J. Agric. Sci. Mansoura Univ., 34 (3): 2279 - 2287, 2009

SPIDER FAUNA AND INFLUENCE OF TRAPPING METHOD AND FIELD MARGIN ON SPIDER POPULATION DENSITY IN SUGAR BEET FIELDS

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ABSTRACT

Experiments were carried out at the experimental farm of Sakha Agricultural Research Station in 2006/07 and 2007/08 sugar beet seasons. The spiders inhabiting the sugar beet fields were surveyed, which indicated to the occurrence of 30 spider species belonging to Araneidae, Dictynidae, Dysderidae, Gnaphosidae, Linyphiidae, Lycosidae, Miturgidae, Philodromidae, Salticidae, Tetragnathidae, Theridiidae and Thomisidae. In all sugar beet plantations (August, September and October), the pitfall traps captured more spiders of families Lycosidae and Gnaphosidae (Ground-dwelling spiders) and Philodromidae and Salticidae (wandering spiders) than did D-vac machine which captured more linyphiids and araneids (orb-weaver spiders). Population density of spiders in the field margins were usually greater than that inside the field for the seven considered families. Traps used inside the field captured less spiders than those used in the margins by 32.50-82.14 % overall spider families.

INTRODUCTION

Sugar beet, as a food crop, should not receive any insecticides, or at least receive minimum insecticidal applications. Consequently, the role of biological control against sugar beet insects has to be maximized. The ecosystem of sugar beet fields is rich in insect predators that were extensively investigated by several authors (e.g. Abo Saied Ahmed 1987, Solouma 1989, Shalaby 2001 and Bazazo 2005). On the other hand, the true spiders prevailing sugar beet fields had considerable attention outside Egypt (e.g. Thornhill 1983, Schrooder *et al* 1999, Dewar *et al* 2002, Brooks *et al* 2003 and Strandberg *et al* 2005). However, few investigations in Egypt dealt with spiders dominating sugar beet fields (e.g. Shalaby 2001, Talha 2001, Mahmoud 2004 and Bazazo 2005).

To maximize the contribution of arthropod predators (including spiders) in integrated pest management, a detailed knowledge of their biodiversity and population dynamics is necessary (Furlong *et al* 2004 and Devotto *et al* 2007). Several studies have shown that assemblages of many predator species may be more effective in controlling agricultural pests than single species augmentation (Chiverton 1986 and Richert and Lawrence 1997). To find out the assemblages of spiders in different agricultural ecosystems, several collecting methods should be used. Churchil (1993) indicated that different collecting methods can misrepresent certain components of spider assemblages. In such concern, Green (1999) reported that pitfall traps, which are commonly used for spider collecting, are effective for estimating ground-dwelling spiders, but underestimate the diversity and abundance of the foliage-dwelling fauna. So, Coddington *et al* (1990) emphasized that sampling methods should be kept to a minimum to reduce complexity in sampling protocol, and methods chosen should minimize species overlap by collecting different spider assemblages. Green (1999) surveyed no lycosids in citrus trees by D-vac machine sampling, as the spiders of this family are ground-dwelling. Thus, the use of D-vac machine in these trees should be faraway from the spiders. Pitfall trapping is an effective method of sampling the active invertebrates, primarily arthropods, on the soil surface (Uetz and Unzicker 1976), but the estimates of this collecting method should be carefully considered, as Lang (2000) reported that pitfalls overestimate the relative abundance of Lycosidae.

The plant type is another factor can affect the spider complex on different habitats. In other words, the spider fauna in a crop like sugar beet should differ from that in citrus trees, as the foliage of the former habitat is near to the ground surface, while the foliage of the latter is faraway from the ground level. This was indicated by Scheidler (1990) who reported that vegetational architecture plays a major role in the arthropod species composition found within a habitat. In addition, Hartely and MacMahon (1980) assured that vegetation which is structurally more complex can sustain a higher abundance and diversity of spiders than those in simple vegetation.

Bell et al (2002) reported that field margins provide an excellent source habitat for the spiders. Cutting margins reduces the population of the spider, but no cutting ensures higher numbers. Bazazo (2005) indicated that population densities of spiders were always higher in the margins of sugar beet fields than in the interior, as the populations of Linyphiidae, Araneidae ,Salticidae and Philodromidae were less in the interior than in the margin by 67.71-84.21%.

The current investigation was carried out to survey the spiders inhabiting sugar beet fields using pitfall traps and D-vac machine. Numbers of spiders collected by each method were compared to find out the more suitable trapping method for certain spiders. Also, the populations of spiders in the sugar beet field margins were compared with those inside the field.

MATERIALS AND METHODS

Field experiments were carried out during two successive sugar beet seasons, 2006/07 and 2007/08 at the experimental farm of Sakha Agricultural Research Station. Spider inhabiting the three plantations (August, September and October) of sugar beet were surveyed using pitfall traps and D-vac machine. Ten pitfall traps were embedded into the soil in an area of about ½ feddan. Biweekly samples were taken about one month after sowing. The catch of the pitfall was taken begining one week after fixing into the soil. The trapped arthropods into the pitfall were obtained by screening the water of the jar, and then the spiders were separated from the catch, and transferred to the laboratory for identification and counting.

The D-vac machine was installed and directed to sugar beet plants for a distance of 10 m long to suck the arthropods. The captured arthropods were obtained from gauze bag fixed inside the machine. The spiders were separated from the whole catch and transferred to the laboratory for identification and counting.

Also, the sampling of spiders was conducted at two sites, in the field margin the and inside the field. This was to compare the spider populations in the margin (where little cultural practices are conducted, and much weeds can grow) to those inside the field (where intensive cultural practices are carried out and weeds are usually controlled).

RESULT AND DISCUSSION

1. Spider survey at sugar beet fields:

Spiders inhabiting sugar beet plants were surveyed at the experimental farm of Sakha Agricultural Research Station for two successive seasons; 2006/07 and 2007/08 sugar beet (Table 1). The survey, achieved by pitfall traps and D-vac machine, revealed the occurrence of 30 spider species belonging to twelve families. The most occurring family was Araneidae that was represented by six species, and thus constituted 20.00% out of total recorded species. The second rank was occupied by Lycosidae and Salticidae (each was represented by four species, constituting 13.33% out of total). The third dominant families were Linyphiidae and Philodromidae (three species, 10.00% each). Families Gnaphosidae, Theridiidae and Thomisidae were each represented by two species, while Dictynidae, Dysderidae, Miturgidae and Tetragnathidae were each represented by one species.

Surveying twelve spider families in the current investigation shows that sugar beet fields not only rich in insect predators but also rich in true spiders. From the point of view of insect pest management, the variation in spider species is more effective in controlling insect pests than one species, even if that species was found in a great number (Sunderland, 1999). This phenomenon was explained by Nyffeler et al (1994) who indicated that variation in body size of both predator and prey species enhances the reduction in prey population, because the large spiders feed upon large prey, and the small spiders feed upon small prey. Thus, the competition among spider species for feeding upon insect pests will be minimized, as the spiders of different body sizes can find their prey available.

Table (1): Araneofauna of sugar beet fields at Kafr El-Sheikh region, during 2006/07 and 2007/08 seasons.

Family/ Common name	Taxon	No. of Taxa	Occurrence %
Araneidae Typical-orb weaver	*Araneus* sp. *Argiope trifasciata* Forscal *Cyclosa* sp. *Larinia* sp. *Singa albobivittata* Dicaporiacco *Hypsosinga* sp.	6	20.00
Dictynidae Mesh web weaver	*Dictyna* sp.	1	3.33
Dysderidae Dysderid six-eyed spider	*Dysdera crocata* C.L. Koch	1	3.33
Gnaphosidae Ground spider	*Pterotricha* sp. *Zelotes* sp.	2	6.67
Linyphiidae Sheet-web spider	*Bathyphantes* sp. *Erigone dentipalpis* (Wider) *Gnathonarium dentatum* (Wider)	3	10.00
Lycosidae Wolf spider	*Hogna ferox* Simon *Pardosa* spp. *Trochosa* sp. *Wadicosa fidelis* (O.P. Cambrige)	4	13.33
Miturgidae Long-legged sac spider	*Cheiracanthium* sp.	1	3.33
Philodromidae Philodromid crab spider	*Philodromus* sp. *Thanatus albini* (Audouin) *Thanatus* sp.	3	10.00
Salticidae Jumping spider	*Ballus* sp. *Bianor albobimaculatus* (Lucas) *Heliophanillus* sp. *Thyene imperialis* (Rossi)	4	13.33
Tetragnathidae Long-jawed spider	*Tetragnatha nitens* (Savigny)	1	3.33
Theridiidae Comb-footed spider	*Theridion melanostictum* O.P.-Cambridge *Steatoda erigoniformis* (O.P.-Cambridge)	2	6.67
Thomisidae Crab spider	*Thomisius* sp. *Xysticus* sp.	2	6.67
Total		30	

2. Composition between pitfall traps and D-vac machine in capturing spiders:

Data in Tables (2,3,4) present a comparison between pitfall traps and D-vac machine in capturing spiders of six families (the most occurring). In August plantation (Table 2), pitfall traps trapped more spiders of Lycosidae (89.34%), Philodromidae (65.69%), Gnaphosidae (78.79%) and Salticidae (60.98%) as compared with D-vac that trapped 10.66, 34.31, 21.21% and 39.02% of the four families, respectively. The situation was reversed in case of Gnaphosidae, Linyphiidae and Araneidae as the catches were 28.65 and 32.18% for the pitfall traps compared to 71.35 and 67.82% for the D-vac machine, respectively. Similar trends were found for September (Table 3) and October (Table 4) sugar beet plantations. The catches were 87.57, 86.32, 84.62 and 67.86% for the pitfall traps compared to 12.43, 13.68, 15.38 and 32.14% for Lycosidae, Philodromidae, Gnaphosidae and Salticidae, respectively. By contrast, D-vac machine trapped more linyphiids (59.97%) and araneids (63.30%) compared to 40.03 and 36.70% for the pitfall, respectively. In October plantation, the obtained results exactly confirmed those of August and September plantations assuring that the pitfalls trapped more lycosids, philodromids, gnaphosids and salticids while the D-vac trapped more linyphiids and araneids.

Table (2): Comparison Between pitfall traps and D-vac machine in capturing spider families in August sugar beet plantation (2006/07 season)

Month of sampling	Lycosidae		Philodromidae		Linyhiidae		Araneidae		Salticidae		Gnaphosidae	
	Pitfall	D-vac	Pitfall	D-vac	Pitfall	D-vac	Pitfall	D-vac	Pitfall	D-vac	Pitfall	D-vac
September	119	5	21	6	16	17	1	8	13	2	16	2
October	102	9	32	14	9	29	8	11	7	1	7	1
November	51	6	52	18	17	7	5	5	3	7	2	0
December	35	11	39	41	6	41	3	21	1	0	1	3
January	27	6	15	9	5	11	0	14	0	2	0	0
February	34	8	21	6	2	32	1	9	1	4	0	1
Total of trap	377	45	180	94	55	137	28	59	25	16	26	7
Occurrence % in trap	32.34	10.66	65.69	34.31	28.65	71.35	32.18	67.82	60.98	39.02	78.79	21.32
Total of family	422		274		192		87		41		33	
Occurrence % of family	41.23		26.12		18.30		8.29		3.91		3.15	

Regardless of trapping method, the most trapped family in August plantation (Table 2) was Lycosidae (41.23%) followed by Philodromidae (26.12%), while the least trapped were Gnaphosidae (3.15%) and Salticidae (3.91%). Linyphiidae was the most represented in September and October plantations; 36.22 and 32.51%, respectively, while the least represented was Gnaphosidae (2.89 and 2.54% for the two plantations, respectively). These results could be interpreted that Lycosidae and Gnaphosidae are ground–dwelling spiders, and Philodromidae and Salticidae are wandering spiders, and thus they were mostly captured by the pitfall traps, while Linyphiidae and Araneidae are orb-weaver spiders. The latters are usually occurring on sugar beet foliage. These findings are in agreement with those of Green (1999) who indicted that pitfall traps are effective in collecting ground-dwelling spiders. However, the latter author surveyed no lycosids from citrus trees by D-vac machine sampling, but the results in the current investigation showed that D-vac machine collected 10.66-12.70 % of the lycosids (Tables 2, 3, 4) inhabiting sugar beet plots. This because of the plant architecture. The foliage of citrus trees is faraway from the ground (no lycosids were obtained), while the foliage of sugar beet is near to the ground (some lycosids were trapped).

Table (3): Comparison Between pitfall traps and D-vac machine in capturing spider families in September sugar beet plantation (2006/07 season)

Month of sampling	Lycosidae		Philodromidae		Linyhiidae		Araneidae		Salticidae		Gnaphosidae	
	Pitfall	D-vac	Pitfall	D-vac	Pitfall	D-vac	Pitfall	D-vac	Pitfall	D-vac	Pitfall	D-vac
October	121	15	42	7	49	76	4	6	7	4	8	3
November	76	14	63	6	55	50	2	4	5	3	13	2
December	57	12	48	3	62	100	3	8	3	1	3	1
January	39	10	21	12	16	40	7	13	2	0	1	0
February	55	3	32	16	26	50	10	12	6	2	2	1
March	69	15	44	1	39	52	15	21	13	7	3	1
April	83	2	53	3	14	23	1	5	2	1	14	0
Total of trap	500	71	303	48	261	391	40	69	38	18	44	8
Occurrence % in trap	87.57	12.43	86.32	13.68	40.03	59.97	36.70	63.30	67.86	32.14	84.62	15.38
Total of family	571		351		652		109		65		52	
Occurrence % of family	31.72		19.50		36.22		6.06		3.61		2.89	

Table (4): Comparison Between pitfall traps and D-vac machine in capturing spider families in October sugar beet plantation (2006/07 season)

Month of sampling	Lycosidae		Philodromidae		Linyhiidae		Araneidae		Salticidae		Gnaphosidae	
	Pitfall	D-vac	Pitfall	D-vac	Pitfall	D-vac	Pitfall	D-vac	Pitfall	D-vac	Pitfall	D-vac
November	65	14	49	19	39	49	3	6	8	9	8	3
December	93	10	32	7	12	29	1	3	3	4	4	0
January	32	7	18	13	10	21	0	2	3	1	5	1
February	49	5	26	16	23	44	3	12	6	2	1	0
March	63	18	36	19	41	36	9	33	11	6	3	1
April	72	3	21	5	53	85	4	9	16	8	4	1
May	102	5	26	14	22	48	1	32	23	16	9	0
Total of trap	4.26	62	208	93	200	312	21	97	70	46	34	6
Occurrence % in trap	87.30	12.70	69.10	30.90	39.06	60.94	17.80	82.20	60.34	39.66	85.00	15.00
Total of family	488		301		512		118		116		40	
Occurrence % of family	30.98		19.11		32.51		7.49		7.37		2.54	

Data in Table (5) show the effect of field margin in enhancing the population of spiders of seven families. For the traps (pitfall and D-vac) used inside the field, it was clear that the numbers of all spider families were lower than those in margins. Dictynidae and Theridiidae suffered the greatest reductions inside as compared to the margin; 82.14 and 80.49% reduction, respectively. These were followed by Araneidae (72.73% reduction) and Linyphiidae (70.90% reduction). However, Philodromidae and Lycosidae had reductions of 32.50 and 37.38%, respectively.

Diversity of spiders on foliage of sugar-cane was 27-39% higher in grass and mixed weedy than in weed-free habitats (Ali and Regan 1985). Bell et al (2002) reported that field margins provided an excellent source habitat for the linyphiid spider, *Lepthyphantes tenuis*. Cutting margins reduced the population of the spider, but no cutting ensured higher numbers. Toth and Kiss (1999) indicated that the wheat field margins are more dense and rich habitats of spiders than the field itself. They explained that the fields are strongly and repeatedly disturbed every year by tillage, harvest, pesticides application and other field works, while occasional disturbance in the margins (e.g. mowing, pesticide drifting) does not destroy the habitat basically. Bell et al (2002) indicated that field margins provide an excellent source habitat for the spiders. Also, Bazazo (2005) investigated the population density of Linyphiidae, Araneidae, Salticidae and Philodromidae in sugar beet fields, and found that the numbers were less in the interior of the field than in the margins by 67.71-84.21%.

Table (5):Occurrence of spiders in margins and inside of three sugar beet plantations, season 2007/08 (10 m long by D-vac machine and 10 Pitfall traps) .

Month of	Linyphiidae		Araneidae		Salticidae		Philod-romidae		Dictynidae		Lycosidae		Theridiidae	
sampling	Margin	Inside	Margin	Inside	Margin	Inside	Margin	Inside	Margin	Inside	Margin	Inside	Margin	Inside
September	90	26	10	2	9	2	41	27	10	1	130	68	15	3
October	56	18	8	3	6	1	56	39	6	1	121	51	5	1
November	38	11	3	0	5	2	61	42	5	0	62	35	3	0
December	31	9	2	0	1	0	43	21	1	0	42	24	2	0
January	19	4	1	0	4	1	24	9	3	0	34	22	0	0
February	36	8	3	0	11	4	35	21	5	0	45	36	1	0
March	69	19	7	2	17	7	55	40	5	0	75	61	2	0
April	73	27	9	3	11	2	71	51	9	3	91	78	4	1
May	124	34	12	5	26	14	54	47	12	5	141	89	9	3
Total	536	156	55	15	90	32	440	297	56	10	741	464	41	8
Reduction	70.90		72.73		64.44		32.50		82.14		37.38		80.49	

Acknowledgements

The author are grateful to Dr. Alberto Barrion, the taxonomist of International Rice Research Institute (IRRI), Philippines, for identifying and confirming the specimens of some spiders and for providing valuable publications that contributed in preparing the paper. Too much thanks to Prof. Dr. Mahmoud R. Sherif, Rice Research and Training Center, Agricultural Research Center, Egypt for valuable comments and reviewing the manuscript. Thanks are also due to Mr. Kamal G. Bazazo, Sugar Crops Research Institute, for sincere help in field works and sampling.

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حصر العناكب وتأثير طريقة الجمع الحقلي و حواف الحقل علي كثافتها العددية في حقول بنجر السكر

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أجريت تجارب حقلية في المزرعة البحثية لمحطة البحوث الزراعية بسخا عامي ٢٠٠٧/٢٠٠٦ و ٢٠٠٨/٢٠٠٧ في حقول بنجر السكر. أشارت الدراسة إلى حصر ثلاثين نوعا من العناكب تقطن حقول بنجر السكر و تنتمي إلى أثني عشرة عائلة هي: Araneidae، Dictynidae، Dysderidae، Gnaphosidae، Linyphiidae ، Lycosidae، Miturgidae، Philodromidae، Salticidae، Tetragnathidae ، Theridiidae و Thomisidae.

في جميع عروات بنجر السكر (أغسطس و سبتمبر و أكتوبر) كانت أعداد العناكب لعائلات Lycosidae و Gnaphosidae (عناكب أرضية) و عائلات Philodromidae و Salticidae (عناكب متجولة) أعلي في مصائد الحفرة عنها في آلة الشفط ، بينما كان الوضع معكوسا في عائلتي Linyphiidae و Araneidae (العناكب الناسجة).

كما أوضحت الدراسة أن كثافة تعداد العناكب في حواف الحقل في العادة كانت دائما أعلي منها داخل حقول بنجر السكر في جميع العائلات السبع التي تناولتها الدراسة ، حيث انخفضت الأعداد داخل الحقل عنها في الحواف بقيم تراوحت بين ٣٢,٥٠، ٨٢,١٤ ٪.