SPIDER POPULATIONS ASSOCIATED WITH DIFFERENT CROPS IN MENOUFIYA GOVERNORATE, NILE DELTA, EGYPT

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Abstract

A survey on spiders in 18 different agricultural crops in the southern Nile Delta was carried out in 1996, by the pitfall trap method, expressed as "activity density". In summer crops, density of spider individuals was 2.28 ± 1.29 per trap, compared with 2.38 ± 1.69 in winter crops. Highest densities in summer crops were in tomato, eggplant, and cucurbit cultivations, while in winter occurred in caraway, cabbage and onion cultivations. Sweet potatoes had the lowest density. Densities in spring varied from 0.4/trap in taro to 6.55/trap in caraway cultivations. It appears that plants with a dense foliage covering the ground (sweet potatoes and taro), constrain the movement of roaming spiders. Ten spider families were recorded in winter crops compared to 12 in summer. Lycosidae was dominant in both seasons, constituting about 80%, followed by Linyphiidae, Philodromidae, Gnaphosidae and Tetragnathidae. Males were trapped in higher numbers than females. Juveniles constituted 23-26% of the trapped samples, while subadults were more abundant in winter. Female lycosids carrying eggsacs had two peaks; one in spring and one in summer, but none was observed in winter. Correspondence analysis has shown that *Zelotes* complex was more associated with cabbage, and a group of *Lycorma ferox*, *Thanatus albini*, Dictynidae, and Clubionidae, with peas, while *Erigone dentipalpis*, Philodromidae, Tetragnathidae and *Dysdera* spp. were more associated with caraway. As for summer crops *Prinerigone vagans*, *Erigone dentipalpis*, Linyphiidae, Philodromidae and Salticidae were more associated with potato and soya bean crops, while *Lycorma ferox*, *Thanatus albini*, *Zelotes* complex and *Trachzelotes* spp. were more associated with cotton.

INTRODUCTION

Spiders are known to be wide range predators of a considerable number of important agricultural pests. In Egypt, biological, ecological and taxonomical studies concerning spiders have not yet been adequate to determine which species can be used as biological control agents. Workers interested in the ecology of soil fauna did not give enough attention to spiders, which are believed to be highly beneficial arthropods in biological control aspects (Tawfik, 1993).

The importance of spiders as biological control agents may be due to their occurrence in a wide variety of environments (Alderweireldt and Maelfait, 1989), their spread in a majority of plantations with remarkable density (Bogya, 1995), their high tolerance for chemicals and pesticides (Thang *et al.*, 1990), and their predatory behaviour against moving stages of insects, that are harmful to plants. The majority of spiders have effective venoms against their prey (Quistad *et al.*, 1992) in addition to webs and spinning apparatus. Spiders as predators are generalist feeders and they are the most abundant and polyphagous predators among the group of natural enemies (Rubia and Heong, 1990).

In Egypt, spiders represent a considerable ratio (36.34%) of the total soil fauna, collected by pitfall traps, in different agroecosystems (old lands) in Fayoum, Middle Egypt (Ghabbour and Mikhail, 1993), but only 4.44% in the newly reclaimed desert ecosystem west of the Nile Delta (Hussein, 1993).

The aim of this study is to survey the spider fauna in plantations cultivated in Menoufiya Province, Lower Egypt (old lands). No studies on the spider fauna of the Nile Delta have been carried out, although there have been studies in adjacent areas (El-Hennawy, 1990).

MATERIALS AND METHODS

Site description: The survey was carried out in Shebin El Kom area in Menoufiya Province, the southern part of the Nile Delta, Lower Egypt (30° 33' N, 31° 01'E). The soil is high fertile grade with clay texture (SWRI, 1967). Land use is extremely intensive and cultivation of many kinds of fruits, vegetables and field crops in constant rotation is usual. Land is thus occupied all the year round. The research was carried out in farms in close neighbourhood to Shebin El Kom city for 12 months during the period from December 1995 to November 1996. Eight vegetable crops in the winter season, and ten in summer season were chosen for this study. The winter crops were : onion (*Allium cepa*: Alliaceae), garlic (*Allium sativum*: Alliaceae), carrot (*Daucus carota* : Appiaceae), caraway (*Carum carvi*: Apiaceae), pea (Pisum sativum: Bramicaceae), broad bean (Vicia faba: Bramicaceae), winter cabbage (*Brassica oleracea* var. *capitata*: Cruciferae) and lettuce (*Lactuca sativa*: Asteraceae). The summer crops were : sweet potato (*Ipomoea batatas*: Convolvulaceae), potato (*Solanum tuberousm* : Solanaceae), taro (*Colocasia esculenta*: Araceae), egg-plant (*Solanum melongena* : Solanaceae), tomato (*Lycopersicon esculentum*: Solanaceae), okra (*Abelmaschus esculents*: Malvaceae), cucurbits

(Cucurbitaceae), summer cabbage, soya bean (*Glycine max*: Bramicaceae), and cotton (*Gossypium barbadense*: Malvaceae).

Sampling methods: Pitfall traps, 10 cm diamater and 15 cm depth were used. Five traps/week were regularly applied for each crop. The total number of traps varied in the crops according to its duration in the soil. Spiders obtained were preserved in 70% ethyl alcohol and classified to species level as much as possible. Table 1 indicates the period of each crop, which varied from 12 to 24 weeks, except for Taro, which, as a biannual crop, is cultivated for approximately 49 weeks.

Statistical Methods: The results of spider/trap/month were used to compare spider activity density in the crops. Total numbers of spiders obtained from the traps were divided by 20 (number of traps/month). The average for each crop/season was calculated by taking the period of the crop duration only in consideration.

The number of individuals trappped is primarily dependent on their locomotory activity. These are called activity densities rather than population densities and can not be related to abundance per unit area but as number/trap (Mikhail et al., 1995).

Since family Lycosidae is the only recorded here whose females carry their eggsacs attached to spinnerets during normal activities, the number of eggsacs obtained in the traps and the total lycosid individuals were used to estimate the lycosid females carrying eggsacs percentage as an indicator of the reproduction season, in this predominant family.

Data of activity density of spider fauna were treated by multivariate statistical method: correspondence analysis CA (Greenacre, 1984) and ascending hierarchic classification AHC (Roux, 1985). The computer calculations for CA and AHC were carried out at University of Cairo using DATAVISION programme 1.2 (Roux, 1987) developed for APPLE IIe in BASIC. Activity densities of spiders per trap in the different crops were subjected to the correspondence analysis method to show characteristic species of spiders in each crop.

RESULTS AND DISCUSSION

A total of 2170 spiders belonging to 12 families were collected during the study period. From table 1, it can be calculated that the ten summer season crops, as a whole, recorded an average 2.28±1.29 spides/trap, approximately similar to

Table 1. Mean numbers of spiders/trap in the different crops during the period of study.

Months	On	Ga	Ct	Ca	Pe	Fb	Cw	Le	Ta*	Po	Sp	Ep	To	Ok	Cu	Cs	S b	Co
December 95	2.65	0.90			1.28	1.44		0.53	0.15									
January 96	0.85	0.85			1.30	0.55		1.20	0.35	0.67								
February	3.30	2.40		5.80	2.87	0.73		2.87	0.73	1.10								
March	3.20	3.90		6.55	4.55			1.00	3.67	2.30								
April	4.40	1.80		4.47	1.00				1.75	2.05								3.01
May				4.10					2.80	2.40	2.20	3.85	5.20	1.40	3.45	0.60	3.20	3.40
June				0.20					2.13		1.80	4.67	4.20	2.93	2.67	1.73	3.40	0.60
July									1.10		2.47	2.67	2.00	1.53	3.60	1.53	2.13	1.60
August									3.50		0.42	3.30		1.60		1.90	2.90	2.40
September			0.80				2.20		0.60			5.40		4.40				2.60
October			1.20				5.60		0.40			2.00						
November 96			1.30				2.44		0.40									

Ca = Caraway, Co = Cotton, Cs = Summer Cabbage, Ct = Carrot, Cu = Cucurbits, Cw = Winter Cabbage, Ep = Egg plant, Fb = Broad Bean, Ga = Garlic, Le = Lettuce, Ok = Okra, On = Onion, Pe = Pea, Po = Potato, Sb = Soya Bean, Sp = Sweet Potato, Ta = Taro, To = Tomato.
* Taro is a biannual crop.

the value of the eight winter season crops 2.38 ± 1.69. During winter season, the highest densities were 4.22, 3.41 and 2.88 spider/trap for caraway, cabbage and onion and the lowest were 0.91, 1.10 and 1.40 for broad bean, carrot and lettuce, respectively. Summer season crops recorded the highest values 3.80, 3.65, 3.24 and 2.91 for tomato, egg plant, cucurbits and soya bean, while the lowest in summer were 1.44 and 1.72 for cabbage and sweet potato, respectively.

Highest densities (3.60 and 2.96 spider/trap) were recorded in March and May 1996, while the lowest densities (1.15 and 0.82) were recorded during December 1995 and January 1996, respectively.

The spider species recorded in this work, Tables 2 and 3 are new locality records in Egypt. They were not recorded before from Menoufiya Governorate (EL-Hennawy, 1990, 1992). Table 2 shows the total number of spider families and/or species, identified as much as possible, obtained from the eight studied winter crops, divided into adults (male and female), subadults (male and female) and juveniles. Ten families were recorded and ranked according to their abundance. Lycosidae is the highly dominant family (826 individuals) in all plantations, followed by Philodromidae (61), Linyphiidae (58), Gnaphosidae (29), Theridiidae (13), Tetragnathidae (5), Salticidae (4), Dictynidae (2) individuals, in addition to two other families: Clubionidae and Dysderidae (1).

Regarding particular species, *Thanatus albini* comprises 54.10% of Philodromidae, Table 2. Three species *Prinerigone vagans*, *Erigone dentipalpis* and *Erigone* sp. belong to Linyphiidae, with 22.41, 15.52 and 13.79% of the linyphiid spiders, respectively. *Zelotes* complex and *Setaphis subtilis* were the two identified species of Gnaphosidae comprising 44.82 and Setaphis subtilis were the two identified species of Gnaphosidae comprising 44.82 and 17.24% of their total numbers, respectively. Although Lycosidae is the predominant family (82.60%) of spider fauna in the winter crops, it is noticed that the wolf spider Lycorma ferox, the largest species in size recorded here, comprising only 1.93% of lycosid spiders.

Table 3 shows the total number of spider families and/or their identified species obtained from the ten summer season crops; also divided into adults (male and female) and subadults (male and female) in addition to juveniles. Twelve families were recorded. Two more families Araneidae and Titanoecidae were recorded in addition to ten families previously recorded during winter season. Lycosidae was also the predominant family (79.06%) of spider fauna represented with (925) individuals

in all crops, followed by Linyphiidae (108), Philodromidae (75), Gnaphosidae (46) and Theridiidae (4). The families fewer in occurrence are Salticidae, Dysderidae (3) for each, Araneidae (2), Tetragnathidae, Dictynidae, Clubionidae and Titanoecidae (1). Males showed an increase in numbers, compared with females, in all families and in different crops, Tables 2 and 3. *Erigone dentipalpis* comprises 16.67%, *Prinerigone vagans* and *Erigone* sp. comprise nearly similar values 8.33 and 7.46% of linyphiid piders. *Thanatus albini* represents 86.67% of Philodromidae. The taxa of Gnaphosidae: *Zelotes* complex, *Setaphis subtilis* and *Trachyzelotes* sp. recorded 76.09, 15.22 and 6.52% of their total individuals, respectively. *Lycorma ferox* comprises 2.38% of lycosid spiders.

Comparing numbers and percentages of adults, subadults and juveniles, it is noticed that the juveniles have approximately a constant percentage of the total spider fauna (25.65 and 23.65%) in winter and summer seasons, respectively. In winter season crops, the subadults recorded higher occurrence (22.37%) against (5.00%) only in summer season.

Tables 2 and 3 show that the sex ratios (females: males) recorded are 1: 2.44 and 1: 2.82 as an average for winter and summer crops, respectively. When subadult males and subadult females are excluded, the ratio became higher 1: 3.65 and 1: 3.08 for winter and summer season crops. The subadult females represent 40.96% of the total immature spiders in winter, while it was 49.12% in summer crops. This may be explained by the probability that moulting and body development requirements are more suitable in summer for females, which has to be confirmed by laboratory studies. In addition, continuous mobility of males searching for food and females, is a factor leading to their easy trapping in the pitfall traps.

Lycosid females carrying eggsacs were estimated as percentage of the total lycosid spiders. The values show two peaks. The most important one occurred in July, August and September, 13.91, 12.11 and 15.69%, respectively, while the second in April, 10.52% and recorded in six crops.

During the cold season (October-February), no females carrying eggsacs were noticed, except in December 1995, when it was only 3.60% under peas. Alderweireldt and Jocque (1991) reported that copulation period for a wolf spider in southern Spain, appeared to occur in autumn and/or winter. In our study, it appears to be mainly in summer, extended to autumn, preceded by another small peak in spring, in a wider variety of crops.

Average weight of an eggsac of Lycosidae (previously preserved in 70% ethyl alcohol, then air dried) was 15.50 mg. The average size was 23.53 mm3. Number of eggs per sac varied from 50 to 109, with an average of 88 eggs. Muniappan and Chada (1968), reported that number of eggs per sac in family Thomisidae varied between 55 and 234. Gertsch (1979) recorded that the large Araneidae and Pisauridae spin more than one eggsac containing together 2652 eggs. Generally, the number of eggs is often directly related to the size of the mother (Preston-Mafham and Preston-Mafham, 1996).

Applying the correspondence analysis method to the results of spider activity densities in the winter season crops, yields Fig. 1, in which the horizontal axis explains 39% of the variance, while the vertical axis explains 27%. Peas crop and its associate spider species are on the lower left hand side. This crop is characterized by the occurrence of *Lycorma ferox* (Lycosidae), *Thanatus albini* (Philodromidae), Dictynidae and Clubionidae. The winter cabbage and its associate spider species are on the upper left hand side and is characterized by only one species *Zelotes* complex (Gnaphosidae). Caraway and its associate spider species are on the right hand side and is characterized by two species of Linyphiidae, *Erigone dentipalpis* and *Erigone* sp. in addition to philodromid, tetragnathid and *Dysdera* sp. (Dysderidae). The other winter crops: onion, garlic, carrot, faba bean and lettuce are grouped with the other species and/or families of spiders.

The same method of analysis applied in summer season crops is shown in Fig. 2, in which the horizontal axis explains 38% of the variance, while the vertical axis explains 22%. Cotton crop and its associate spider species are on the lower right hand side and are clearly characterized by the occurrence of *Lycorma ferox* (Lycosidae), *Thanatus albini* (Philodromidae) *Zelotes* complex, *Trachyzelotes* sp. (Gnaphosidae), in addition to members of Family Araneidae. Potato and soya bean crops and their associate spider species are on the upper side and are characterized by the occurrence of *Prinerigone vagans*, *Erigone dentipalpis* (Linyphiidae), Philodromidae and Salticidae families. The other summer crops are grouped with the other species of families of spiders on the lower left hand side.

These differences may be due to shade of plants and available humidity expressed as water requirements for each crop in addition to density of plants/acre. This directly affects abundance of spiders' preys and governs occurrence of birds and other spiders' natural enemies.

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Table 2. Mean numbers of individuals of spider species in the different winter season crops.

Crop	Onion					Garlic					Carrot					Caraway				
Taxon/Sex	M	SM	F	SF	J	M	SM	F	SF	J	M	SM	F	SF	J	M	SM	F	SF	J
Lycosidae	155	22	45	46	40	53	5	12	4	17	2	2	2	7	7	93	4	30	7	16
Lycorma ferox	4			1		1										1		1		
Philodromidae	7		2			4	1	1								12		1		
Thanatus albini	4			1				1	2		1								1	1
Linyphiidae	9	1		1		6						1							1	1
Prinerigone vagans	4					2										3		1		
Erigone dentipalpis	1										1					5		2		
Erigone sp.			1		2			1										3		
Gnaphosidae	7					3														
Zelotes complex					1	2		1								2				
Setaphis subtilis	2							1			1									
Theridiidae	6		1			1	1					1								
Tetragnathidae	3															2				
Salticidae	2		1			1														
Dysderidae																				
Dysdera sp.																1				

Table 2. Continued.

Crop	Pea					Broad bean					Winter Cabbage					Lettuce				
Taxon/Sex	M	SM	F	SF	J	M	SM	F	SF	J	M	SM	F	SF	J	M	SM	F	SF	J
Lycosidae	41	5	10	10	48	21	8	4	11	21		1	1	3	11	18	7	5		16
Lycorma ferox	3	2		2									1							
Philodromidae																				
Thanatus albini	13	1	1	1	1					2		1								2
Linyphiidae	3					1					3		1					1		
Prinerigone vagans						1					1					1				
Erigone sp.																		1		
Gnaphosidae	1																			
Zelotes complex			1	1								4					1			
Setaphis subtilis						1														
Theridiidae											1					1		1		
Dictynidae	1	1																		
Dysdera sp.	1																			

M = male, SM = subadult male, F = female, SF = subadult female, J = juvenile.

Table 3. Mean numbers of individuals of spider species in the different summer season crops.

Crop	Sweet potato					Potato					Taro					Egg-plant					Tomato				
Taxon/Sex	M	SM	F	SF	J	M	SM	F	SF	J	M	SM	F	SF	J	M	SM	F	SF	J	M	SM	F	SF	J
Lycosidae	27	2	7	7	16	40	3	11	3	16	98	2	26	3	52	115	3	44	2	46	47	4	14	3	30
Lycorma ferox	1					1		1			3					3		1							
Linyphiidae			1			4		3		1	1		2			2		3			2		1		
Prinerigone vagans						5					2										1				
Erigone dentipalpis	1		1			8															1				
Erigone sp.								8																	
Philodromidae	2					2					5		1												
Thanatus albini	2		2			4					5		2		3	6	1	1			2	2			1
Gnaphosidae																		1							
Zelotes complex	3					2										3		2			4				
Setaphis subtilis																2		2							
Trachyzelotes sp.																					1		1		
Theridiidae													1												
Salticidae	1		1			1																			
Araneidae													1												
Tetragnathidae																1									
Dictynidae																					1				
Clubionidae																	1								

Table 3. Continued.

Crop	Okra					Cucurbits					Summer Cabbage					Soya bean					Cotton				
Taxon/Sex	M	SM	F	SF	J	M	SM	F	SF	J	M	SM	F	SF	J	M	SM	F	SF	J	M	SM	F	SF	J
Lycosidae	39	2	7		19	46	2	11		27	35	2	26		30	51	2	15	7	37	9		6	1	1
Lycorma ferox											2		1			1					6		1	1	
Linyphiidae						2	1									15		5		20	6	1	3		
Prinerigone vagans																1									
Erigone dentipalpis						1					1					2					3				
Philodromidae																									
Thanatus albini						8				1	4		1			1		1		1	9		6	1	1
Gnaphosidae																									
Zelotes complex				1		1		2								1		1		1	9		1		4
Setaphis subtilis						1		1			1														
Trachyzelotes sp.																							1		
Theridiidae																					1		2		
Dysderidae																									
Dysdera sp.			3																						
Araneidae																					1				
Titanoecidae						1																			

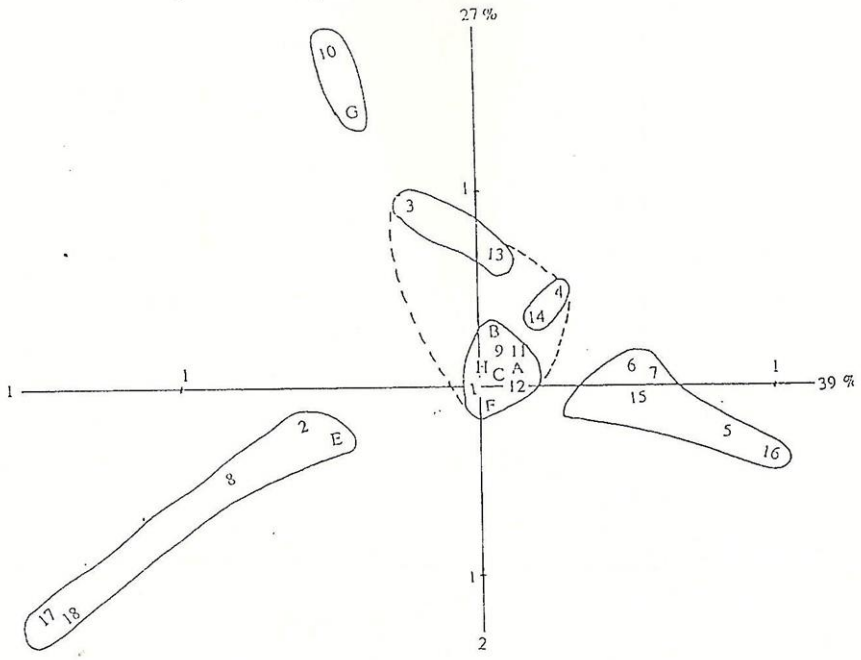

Fig. 1. Graphical representation of the application of CA and AHC methods to data of activity density of spiders collected in winter crops. Lettters A-H = crops: A, Onion; B, Garlic; C, Carrot; D, Caraway; E, Pea; F, Broad bean; G, Winter cabbage and H, Lettuce. Numbers 1-18 = spider taxa: 1, Lycosidae; 2, *Lycorma ferox*; 3, Linyphiidae; 4, *Prinerigone vagans*; 5, *Erigone dentipalpis*; 6, *Erigone* spp.; 7, Philodromidae; 8 , Thanatus *albini; 9,* Gnaphosidae; 10, *Zelotes* complex; 11, *Setaphis subtilis*; 12, *Trachzelotes* spp., 13, Theridiidae; 14, Salticidae; 15, Tetragnathidae; 16, *Dysdera* spp.; 17, Dictynidae and 18, Clubionidae.

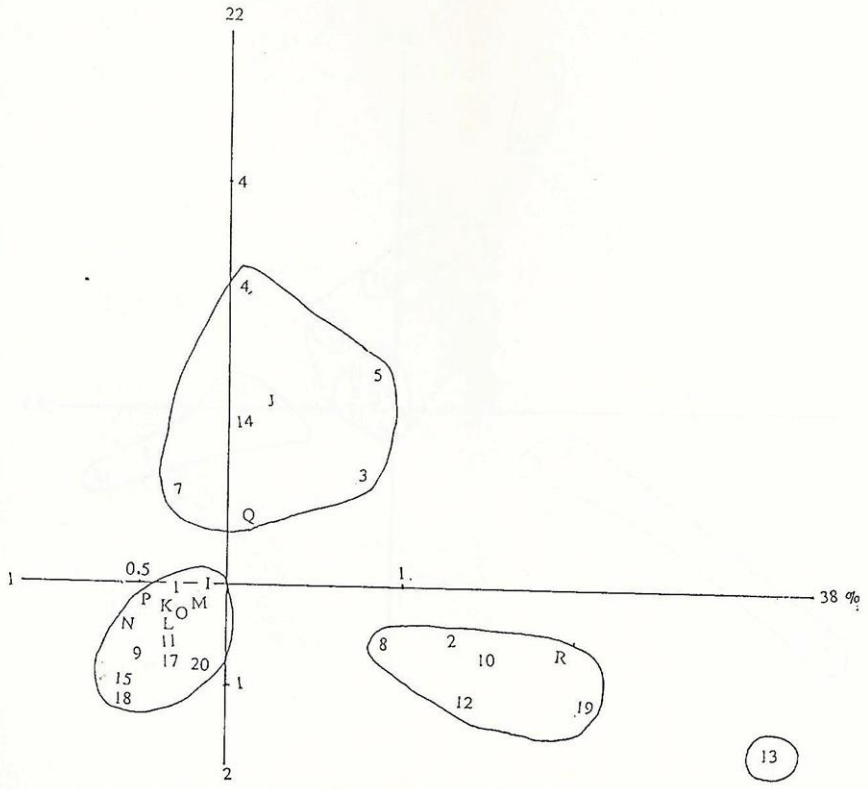

Fig. 2. Graphical representation of the application of CA and AHC methods to data of activity density of spiders collected in summer crops. Lettters I-R = crops: I, Sweet potato; J, Potato; K, Taro; L, Egg plant; M, Tomato; N, Okra; O, Cucurbits; P, Summer cabbage; Q, Soya bean and R, Cotton. Numbers 1-18 = spider taxa as in Fig.1; 19, Araneidae and 20, Titanoecidae.

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عشائر العناكب المرتبطة بمختلف المحاصيل في محافظة المنوفية بدلتا النيل - مصر

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٢ معهد بحوث وقاية النباتات - مركز البحوث الزراعية، الدقى ، الجيزه.
٣ ٤١ ش المنطقة الرابعة مصر الجديدة القاهرة.

في دراسة بيئية تم عمل حصر للعناكب في ١٨ محصولاً مختلفاً بمحافظة المنوفية خلال ديسمبر ٩٥ - نوفمبر ١٩٩٦ م. واستخدمت مصايد السقوط الأرضية لتقدير كثافات العشائر تحت الدراسة ووجد أن متوسط الكثافة في المحاصيل الصيفية ٢,٢٨ ± ١,٢٩ وفي المحاصيل الشتوية ٢,٣٨ ± ١,٦٩ فرد / مصيدة وسجلت أعلي القياسات في الطماطم والباذنجان والقرعيات خلال الصيف ، وفي الكراوية والكرنب والبصل خلال الشتاء. بينما سجلت أقل الكثافات في البطاطا والقلقاس. سجلت الدراسة علي ١٠ عائلات في المحاصيل الشتوية و ١٢ عائلة في المحاصيل الصيفية وكانت عائلة Lycosidae هي السائدة في كلا الموسمين مكونه ٨٠٪ من عشائر مجتمع العناكب يتلوها عائلة Linyphiiae ثم Philo-dromidae ثم Gnaphosidae وأخيراً Tetragnathidae. وقد وجد أن تعداد الإناث أقل من تعداد الذكور، إذ سجلت النسبة الجنسية بينهما ١: ٢,٤٤ في محاصيل الشتاء و ١: ٢,٨٢ في المحاصيل الصيفية كما كانت نسبة الصغار (Juveniles) ٢٣ ، ٢٦ ٪ ضمن التركيب العمري للعناكب تحت الدراسة. وقد سجلت النسبة المئوية لإناث عائلة Lycosidae الحاملة لأكياس البيض وإتخذت مؤشراً لتحديد موسم التكاثر لها وكانت بمتوسط ١٣,٩٠٪ خلال شهور يوليو وأغسطس وسبتمبر التي تمثل موسم التكاثر الرئيسي، وكذلك خلال أبريل ١٠,٥٢ ٪ وهو موسم أخر للتكاثر خلال العام ولم يسجل خلال الشتاء ظهور أي إناث حاملة لأكياس البيض.

عولجت النتائج إحصائياً بطرق التحليل المتعدد المتغيرات: التحليل التوافقي والتقسيم الهيراركي وأوضح ذلك إرتباط النوع *Zelotes complex* مع محصول الكرنب وأن الأنواع *Lycorma ferox* وكذلك *Thanatus albini* وكذلك عناكب Dictynidae وعناكب Clubionidae ترتبط بزراعات البسلة. كما أوضح التحليل التوافقي أيضا أن النوع *Erigone dentipalpis* وكذلك *Dysdera* spp. والعناكب من عائلتي Philodromidae Tetragnathidae ترتبط بزراعات الكراوية بوضوح. وأظهرت أيضاً أن البطاطا وفول الصويا يرتبط معهما عناكب Salticidae, Philodromidae, Linyphiidae كما اتضح أن محصول القطن يرتبط ويتميز بوجود الأنواع *Ze-lotes Complex Thanatus albini, Lycorma ferox* وأخيراً مع *Trachyzelotes*. spp.