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Ecological and Toxicological Studies on *Thrips tabaci* Lindeman and Associated Spiders on Onion Plantations

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ABSTRACT

Population fluctuation of *Thrips tabaci* Lind. and its associated spiders in onion plantations, as influenced by some weather factors, was studied at El-Riad district, Kafr El-Sheikh Governorate, Egypt in two successive growing seasons 2008/09 and 2009/10. Toxicity of certain compounds; fenitrothion, etoxazole, super misrona, sour orange, acidless orange, baladi mandarin and Bermectine in reducing the population density of *T. tabaci* were evaluated. Also, the side effect of these compounds on spiders' population was assessed. The population density of *T. tabaci* and spiders peaked in March and April in both seasons. Surveyed spiders were found belong to seven families; Araneidae, Dictynidae, Lycosidae, Linyphiidae, Philodromidae, Theridiidae and Thomisidae. Temperature had highly significant positive correlation, while the spiders were highly significant negative for *T. tabaci* in 2008/09 season. Combined effect of spiders and weather factors on the density of *thrips* was high. All tested compounds under field conditions showed reduction of infestation of *T. tabaci*. For the residual effect, all tested compounds gave significant reduction of *thrips* infestation up to day 14th post treatment. Fenitrothion and Bermectine were the most effective, followed by etoxazole, sour orange, super misrona and then, acidless orange and baladi mandarin which induced the lowest reduction in *thrips* population. Concerning the side effect of these compounds on spiders; Bermectine and plant oil extracts (sour orange, acidless orange and baladi mandarin) had slight effects, whereas etoxazole and super misrona were moderate. Fenitrothion was the highly toxic compound against spiders.

Key words: *Thrips tabaci*, spiders, onion, population density, climatic factors, chemical compounds.

INTRODUCTION

Onion (*Allium cepa* L.) is one of the most popular and important vegetables for fresh and dry consumption in Egypt. Thrips infestation causes damage to onion plants which reflects direct and indirect yield losses. *Thrips tabaci* is the most serious pest of onion (Vierbergen and Ester 2000 and Mahmound and Osman 2007). However, onions are very capable of compensating for damage done by *thrips* (Lewis, 1997 and Richter *et al.*, 1999). Therefore, the impact of a crop depends on many factors; size of the pest (*thrips*) population, plant growth stage, time and duration of infestation and suitability of weather factors for plant growth (Hamdy and Salem 1994 and Lewis 1997).

A wide range of chemicals have been marketing for controlling pests, but the intensive use of chemical compounds result many problems. Alternatively, non-chemical control methods have been widely assessed and the most successful non-chemical techniques had been the exploitation of predators (Saied *et al.*, 2002 and Mahmound and Osman 2007).

The objective of this study was to estimate the impact of spiders and certain weather factors on the population fluctuation of *T. tabaci* on onion plantation. Also, to evaluate efficiency of certain compounds on its population density and their side effects on spiders.

MATERIALS AND METHODS

Population fluctuation of *Thrips tabaci* and spiders on onion plantations

Population fluctuation of *T. tabaci* and spiders on onion (*Allium cepa* L.) was investigated. Field experiments were carried out at El-Riad district, Kafr El-Sheikh Governorate, Egypt during the two growing seasons; 2008/09 and 2009/10. Onion seedlings were sown on December 15th in both seasons. An area of about a half feddan was divided into three equal plots and considered as three replicates. Inspection started 30 days after sowing and continued weekly till the end of the crop season. Numbers of *thrips* (nymphs and adults) and mobile stages of spiders were counted on ten plants/ replicate in the morning (7-9 am). Spider catches were transferred to the laboratory, classified counted and identified by Dr. Ahmed S. Hendawy, Biological Control Department, Plant Protection Research Institute, Giza, Egypt.

Climatic factors

Daily mean temperatures, relative humidity and wind velocity were obtained from the Meteorological station of Rice Research and Training Center at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, Egypt.

Toxicity of the tested compounds to thrips and spiders

Efficiency of tested compounds against *T. tabaci* was evaluated in an experimental area, which was divided into plots; each was a half feddan at El- Riad district, Kafr El-Sheikh Governorate. The treatments were arranged in a randomized complete block design with three replicates. The tested compounds were applied at recommended doses using a knapsack sprayer with one nozzle. The compounds were sprayed on March 23rd in 2008/09 and 2009/10 seasons. The tested compounds used and their rates were as follows:

A. Pesticides: Fenitrothion (Sumithion) 50% EC at 375 ml/100L water and Etoxazole (Baroque) 10% SC at 25 ml/100L water.
B. Mineral oil: Super misrona 94 % EC at 1.5 L /100L water.
C. Plant oil extracts: Volatile oils were extracted from three citrus peels of [(sour orange, *Citrus aurantium* L.), (acidless orange, *Citrus sinensis* Osbek) and (baladi mandarin, *Citrus deliciosa* Blanc)] (Family: Rutaceae) at the Pesticide Department at Kafr El-Sheikh. The volatile oils were isolated by steam distillation using the method of A. O. A.C. (1990). Plant oil extracts were used at 1.5 L /100L water.
D. Biopesticide: Abamectin (Bermectine) 1.8% EC at 40 ml/100L water.

Counts of *T. tabaci* (nymphs and adults) and spiders (spider lings and adults) were recorded before spraying on 30 onion plants. Counts were also recorded 1, 3, 5, 7 and 14 days after application. Percentage of population reductions were calculated according to Henderson and Telton (1955) equation.

RESULTS AND DISCUSSION

Population fluctuation of *Thrips tabaci* and spiders

T. tabaci occurred first by mid-January in both seasons (Fig. 1).The population reached its peak level for nymphs and adults on 20th and 13th April in 2008/09 and 2009/10, respectively. Thereafter, the insect population fluctuated showing two peaks; on 23rd March and 20th April in the first season. In the second season, the peaks took place on 2nd and 16th February, 23rd March and 13th April. Similar results were reported by Sharaf El-Din *et al.* (1993), Abou-Elhagag (1998) and Alston (2008).

In season 2008/09, spiders began to appear on onion on January 19th with four peaks; on January 26th, February 23rd and March (16th and 30th). In 2009/10 season, also four peaks were recorded on January 26th, February 9th, March 16th and May 4th (Fig. 2).

Araneidae, Dictynidae, Lycosidae, Linyphiidae, Philodromidae, Theridiidae and Thomisidae were the families of spiders found at El-Riad district, Kafr El-Sheikh Governorate (Table 1). However, the identified species were; *Larinia* sp. (Araneidae), *Dictyna* sp. (Dictynidae), *Pardosa* spp. and *Wadicosa fidelis* (Lycosidae), *Thanatus albini* (Philodromidae) and *Thomisus* sp. (Thomisidae).

Effect of climatic factors and spiders on *thrips* populations

Data in table (2) showed that the temperature had significant positive effect on *T. tabaci* population in 2008/09. While, the predator's correlation with *T. tabaci* population was significantly negative. Hamdy and Salem (1994) found that temperature correlated significantly and positively with *thrips*. *Thrips* had highly significant negative correlation with temperature (El-Fakharany, 2005). *T. tabaci* was insignificant negative correlated with relative humidity and insignificant positive with wind velocity in 2008/09. In 2009/10 season, temperature and wind velocity correlated insignificantly positive with *T. tabaci* and insignificantly negative with relative humidity and predator.

Combined effect of temperature, relative humidity, wind velocity and the spiders on *thrips*

In general, the combined effect (percentage of explained variance (EV %), Table, 2) of the four factors on *thrips* population was higher in the first season than in the second one. These interactions induced the greatest effect against *thrips* (74.40 and 42.40 %) during 2008/09 and 2009/10, respectively.

Follow–up the potency of tested compounds

Effect of the tested compounds on *T. tabaci* infesting onion plants at El-Riad district, Kafr El-Sheikh Governorate is presented in table (3). Data revealed that Fenitrothion and Bermectine were the most potent compounds in reducing the population density of *thrips* during 2008/09 and 2009/10 seasons, with reduction of 94.58 & 94.02 and 93.89 & 93.87%%, respectively, followed by Etoxazole (86.04 & 85.18%), Sour orange (85.44 &84.69%) and Super misrona (82.16 & 81.34%), respectively and then Acidless orange (78.89 & 78.01%) and Baladi mandarin (75.88 & 75.08 %) in 2008/09 and 2009/10 seasons, respectively.

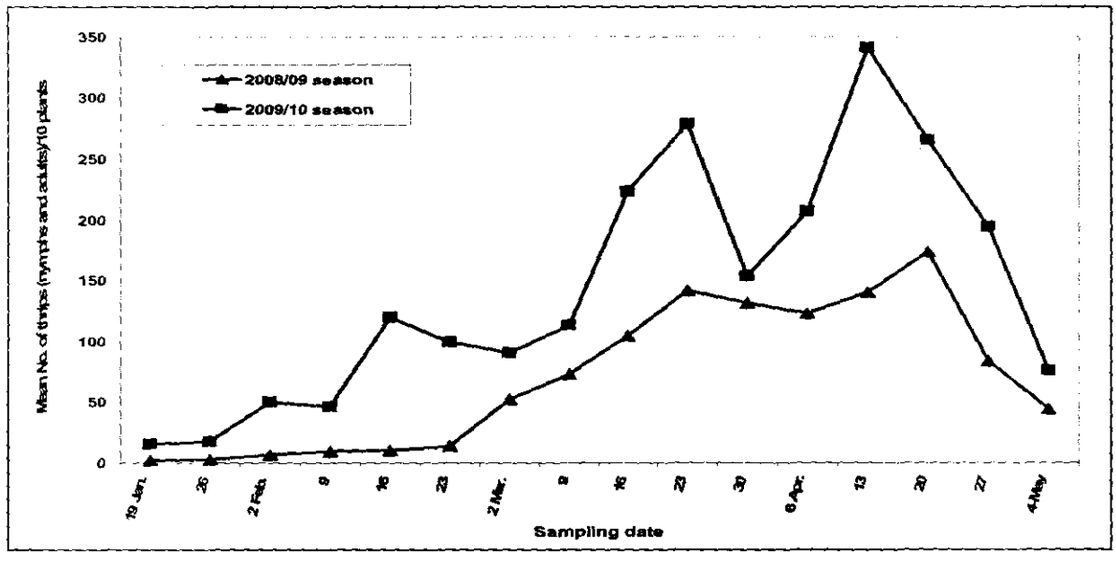

Fig. (1): Population fluctuation of *Thrips tabaci* on onion plants at El-Riad district, Kafr El-Sheikh Governorate, seasons 2008/09 and 2009/10.

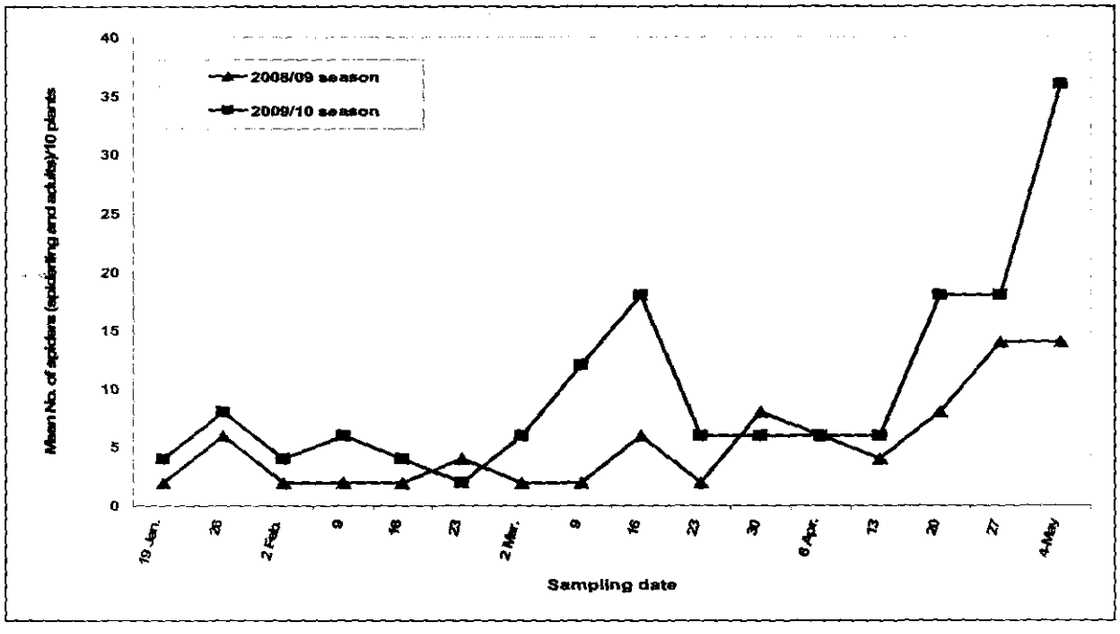

Fig. (2): Population fluctuation of spiders on onion plants at El-Riad district, Kafr El-Sheikh Governorate, seasons 2008/09 and 2009/10.

Table (1): Spiders inhabiting onion plantation at El-Riad district, Kafr El-Sheikh Governorate in seasons 2008/09 and 2009/10

Family/ Common name	Species	Stage
Araneidae (orb-web spiders)	*Larinia* sp.	Adult + Spider lings
Dictynidae (meshweavers spiders)	*Dictyna* sp.	Adult+ Spider lings
	Pardosa spp.	Adult + Spider lings
Lycosidae (wolf spiders)	*Wadicosa fidelis* (O.P.Cambridge)	Adult
	Unidentified species	Adult + Spider lings
Linyphiidae (sheetweb weavers spiders)	Unidentified species	Spider lings
Philodromidae (running crab spiders)	*Thanatus albini* (Audouin)	Adult + Spider lings
Theridiidae (cobweb weavers spiders)	Unidentified species	Spider lings
Thomisidae (crab spiders)	*Thomisus* sp.	Adult + Spider lings

Table (2): Partial correlation (r) and regression coefficient (B) between each of the climatic factors, spiders and the population of *Thrips tabaci* on onion at El-Riad district, Kafr El-Sheikh Governorate in seasons 2008/09 and 2009/10

Season	Variables	*Thrips tabaci*		
		r	B	E.V%
2008/09	Mean temperature (c°)	0.8029**	14.758**	74.40
	Mean R.H (%)	-0.3276	-2.752	
	Wind velocity (m/h)	0.0427	.0786	
	Spiders	-0.5972**	-52.810**	
2009/10	Mean temperature (°c)	0.2331	9.360	42.40
	Mean R.H (%)	-0.1931	-6.883	
	Wind velocity (m/h)	0.4579	2.736	
	Spiders	-0.3694	-27.632	

Table (3): Potency of tested compounds in reducing *Thrips tabaci* populations on onion plants at El-Riad district, Kafr El-Sheikh Governorate in seasons 2008/09 and 2009/10.

Compound	Rate/100 liter of water	Season	Number pre-treatment/10 plants	% Reduction						
				Initial effect %	Residual effect after indicated days				Residual effect average	Grand average
					3	5	7	14		
Pesticides										
Fenitrothion	375 ml	2008/09	490	97.77^{a}	98.27^{a}	93.74^{a}	93.26^{b}	89.86^{a}	93.78^{a}	94.58
Etoxazole	25 ml		495	94.79^{b}	95.35^{a}	83.13^{c}	77.76^{d}	79.19^{c}	83.86^{b}	86.04
Mineral oil										
Super misrona	1500 ml		480	90.24^{c}	84.30^{d}	89.56^{b}	75.90^{d}	70.82^{d}	80.15^{c}	82.16
Plant oil extracts										
Sour orange	1500 ml		505	91.65^{c}	91.93^{b}	93.93^{a}	83.99^{c}	65.69^{e}	83.89^{b}	85.44
Acidless orange	1500 ml		482	83.80^{e}	83.73^{d}	90.16^{b}	85.91^{c}	50.86^{f}	77.67^{d}	78.89
Baladi mandarin	1500 ml		475	88.66^{d}	88.83^{c}	82.41^{e}	75.65^{d}	43.84^{g}	72.68^{e}	75.88
Biopesticide										
Bermectine	40 ml		511	95.42^{b}	95.94^{a}	99.29^{a}	99.29^{a}	83.79^{b}	93.67^{a}	94.02
Untreated*	-		500	640	650	179	272	150	-	-
Pesticides										
Fenitrothion	375 ml	2009/10	450	97.39^{a}	97.96^{a}	92.58^{a}	92.69^{b}	88.81^{a}	93.01^{a}	93.89
Etoxazole	25 ml		456	94.33^{b}	94.94^{b}	81.68^{c}	77.12^{d}	77.85^{b}	82.89^{b}	85.18
Mineral oil										
Super misrona	1500 ml		441	89.86^{c}	83.77^{c}	88.62^{b}	75.10^{d}	69.37^{c}	79.22^{c}	81.34
Plant oil extracts										
Sour orange	1500 ml		465	91.39^{c}	91.56^{c}	92.82^{a}	83.48^{c}	64.21^{e}	83.02^{b}	84.69
Acidless orange	1500 ml		444	83.03^{e}	83.36^{c}	88.69^{b}	85.18^{c}	49.79^{d}	76.76^{d}	78.01
Baladi mandarin	1500 ml		438	88.19^{d}	88.39^{d}	80.93^{c}	74.93^{d}	42.96^{d}	71.80^{e}	75.08
Biopesticide										
Bermectine	40 ml		471	95.02^{b}	95.59^{b}	94.72^{a}	98.87^{a}	85.13^{ab}	93.58^{a}	93.87
Untreated*	-		462	588	600	165	252	137	-	-

Table (4): Potency of tested compounds in reducing spider numbers on onion plants at El-Riad district, Kafr El-Sheikh Governorate in seasons 2008/09 and 2009/10

Compound	Rate/100 liter of water	season	Number pre treatment/10 plants	% Reduction						
				Initial effect %	Residual effect after indicated				Residual effect average	Grand average
					3	5	7	14		
Pesticides										
Fenitrothion	375 ml	2008/09	4	66.67^{a}	72.73^{a}	71.43^{a}	33.33^{a}	20.00^{a}	49.37^{a}	52.83
Etoxazole	25 ml		5	20.00^{b}	34.55^{b}	14.29^{b}	9.33^{b}	00.00^{b}	14.54^{b}	15.63
Mineral oil										
Super misrona	1500 ml		4	16.67^{c}	27.14^{c}	7.14^{c}	00.00^{c}	00.00^{b}	8.60^{c}	10.22
Plant oil extracts										
Sour orange	1500 ml		3	11.11^{d}	15.15^{d}	00.00^{d}	00.00^{c}	00.00^{b}	3.79^{d}	5.25
Acidless orange	1500 ml		5	00.00^{e}	9.09^{e}	7.14^{c}	00.00^{c}	00.00^{b}	4.06^{d}	3.25
Baladi mandarin	1500 ml		3	11.11^{d}	3.03^{f}	14.29^{b}	00.00^{c}	00.00^{b}	4.33^{d}	5.69
Biopesticide										
Bermectine	40 ml			00.00^{e}	9.09^{e}	00.00^{d}	00.00^{c}	00.00^{b}	2.27^{e}	1.82
Untreated*	-		4	6	11	14	15	15	-	-
Pesticides										
Fenitrothion	375 ml	2009/10	4	66.67^{a}	75.00^{a}	62.50^{a}	42.86^{a}	21.43^{a}	50.45^{a}	53.69
Etoxazole	25 ml		4	33.33^{b}	37.50^{b}	12.50^{b}	7.14^{b}	00.00^{b}	14.29^{b}	18.09
Mineral oil										
Super misrona	1500 ml		4	16.67^{c}	12.50^{b}	12.50^{b}	00.00^{c}	00.00^{b}	6.25^{c}	8.33
Plant oil extracts										
Sour orange	1500 ml		3	11.11^{d}	16.67^{c}	00.00^{c}	00.00^{c}	00.00^{b}	4.18^{d}	5.56
Acidless orange	1500 ml		5	00.00^{e}	10.00^{e}	00.00^{c}	2.86^{d}	00.00^{b}	3.22^{e}	2.57
Baladi mandarin	1500 ml		3	11.11^{d}	16.67^{c}	00.00^{c}	4.76^{c}	00.00^{b}	5.36^{d}	6.51
Biopesticide										
Bermectine	40 ml		5	00.00^{e}	10.00^{e}	00.00^{c}	00.00^{c}	00.00^{b}	2.50^{e}	2.00
Untreated*	-		2	3	4	4	7	7	-	-

* Numbers Mean followed by a common letter are not significantly different at the 5% level by DMRT (1955)

The tested compounds showed satisfactory residual effect, reducing the population *T. tabaci* with >71.8 %. Nassed and Link (1990) and El-Fakharany (2005) found that Fenitrothion gave satisfactory results against *T. tabaci.* Mineral oils significantly reduced *T. tabaci* (Rizk *et al.,* 1999 and Iskander and El–Sisi, 2001). Plant oils gave also good results in reducing *T. tabaci.* Similar results were also obtained by Abdel-Wahab *et al.,* (2001), Al-Fawaeer and Abu-Abeid (2002) and El-Fakharany (2005).

Generally, most of the tested bioinsecticides exhibited high effectiveness. These results agree with the findings of Omar and El-Kholy (2001), Thungrabeab *et al.*, (2006) and Mahmound and Osman (2007).

Side toxic effects of tested compounds on the spiders inhabiting onion plantations

The results recorded in table (4) revealed that Fenitrothion was very harmful compound against spiders as it reduced their numbers by 52.83 and 53.69%, in 2008/09 and 2009/10 seasons, respectively. Etoxazole had moderate effect (15.63 & 18.09 %), followed by super misrona (10.22 & 8.33%). Significant differences were found among them. The present results agree with the findings of Rizk *et al.*, (1999), Saied *et al.*, (2002), Sharaf *et al.*, (2003) and El-Fakharany (2005).

The other tested compounds had low effect on spiders. The tested compounds could be arranged descendingly according to their safety to the spiders as follows; microbial pesticides > plant oil extracts > mineral oil > pesticides.

In conclusion, highest population density of onion *thrips* and spiders was recorded in 3rd week of March and April. Temperature was highly significant positive, while the spiders were highly significant negative with *T. tabaci* in 2008/09 season. A combined effect of spiders and weather factors was remarkable high on the population density of *thrips*. All the tested compounds gave significant reduction of *thrips* infestations. Fenitrothion was the most toxic compounds one on *thrips*, spiders, while the plant oil extracts were not harmful to spiders. The bio-rational insecticides proved to be promising and could be used as alternative safely insecticides for controlling onion *thrips.*

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الملخص العربى

دراسات ايكولوجية و تكسوكولوجية على التربس والعناكب المصاحبة له فى زراعات البصل

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معهد بحوث وقاية النباتات، مركز البحوث الزراعية، الجيزة، مصر

أجرى هذا البحث لدراسة الكثافة العددية لتربس البصل و مفترسه من العناكب في زراعات البصل بمركز الرياض محافظة كفر الشيخ - مصر خلال موسمي 09/2008، 10/2009 تحت بعض الظروف الجوية (متوسط درجات الحرارة و الرطوبة). كما تمت دراسة التأثير السام لبعض المركبات في خفض تعداد التربس الذي يصيب نباتات البصل خلال موسمي الدراسة. وكذلك دراسة الأثر الجانبي للمركبات المختبرة على العناكب المصاحبة للتربس. أظهرت النتائج أن أعلى كثافة عددية للتربس والعناكب كانت في شهري مارس وابريل خلال موسمي الدراسة. كما أظهرت النتائج أن هناك تأثيراً واضحا للظروف الجوية والعناكب على تعداد التربس خلال الدراسة حيث كانت لدرجات الحرارة ارتباط موجب عالي المعنوية، بينما كان للعناكب ارتباط سالب عالي المعنوية على التربس في موسم 09/2008. دلت النتائج أن كل المركبات المختبرة قد أدت إلى خفض تعداد التربس على نباتات البصل مع تفاوت نسب الخفض. كما دلت النتائج أيضا على أن المركبات المختبرة ذات تأثير متبقي في خفض التعداد حتى 14 يوماً من المعاملة. كان الفنتروثيون والبرمكتين أكثر المركبات سمية ضد حشرات التربس، تلاهما التوكسازول وزيت النارنج وسوبر مصرونا، بينما أعطى زيت البرتقال السكري وزيت اليوسفي أقل تأثير في خفض تعداد التربس. وعند دراسة الأثر الجانبي للمركبات المختبرة على العناكب المصاحبة للتربس، ظهر أن كلا من البرمكتين والزيوت النباتية الطيارة ذو سمية منخفضة على العناكب، بينما كان التوكسازول وسوبر مصرونا متوسطا السمية على المفترس. كان مركب الفنتروثيون الأكثر سمية على العناكب.

كلمات مفتاحيه: ايكولوجي، تكسوكولوجي، التربس، العناكب، زراعات البصل، مصر.