulus californicus* is released at a low rate before twospotted spider mites infestations appear, has become popular in California strawberries. If two spotted spider mite populations are already high, it may be necessary to spray a matricide before releasing *Neoseiulus californicus*. The predatory mite can tolerate applications of some matricides (Fraulo *et al.*, 2008).

The divergence in mite population between two growing seasons was attributed mainly to temperature differences between the two seasons that affected mite population development and establishment. (Teresia and Oscar 2013).

Recently, aromatic and medicinal plants attracted more attention and their economic importance increased nowadays in Egypt as exported agricultural products used in various pharmaceutical therapeutic purposes. Thus, there has been a considerable expansion in cultivation of these crops in Egypt. The Japanese honeysuckle, *Lonicera japonica* Thunb, which known as Jasmine (Family: Caprifoliaceae) has been a valued herb in traditional Chinese medicine for many centuries and is used in other countries as a natural remedy as well.

Although, it is native to Korea, Japan, and China, this perennial, which can be either a vine or a shrub, has become naturalized in other countries, including Great

Britain and the United States. Every part of this plant can be used medicinally (Morad *et al.*, 2016). The present work was Effect of some ecological factors on abundance of mite infesting sweet marjoram and sweet basil at Giza governorate and its predator *Neoseiulus californicus*.

MATERIALS AND METHODS

In order to study the seasonal abundance of the mite, *Tetranychus urticae* Koch on sweet marjoram, *Origanum Majorana* L. , and sweet basil, *Ocimum basilicum* L , field experiment was carried out during two successive years 2014 and 2015 at the experimental farm of different locations (Giza). The previous locality was visited weekly.

Mite and its natural enemies occurred on sweet marjoram, *Origanum Majorana* L. and sweet basil, *Ocimum basilicum* L. were population for two years (2014&2015). All the recommended agricultural practices were adopted. No chemical insecticidal treatments were used during the two studied growing seasons.

The survey was carried out by using direct field observation followed by laboratory examination; this method was done by inspecting 25 leaves from the four different directions (North, South, East and West), in addition to the center of the field., then transferred in paper bags to the laboratory to examine by the aid of stereomicroscope and identify the collected mite and natural enemies.

For sweet marjoram plant, the seeds were cultivated in an area of about in 2100 m² the vegetative part was harvested four times (cuts) each year (2014 and 2015) 25 shoots were collected weekly at random, kept in paper bag and transferred to the laboratory to examine and count the number of investigated mites as well as the predator, *Neoseiulus californicus* as a biotic factor. The total counts of the investigated mite and the predator /25 shoot were registered and the counts started from 16th of January, 2014 to 28th of December, 2015 for both years at Giza governorate.

For sweet basil, seeds were cultivated in an area of 700m²; in a nursery on 16 April 2014 or 2015 and the seedling were transplant to field from 15 June 2014 or 2015 to 16 of November, for both seasons at Giza governorate. The vegetative part was harvested from 15th of June, 2014 or 2015 to 16th of November, during both seasons (2014 and 2015), 25 leaves were collected weekly at random, introduced to paper bag and transferred to the laboratory to examine and count the number of investigated mite as well as the predator, *Neoseiulus californicus* as a biotic factor. The total counts of mite and the predator /25 leaves were registered. The experiment was designed in a complete randomized block. All the experimental plots received the normal agricultural practices of mechanical weed control, irrigation, and fertilization, and kept with no pesticide application.

Effect of some ecological factors on abundance of mite infesting sweet marjoram and sweet basil at Giza governorate:

This study involved the seasonal fluctuation of the investigated mite in relation to certain weather factors (the weekly mean of the weather factors (Mean temperature. Mean relative humidity (R.H %), in addition, the relation to the predator, *Neoseiulus californicus*. The simple correlation coefficient (r) and the regression coefficient (b) were calculated between each of the above mentioned factors and the weekly mean numbers of mite or the predator at both seasons.

The experiment was designed in a complete randomized block. All the experimental plots received the normal agricultural practices of mechanical weed

control, irrigation, and fertilization, and kept with no pesticide application. This study involved the seasonal fluctuation of the investigated pests in relation to certain weather factors (the weekly mean of the weather factors (Maximum temperature, Minimum temp., Mean temp., Mean relative humidity (R.H%)), in addition, the relation to the predator, *Neoseiulus californicus*. The simple correlation coefficient (r) and the regression coefficient (b) were calculated between each of the above mentioned factors and the weekly mean numbers of mite or the predator at both seasons. The partial regression used to obtain basic information about the amount of variability in the activity of the studied pests.

Five ecological factors (4 physical + 1 biotic) were tested to clarify their simultaneous effects on the abundance of mite infesting sweet marjoram and sweet basil at Giza governorates throughout two successive years (2014 & 2015). Weekly counts of total numbers of mite was used as dependent factor (y), while the corresponding means of the five selected factors were used as independent factors, i.e. maximum mean temperature (x1); minimum temperature (x2); mean temperature (x3); mean percentage of relative humidity (x4); mean number of predator (x6). The effect of each factor separately was obtained by applying simple correlation formula and the regression coefficient (b). The combined effects of these five factors were obtained by applying C-multipliers formula and expressed as percentage of explained variance.

The variance ratio "F" was used as a measure of significant.

RESULTS

Survey of mite and associated predator occurred on two herbs species from family, Lamiaceae, sweet marjoram, *Origanum majorana* L. and sweet basil, *Ocimum basilicum* L. and their abundance were carried out throughout two successive years from January, 2014 till December, 2015 at Giza, governorate. The mite species recorded on these two herbs revealed the occurrence of one mite species *Tetranychus urticae* Koch (Order: Acariformes Fam.: Tetranychidae), and its associated predator *Neoseiulus californicus* (McGregor).

The data in Table (1) revealed that the population of *T. urticae* was higher in the second year with annual mean numbers of (20.5 individuals/ 25 shoots) when compared with the first year which reached 15.1 individuals/ 25 shoots.

In the first year, *T. urticae* began to attack sweet marjoram in the fourth week of January, 2nd week of February, first week of March, 3rd week of May, 2nd week of June of 3rd week July, first week of August, 2nd week of September, 2nd week of October, first week of November and 3rd week of December with mean number of 19, 15, 17, 15, 12, 47, 38, 41, 31, 25 and 46 individuals/25 shoots, respectively. Also, the mite population was totally disappeared in the period of the 4th week of March to 3rd week of April, for the first two weeks of May and the end of June to the first week of July.

To give six peaks on the 4th week of January, 1st week of March, 3rd week of May, 3rd week of July, 2nd week of September, and 3rd week of December.

While in the second year, the population of *T. urticae* was more active than the first year. In this year the activity recorded only five peaks in 1st week of February, 3rd week of July, 1st week of September, 4th week of October and 3rd week of November.

The mean number of the peaks was 41, 110, 60, 31 and 43 individuals / 25 shoots, respectively.

From the mentioned results, it can be concluded that the activity of the red spider, *T. urticae* was higher in the second year than the first one.

Table 1: Weekly mean numbers of mite infesting sweet marjoram at Giza Governorate during 2014 and 2015 seasons.

Sampling dates	2014	2015
	<i>Tetranychus urticae</i>	<i>Tetranychus urticae</i>
16/Jan.	13	0
26/01	19	40
02/Feb.	13	41
09/02	0	39
16/02	15	0
23/02	10	24
02/Mar.	17	0
09/03	16	0
16/03	7	10
23/03	0	15
06/Apr.	0	0
13/04	0	11
20/04	0	12
27/04	11	0
04/May	0	14
11/05	0	23
25/05	15	18
01/June	0	16
15/06	12	11
22/06	12	27
29/06	0	35
06/July	0	31
13/07	12	21
20/07	47	110
27/07	32	20
03/Aug.	38	30
10/08	23	28
24/08	12	37
31/08	17	56
07/Sept.	40	60
14/09	41	46
21/09	19	31
28/09	18	19
05/Oct.	27	20
12/10	31	3
19/10	30	0
26/10	25	31
09/ Nov.	25	21
16/11	18	20
23/11	11	43
30/11	15	41
07/Dec.	10	41
14/12	19	39
21/12	46	0
28/12	31	15
Total	698	943
Mean	15.1	20.5
F value	4.37*	

The data in Table (2) revealed that the population of *T. urticae* in the first season was almost similar to that in the second season with annual mean number of 22.96 and 23.69 individuals/ 25 leaves).

In the first season, *T. urticae* began to appear on sweet basil on the 3rd week of June. The population of this mite gave three peaks on the 3rd week of June, 2nd week of September and 4th week of October with 52, 134 and 31 individuals / 25 leaves, respectively. This mite totally disappeared for two weeks in July (third and fourth week) and also on the 1st week of October.

While in the second season, the population of *T. urticae* recorded five peaks on the 3rd week of July, 1st week of August, 4th week of September 4th week of October and 3rd week of November (the end of this season) with 61, 27, 53, 46 and 56

individuals / 25 leaves, respectively. *T. urticae* was higher in the second year than the first one at Giza governorate.

Effect of some ecological factors on population of mite infesting sweet marjoram and sweet basil at Giza governorates:

Five ecological factors (4 physical+1biotic) were tested to clarify their simultaneous effects on the population dynamics of *T. urticae* infesting sweet marjoram Giza governorates throughout two successive years (2014 and 2015).

Table 2: Weekly mean numbers of mite infesting Sweet basil, *Ocimum basilicum* L. at Giza governorate during seasons, 2014 and 2015.

Sampling dates	Season 2014	Season 2015
	<i>Tetranychus urticae</i>	<i>Tetranychus urticae</i>
15/Jun.	10	19
22/06	52	8
29/06	24	0
06/Jul	11	3
13/07	10	11
20/07	0	61
27/07	0	43
03/Aug	5	27
10/08	9	12
17/08	12	3
24/08	46	12
31/08	35	15
07/Sept	12	2
14/09	134	4
21/09	61	5
28/09	21	53
05/Oct	0	45
12/10	14	10
19/10	15	36
26/10	31	46
02/Nov	12	34
09/11	11	40
16/11	3	56
Total	528	545
Mean	22.96	23.69
F value	0.01	

The data in Table (2) revealed that the population of *T. urticae* in the first season was almost similar to that in the second season with annual mean number of 22.96 and 23.69 individuals/ 25 leaves).

In the first season, *T. urticae* began to appear on sweet basil on the 3rd week of June. The population of this mite gave three peaks on the 3rd week of June, 2nd week of September and 4th week of October with 52, 134 and 31 individuals / 25 leaves, respectively. This mite totally disappeared for two weeks in July (third and fourth week) and also on the 1st week of October.

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individuals / 25 leaves, respectively. *T. urticae* was higher in the second year than the first one at Giza governorate.

Effect of some ecological factors on population of mite infesting sweet marjoram and sweet basil at Giza governorates:

Five ecological factors (4 physical+1biotic) were tested to clarify their simultaneous effects on the population dynamics of *T. urticae* infesting sweet marjoram Giza governorates throughout two successive years (2014 and 2015).

The results at Table (3) revealed that maximum, minimum and mean temperatures had significant positive effects on seasonal fluctuations throughout both years ("r" values = 0.38, 0.32 and 0.33 during 2014 and 0.24, 0.38 and 0.31 during 2015 for the three ecological factors throughout both years, respectively). The mean percentage of relative humidity had insignificant positive effect during the first year ("r" value = 0.16), while it had significant positive effect during the second year ("r" value = 0.53). The correlation between *Neoseiulus californicus* and the seasonal fluctuation of *T. urticae* was insignificant positive in the first year ("r" value = 0.13) but in the second year, it had significant positive ("r" value = 0.28). The combined effects of the five selected ecological factors showed significant effect of 25% and 43% on the population dynamics of *T. urticae* throughout both years, respectively, where "F" values were 2.32 & 5.41, respectively.

Table 3: Relationship between five ecological factors and the changes in mean numbers of *Tetranychus urticae* populations on sweet marjoram at Giza governorate during 2014/2015

Tested factors	2014						2015					
	Simple correlation		Partial regression			%	Simple Correlation		Partial regression			%
	r	P	b	S.E.	P		R	P	b	S.E.	P	
Max. Temp.	0.38	0.01	2.19	1.08	0.05	25%	0.24	0.009	-1.82	1.68	0.28	43%
Min. Temp.	0.32	0.02	0.07	1.36	0.96		0.38	0.01	2.65	1.82	0.15	
Mean Temp.	0.33	0.02	-0.03	0.99	0.97		0.31	0.03	0.36	2.62	0.89	
RH%.	0.16	0.27	0.89	0.78	0.25		0.53	0.0001	-0.005	0.40	0.99	
Predator	0.13	0.36	0.07	0.73	0.92		0.28	0.05	-0.19	0.36	0.59	

"F" value= 2.32*

Max. Temp.: Maximum temperature

Min. Temp. Minimum temperature

Mean Temp. Mean temperature

F" value= 5.41**

RH%: Mean relative humidity

Predator: *Neoseiulus californicus*

The associated predators occurred on sweet marjoram at Giza governorates.

Survey of associated predators abundant on sweet marjoram revealed the occurrence of *Neoseiulus californicus* in high numbers throughout the two successive years.

The temperature is inversely proportional on the abundance of mite on the sweet marjoram throughout both years.

The relative humidity directly proportional during the first year with the abundance of mite on the sweet marjoram during the first year, while at the second year is inversely proportional with the abundance of mite on the sweet marjoram.

With regard to the biotic factor (*Neoseiulus californicus*) it is directly proportional during the first year with the abundance of mite on the sweet marjoram while at the second year is inversely proportional with the abundance of mite on the sweet marjoram.

These results at Table (4) revealed that maximum, minimum and mean temperatures had insignificant positive effects in the first season but in the second

season it had insignificant negative effects (“r” values = 0.08, 0.08 and 0.16 during 2014 and -0.39, -0.18 and -0.40 during 2015 for the three ecological factors, respectively). The mean percentage of relative humidity had insignificant negative effect on the seasonal fluctuations in the first season (“r” values = -0.14) but in the second season it had insignificant positive (“r” values = 0.28). Regarding to the effects of the biotic factor, it showed insignificant positive effects on the seasonal fluctuations of *T. urticae* on both seasons (“r” values = 0.01 and 0.25). The combined effects of the five selected ecological factors showed that these factors were responsible as a group for 8 % and 55 % effects on the population dynamics of *T. urticae* throughout both seasons, respectively. These percentages of explained variance were insignificant in the first season, where “F” value = 0.26 and it was significant in the second season (“F” value = 3.45).

Table 4: Results of statistical analysis of simple correlation and partial regression to investigate the relationship between five ecological factors and the changes in mean numbers of *Tetranychus urticae* on sweet basil at Giza governorate during seasons, 2014 and 2015.

	2014						2015					
Tested factors	Simple correlation		Partial regression			%	Simple correlation		Partial regression			%
	r	P	b	S.E.	P	E.V.	r	P	b	S.E.	P	E.V.
Max. Temp.	0.08	0.72	-2.23	4.25	0.61	8%	-0.39	0.06	11.45	7.13	0.13	55%
Min. Temp.	0.08	0.71	2.00	5.69	0.73		-0.18	0.40	8.77	6.08	0.17	
Mean Temp.	0.16	0.44	2.35	4.06	0.57		-0.40	0.05	-22.48	8.93	0.02	
RH%	-0.14	0.52	-3.08	4.34	0.49		0.28	0.19	0.83	1.64	0.62	
Predator	0.01	0.95	-0.44	1.89	0.53		0.25	0.24	4.97	2.04	0.03	

“F” value= 0.26

“F” value= 3.45*

Max. Temp.: Maximum temperature

RH%: Mean relative humidity

Min. Temp. Minimum temperature

Predator: *Neoseiulus californicus*

Mean Temp. Mean temperature

The temperature is directly proportional during the first year, while at second year is inversely proportional with the abundance of mite sweet basil.

The relative humidity inversely proportional during the first year, while at second year is directly proportional with the abundance of mite sweet basil.

With regard to the biotic factor (*Neoseiulus californicus*) it has no mentioned effect on the abundance of mite sweet basil both years.

The combined effects of the four selected ecological factors showed that these factors were insignificant at the first year and significant in the second season on the abundance of mite on sweet basil.

DISCUSSION

The mentioned results, it can be concluded that the relation of the tested weather factors and the predator as biotic factor with population of the studied mite did not provide a consistent pattern on the two kinds of plant. These factors gave different correlations with the population activity at both years. But we can suggest

that the higher temperature can affect positively the abundance of mite on the agriculture of the sweet marjoram (Urais *et al.* 2010) and (Riahi *et al.* 2011).

The climatic conditions throughout growing season are favorable for the development of the two spotted spider mite. Thus, precautions against spider mites must be taken when the mite density reached a peak. To provide a better control against *T. urticae* we may spread the *Neoseiulus californicus* which may be an important predatory mite and disappeared or rarely present due to these unfavorable climate condition on some plants. (Ismail *et al.* 2007).

The predator *Neoseiulus californicus* may exhibit a particularly high capacity for population increase when fed on *T. urticae*, thus may be able to provide effective control of this species in the field of the sweet marjoram. (Geroh *et al.* 2010).

CONCLUSION

According to the findings *Neoseiulus californicus* could be beneficial biocontrol agents in both high and low temperatures which tolerance to the changeable climate on sweet marjoram at Giza governorate.

The biological control agent of *Tetranychus urticae* Koch the *Neoseiulus californicus*, perform poorly on sweet basil probably because they are not well adapted to local climatic conditions.

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ARABIC SUMMERY

تأثير بعض الدراسات الايكولوجية على العنكبوت الاحمر والمفترس *Neoseiulus californicus* على اثنين من النباتات الطبية والعطرية

بسملة ابو النور

جامعة الازهر كلية العلوم - نبات - قسم الحيوان

واستهدفت النتائج الاتي دراسة التذبذبات العددية للأكاروس *Tetranychus urticae* علي نباتي البردقوش و الريحان و سجلت الآفة 6 قمم نشاط في الأسبوع الرابع من يناير و الأسبوع الأول من مارس و الأسبوع الثالث من مايو ويوليو و الأسبوع الثاني من سبتمبر و الأسبوع الثالث من ديسمبر 19، 15، 17، 47، 41، 46 فرد / 25 فرع على التوالي.

بينما في السنة الثانية كان تعداد العنكبوت الاحمر أكبر فقد سجل خمس قمم نشاط بتعداد 41، 110، 60، 31، 43 فرد / 25 فرع في الأسبوع الأول من فبراير الأسبوع الثالث من يوليو و الأسبوع الأول من سبتمبر و الأسبوع الرابع من أكتوبر و الأسبوع الثالث من نوفمبر على التوالي على البردقوش.

سجلت الآفة ثلاث قمم نشاط في السنة الأولى في الأسبوع الرابع من يونيو و الأسبوع الثاني من سبتمبر و الأسبوع الرابع من أكتوبر (52 و 134 و 31 / 25 ورقه على التوالي)

ولكن في السنة الثانية سجلت خمس قمم نشاط بتعداد 61، 27، 53 و 46 و 56 فرد / 25 ورقه في الأسبوع الثالث من يوليو و الأسبوع الأول من أغسطس و الأسبوع الرابع من سبتمبر و الأسبوع الرابع من أكتوبر و الأسبوع الثالث من نوفمبر على الريحان على التوالي.

تمت دراسة العلاقة بين 4 عوامل مناخية (درجة الحرارة العظمى - درجة الحرارة الصغرى - متوسط درجتي الحرارة العظمى والصغرى - متوسط نسبة الرطوبة النسبية) على الكثافة العددية للأكاروس *Tetranychus urticae* بالإضافة إلي المفترس *Neoseiulus californicus* علي أعداد الأكاروس محل الدراسة ومدى تأثيره بهذه العوامل في عامي الدراسة (2015 و 2014) وجد خلال عامي الدراسة 2014 و 2015 أن درجة الحرارة العظمى، درجة الحرارة الصغرى و درجة الحرارة المتوسطة ذات تأثير معنوي موجب مع العنكبوت الأحمر خلال عامي الدراسة. متوسط نسبة الرطوبة النسبية وجد أنها في العام الثاني ارتبطت ارتباط معنوي موجب مع العنكبوت الأحمر العام الأول. اظهر المفترس (*californicus* *Neoseiulus*) في العام الثاني ارتباط معنوي موجب والعنكبوت الأحمر مع نبات البردقوش

كان تأثير درجات حرارة تحت الدراسة معنوي سالب في العام الأول علي تعداد الأكاروس بينما كان التأثير معنوي موجب في العام الثاني. و كان تأثير متوسط نسبة الرطوبة النسبية معنوي موجب في العام الأول بينما كان التأثير معنوي سالب في العام الثاني.

كان وجود المفترس قليلا خلال عامي الدراسة فلا تأثير يذكر له علي تعداد الأكاروس علي نبات الريحان.