ACARINES, 10:71-76, 2016

Side Effects of Some Cotton Pesticides on the Dominant Spider Families in Cotton Fields

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ABSTRACT

Survey was carried out at Elgemmeza Agricultural Research Station in a cotton field for Piercing sucking pests and associated predators along two successive seasons (2013 & 2014) during May-August months by using examination of leaves and plant shaking methods, during vegetative and flowering stages. The toxic effect of three pesticides on piercing sucking pests (whitefly and jassids) and its side effect on true spiders were also studied. Moreover, the toxic effect of three pesticides on cotton leafworm, *Spodoptera littoralis* and its side effect on true spiders. Results showed that, the highest numbers of spiders in cotton fields were recorded in August, in addition, the highest families occurrence were Linyphiidae and Philodromidae representing 39.02 and 21.8 %, respectively. As for the average numbers of collected predators, there were significant differences in the total numbers of true spiders & aphid lion and other predators (Ladybirds, Rove beetle, Flower bugs). As for pesticides, Applud gave the highest average numbers of reduction percentages of white fly stages infested cotton plants followed by Acetamprid and KZ oils. The decrease percentages of true spiders as side effects of applied pesticides were 29.35 and 21.05 % for Lufenuron and Diflubenzuron and 43.77 % for Profenofos in cotton fields. It could be concluded that true spiders played an important role in suppressing pest populations and in delaying pest outbreaks in the cotton growing season.

Key words: True spiders; Predators; white fly; Cotton leafworm; Jassid; Biological control.

INTRODUCTION

Spiders are among the most abundant predators of insects of terrestrial ecosystems (Edwards *et al.*, 1976) playing an important role as stabilizing agents or regulators of its populations in agro and forest ecosystems. They are generalist predators which can attack large numbers of insect pests; thus, reducing and even preventing its outbreaks (Sunderland *et al.*, 1986). Spiders feed on insects and some other arthropods and consequently play important roles in the control of many pests. More than 35000 species of spiders have been identified in the world (Ghavami, 2006).

Conventional pesticides provide many benefits to food production and nutrition, but also pose some hazards. As a result, research- workers are seeking less hazardous alternatives to control the pests of the main crops such as date palm (Gameel and Sayed, 2009) and vegetables (Gameel and Sayed, 2012). Vegetable plants are subjected to be attacked by several major insect pests which cause severe damage directly or indirectly to the crop production (Metwally *et al.*, 1995 and Ghallab *et al.*, 2011). The tomato whitefly, *Bemisia tabaci* (Gennadius) (Homoptera: Aleyrodidae) and cotton aphid, *Aphis gossypii* Glover; (Homoptera: Aphididae) were recorded as key piercing- sucking pests on cucurbit crops under the New Valley conditions (Gameel and Sayed 2008). The main predators associated with these pests are (*Coccinella undecimpunctata aegyptiaca* Reihe and *C. septempunctata* L.) and the true spiders (Younes *et al.*, 2010).

Therefore, this study aimed to survey true spiders cotton fields of El-Gemmeiza Agricultural Research Station for two successive seasons (2013&2014) for May to August months by using leaf examination and plant shaking methods , Moreover, the toxic effect of some pesticides on piercing sucking pests and its side effect on true spiders, was studied.

MATERIALS AND METHODS

1- Surveying study:

1-1- Spiders:

Survey was carried out at El-Gemmeiza Agricultural Research Station in a cotton field for two successive seasons (2013&2014) during May to August months by using plant shaking method, during vegetative and flowering stages. Specimens were collected by shaking 25 plant/ samples five times for plant and were individually picked in plastic vials (3 x 6 cm) and transferred to the laboratory for counting and identification.

1-2- Piercing sucking pests and associated predators:

Sucking pests (whitefly, *Bemisia tabaci*, Jassids cotton jassid, *Amrasca beguttula beguttula* Isida and Aphids, *Aphis* spp.) were surveyed. In addition, the associated predators: Spiders, Ladybirds, Aphid lion, Rove beetle and Flower bugs were recorded. Nymphs and adults of whitefly, Jassids and Aphid stages were counted per 25 leaves for pests and per 25 plants for predators at early morning. Samples were randomizly taken from the experimental plots.

2- Pesticides study:

2-1 The toxic effect of tested pesticides on piercing sucking pests infested cotton plants and the side effect on spiders:

Three plots (105 m^2) of cotton plants were sprayed with three recommended pesticides against piercing sucking pests (Whitefly, Jassids and Aphids) using a manual back sprayer 20 Liters , as well as testing its side effect on spiders.

The tested pesticides were Applud (Buprofezin 25% SC, 600 cm^3 / Feddan), Nuset (Acetamprid 20% SP, 25 g/100 liter) and KZ oil (Mineral oil 95% EC, 2 liter /Feddan). Different stages of piercing sucking pests were counted directly on 25 leaves/ replicate in the field before and after 24 h, 3, 7 and 14 days of application. Reduction percentage was determined according to Henderson and Tilton formula (1955).

2-2 Toxic effect of 3 pesticides on the cotton leafworm, *Spodoptera ittoralis* (Boisduval) and its side effect on spiders:

Three recommended pesticides against *Spodoptera littoralis* were sprayed and its side effect on spiders was studied. These compounds were Verary (Lufenuron 5% EC, 160 cm^3/Feddan), Newbenzuron (Diflubenzuron 48% SC, 125 cm^3/ Feddan) and Cilian (Profenofos 72 % EC, 750 cm^3/ Feddan). Four plots each 175 m^2 were used as replicates for each compound, and another four plots were sprayed with water as control. Numbers of *S. littoralis* larvae were counted on 25 plants for each replicate before; and 1 day, 3, 7 and 14 days after application. In addition, spiders were counted by shaking 25 plants from each replicate, the reduction percentages was determined according to Henderson and Tilton formula (1955).

Statistical analysis:

The obtained data was statistically analyzed using analysis of variance (ANOVA) at 5 % probability. The measurements were separated using Duncan's Multiple Range Test (DMRT) through CoStat software program (Version 6.400). CoStat version 6.400 Copyright © 1998-2008 Cohort Software. 798 Lighthouse Ave. PMB 320, Monterey, CA, 93940, USA.

Corrected reduction percentages were calculated according to Henderson and Tilton (1955) formula.

RESULTS AND DISCUSSION

Table (1) showed the average numbers of collected true spiders and occurrence percentages in cotton fields during 2013 season using plant shaking method. Its highest numbers were recorded at August month; 188 individuals / 25 plants.

Statistical analysis indicated significant differences in the numbers of collected spiders between July and August months and the other two months. In addition there were significant differences among collected spiders where the highest occurrence families were recorded as Linyphiidae and Philodromidae families representing 39.02 and 21.8 %, respectively; while the least families were Araneidae, Salticidae, and Lycosidae with 3 to 6 %.

Table (2) showed the average numbers of collected true spiders and occurrence percentages in cotton field during 2014 season. Its highest numbers were recorded at August month; 247 individuals / 25 plants.

Statistical analysis (Table 2) indicated occurrence of significant differences in the numbers of collected spiders between August and all other months. In addition, there were significant differences among collected spiders where the highest occurrence families were Linyphiidae and Philodromidae representing 31.02and 25.73 %, respectively, where the least families were Araneidae, Salticidae and Dictynidae with 3 to 7 %.

Table (3) showed the average numbers of cotton pests, spiders and predators collected during the two seasons, 2013 & 2014.

Table (3) indicated the occurrence of significant differences in the total numbers of pests between aphid stages and the other two pests, whitefly and jassids along the studied seasons 2013 & 2014.

As for the average numbers of collected predators, the numbers at 2013 season were less than that of 2014 season. Statistical analysis of the data revealed significant differences in the total numbers of the spiders and aphid lion and other predators (Ladybirds, Rove beetle and Flower bugs).

Table (4) showed the average numbers of white fly and jassids infesting cotton plants as influenced by the application of three recommended pesticides, as well as the side effect of pesticides on beneficial spiders 1, 3, 7, 14 days of application.

Table (4) indicated that there were significant differences in the numbers of white fly and jassid insects between pretreatment samples and all other samples after pesticide applications.

Table (5) showed the reduction percentages of piercing sucking pests (Whitefly, Jassids) infesting cotton plants and true spiders after 1, 3, 7, 14 days of pesticide applications.

Applud pesticide gave the highest average numbers of reduction percentages of white fly stages infested cotton plants recording 72.31 % followed by the treatment of Nuset 53.18% , while KZ oil treatment gave 45.5 %.

Table (1): Occurrence of spiders in cotton fields during 2013 season using plant shaking method

Spiders families	May	June	July	Aug.	Mean	Occurrence %
	Average no. per 25 plants					
Philodromidae (*Thanatus albini*)	5	23	35	60	30.75[a]	21.80
Theridiidae (*Steatoda erigoniformis*)	2	17	22	23	16[c]	11.34
Araneidae (Unknown sp.)	3	7	2	5	4.25[e]	3.02
Salticidae (Unknown sp.)	5	7	4	9	6.25[de]	4.43
Linyphiidae *Gnathonarium dentatum*	22	17	39	12	22.5[b]	15.0
Prinerigon vegans	32	42	33	23	32.5[a]	24.02
Total	54	59	72	35	55	(39.02)
Lycosidae	5	12	7	13	9.25[d]	6.56
Dictynidae	2	1	32	43	19.5[bc]	13.82
Total no. of spiders	76[C]	126[B]	179[A]	188[A]	141	100

LSD 5% among spider families = 3.9 LSD 5% among months = 13.1

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

Table (2): Occurrence of spiders in cotton field during 2014 season using plant shaking method

Spiders families	May	June	July	Aug.	Mean	Occurrence %
	Average no. per 25 plants					
Philodromidae (*Thanatus albini*)	10	29	55	72	44.5 a	25.73
Theridiidae (*Steatoda erigoniformis*)	5	25	21	30	20.25 c	12.56
Araneidae (Unknown sp.)	5	9	2	9	6.25 e	3.87
Salticidae (Unknown sp.)	7	12	5	15	9.75 de	6.03
Linyphiidae *Gnathonarium dentatum*	11	22	13	32	19.5 c	12.0
Prinerigon vegans	29	25	47	21	30.5 b	19.02
Total	40	47	60	53	50	(31.02)
Lycosidae	15	14	19	37	21.25 c	13.17
Dictynidae	1	5	12	31	12.25 d	7.6
Total no. of spiders	83 D	141 C	179 B	247 A	161.25	100

LSD 5% among spider families = 5.6 LSD 5% among months = 32.5.

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.

Table (3): Number of cotton pests, spiders and other predators collected during the two seasons, 2013 & 2014

Pests and predators	2013					2014				
	May	June	July	Aug.	Mean	May	June	July	Aug.	Mean
	Pests (Average no. per 25 leaves)									
Whitefly	131	112	121	129	123.25[b]	101	125	215	240	170.25[b]
Jassids	137	140	128	141	136.5[b]	103	140	166	273	170.5[b]
Aphids	27	115	272	453	216.75[a]	14	95	255	513	219.25[a]
LSD 5%					20.0					22.6
	Predators (Average no. per 25 plants)									
spiders	18	14	15	17	16[a]	22	25	35	33	28.75[a]
Ladybirds	6	8	5	7	6.5[b]	6	5	7	9	6.75[c]
Aphid lion	18	15	16	22	17.75[a]	17	21	30	35	25.75[a]
Rove beetle	17	16	20	19	18[a]	15	11	18	24	17[b]
Flower bugs	3	5	7	6	5.25[b]	4	9	11	9	8.25[c]
LSD 5%					3.0					5.3

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.

Table (4): Effect of application of the recommended pesticides in cotton field against sucking pests (Whitefly- Jassids) on spiders

Sampling dates	White fly/25 leaves	Jassids /25 leaves	Spiders/25 plants
Recommended pesticides			
Applud			
Pretreatment	68[a]	45[a]	55[a]
1 day	17[bc]	21[b]	46[b]
3	12[d]	25[b]	32[cd]
7	18[b]	26[b]	37[c]
14	14[cd]	22[b]	28[d]
Mean	15.25	23.5	38.25
LSD %	3.8	8.0	6.5
Nuset			
Pretreatment	62[a]	68[a]	62[a]
1 day	15[c]	24[c]	44[b]
3	21[c]	23[c]	40[bc]
7	27[b]	17[c]	37[c]
14	30[b]	33[b]	29[d]
Mean	23.25	24.25	40
LSD %	3.2	7.5	5.8
KZ oil			
Pretreatment	77[a]	125[a]	66[a]
1 day	34[c]	38[c]	53[b]
3	26[d]	62[b]	45[c]
7	22[d]	36[c]	25[d]
14	53[b]	59[b]	31[d]
Mean	33.75	68.25	52
LSD %	5.7	5.2	7.1
Control			
Pretreatment	85[a]	112[a]	123[a]
1 day	73[c]	102[a]	75[bc]
3	68[cd]	80[b]	66[c]
7	79[b]	68[b]	70[c]
14	66[d]	73[b]	85[b]
Mean	71.5	80.75	72.75
LSD %	5.9	15.4	10.9

Table (5): Reduction percentages of sucking pests (Whitefly, Jassids) and spiders after application of some pesticides

Sampling after applications	White fly	Jassids	Spiders
Applud			
1 day	70.89	48.75	37.16
3	77.94	22.22	8.43
7	66.9	22.22	18.20
14	73.48	24.99	26.33
Mean	72.31	29.55	22.53
Nuset			
1 day	71.83	61.24	16.38
3	57.66	52.64	20.23
7	45.56	52.64	33.44
14	37.68	25.54	32.31
Mean	53.18	48.03	25.59
KZ oil			
1 day	48.58	53.63	31.69
3	57.79	30.56	27.06
7	69.28	52.56	33.11
14	11.35	27.58	32.03
Mean	45.5	47.89	30.97

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.

Table (6): Effect of application of the recommended pesticides of *Spodoptera littoralis* on spiders during 2013 season

Pesticide	Pretreatment		No. of *S. littoralis* larvae after application/ 25 plants									
			1 day		3 days		7 days		14 days		Overall mean	
	S. littoralis	Spiders	*S.* littoralis	Spiders	*S.* littoralis	Spiders	*S.* littoralis	Spiders	*S. littoralis*	Spiders	*S. littoralis*	Spiders
Lufenuron	1113	103	62	1	43	5	7	8	6	7	05 c	8.5 [b]
Diflubenzuron	83	5	15	2	10	0	1	3	3	4	10 c	7.0 [b]
Profenofos	160	18	0	6	12	4	80	2	22	2	24 b	8.5 [b]
Control	580	75	27	17	48	09	31	36	11	22	54 a	68.1 [a]
LSD5%											3.2	0

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.

Table (7): Reduction percentage of *S. littoralis* and the spiders after 1, 3, 7 and 14 days of pesticide treatments

Pesticide	Reduction percentage of *S. littoralis* larvae after application									
	1 day		3 days		7 days		14 days		Overall mean	
	S. littoralis	Spiders	*S. littoralis*	Spiders	*S. littoralis*	Spiders	*S. littoralis*	Spiders	*S. littoralis*	Spiders
Lufenuron	68.36	54.98	41.66	14.27	66.97	27.54	87.56	20.62	66.14	29.35
Diflubenzuron	52.46	33.87	49.19	17.19	65.52	14.67	83.18	18.46	62.58	21.05
Profenofos	85.01	67.04	56.16	40.13	56.16	43.29	72.99	24.63	67.58	43.77

As for the average numbers of reduction percentages of jassid stages infested cotton plants. Nuset and KZ oil gave the highest percentages recording 48.03, 47.89 %, respectively; while Applud gave only 29.55 %.

Regarding to the side effect of tested pesticides on the population of beneficial spiders, KZ oil gave the highest decrease percentages recorded 30.97 % followed by Nuset and Applud treatments which decreased 25.59 , 22.53 % of spider population, respectively.

Table (6) showed the average numbers of *Spodoptera littoralis* larvae infested cotton leaves as influenced by the application of the recommended pesticides: Lufenuron, Diflubenzuron, Profenofos, as well as, the side effect of these pesticides on the spiders.

Table (6) indicated that there were significant differences in the average numbers of *S. littoralis* larvae between control and all other pesticide treatments. Moreover, there were significant differences in the average numbers of spiders on cotton plants between control treatment and all other pesticide treatments.

Table (7) showed the reduction percentage of *S. littoralis* and spiders after 1, 3, 7, and 14 days of pesticide treatments. Results indicated that the overall mean reduction percentages of *S. littoralis* larvae were 66.14, 62.58, 67.58 % for Lufenuron, Diflubenzuron, Profenofos, respectively; while the decrease percentages of true spiders as side effect of applied pesticides were 29.35, 21.05, 43.77 %, respectively.

From the previous results it could be concluded that, the highest numbers of spiders in cotton fields were recorded in August. In addition, the highest occurrence families were Linyphiidae and Philodromidae representing 39.02 and 21.8 %, respectively. As for the average numbers of collected predators, data revealed that there were significant differences in the total numbers of spiders and aphid lion and other predators (Ladybirds, Rove beetle and Flower bugs).

As for pesticides, Applud gave the highest average numbers of reduction percentages of white fly stages infested cotton plants followed by Acetamprid and KZ oils. The decrease percentages of true spiders as a side effect of applied pesticides were 29.35, 21.05 for Lufenuron, Diflubenzuron and 43.77 % for Profenofos.

Obtained results are in harmony with those of Mansour (1987) who studied the spider densities in sprayed and unsprayed cotton fields and found 18 families in unsprayed and only 13 in sprayed fields. Species of Clubionidae, Gnaphosidae and Philodromidae comprised more than half of the total number collected spider and reported that it played an important role in suppressing pest populations and in delaying pest outbreaks early in the cotton growing season. Also, Mansour and Wolfgang (1988) determined the susceptibility of web-building and hunting spiders from the tropics (Panama), Europe (Germany) and the Middle East (Israel) to 30 pesticides (16 insecticides, 4 acaricides, 1 herbicide, 9 fungicides) under laboratory conditions , and found that *Philodromus* sp. (hunting spider), was completely resistant to all substances; *Argiope* sp. (web-building spider), *Linyphia* sp. (web-building spider) and *Chiracanthium* sp. (hunting spider) showed medium to high susceptibility. Insecticides affected spiders in a wide range of responses: from no mortality (most compounds of biological origin) and medium mortality (pyrethroid compounds, organophosphorus and carbamate compounds), to high mortality (cyclo-compounds). To both groups of spiders (the hunting and web-building), most acaricides were highly toxic, whereas herbicides and fungicides were nontoxic. Dinter and Poehling (1995) tested the side-effects of two pyrethroid insecticides (fenvalerate and lambda-cyhalothrin) and one carbamate insecticide (pirimicarb) on the spiders: *Erigone atra* (Blackwall) and *Oedothorax apicatus* (Blackwall) (Araneae, Erigonidae) and investigated the sensitivity of adults of both sexes and juveniles to insecticides and its influence on the rate of emergence of spiderlings from cocoons using topical application, spraying or residual contact. They found that residual contamination caused higher mortality of spiders after contact with lambda-cyhalothrin than fenvalerate. In all tests, males were more susceptible to pyrethroids than females. Recently, Jeyaparvathi *et al.* (2013) found four species of spiders (*Peucetia viridana* (Stoliczka), *Oxyopes birmanicus* (Thorell), *Oxypes salticus* (Hentz) and *Peucetia latikae* (Tikader) in the cotton fields of Tamil Nadu, India and reported that it act as biological control agents of insect pests in agroecosystems.

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