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Field evaluation of recommended insecticides to control bollworms on cotton aphid, *Aphis gossypii* glover and their side effect on associated predators

El-Zahi, E.S. and Arif, S.A.
Sakha Agric. Res. Station, Plant Prot. Res. Inst., Dokki, Giza, Egypt.

ABSTRACT

Cotton aphid, *Aphis gossypii* appears as serious late season pest of cotton causing severe losses in quality and quantity of lint. Field experiments were conducted at Sakha Agriculture Research Station, Egypt in 2009 and 2010 seasons to evaluate the efficacy of six recommended insecticides to control bollworms, i.e. lambda-cyhalothrin, alpha-cypermethrin, deltamethrin, methomyl, profenofos and chlorpyrifos and two aphicides, i.e. thiamethoxam and imidacloprid at their recommended rates against *A. gossypii*. Side effect on associated predators was also studied. Obtained results indicated that methomyl, profenofos and chlorpyrifos proved to be very effective against aphid causing percent reduction ranged from 83.74 to 98.06 % in 2009 and from 85.57 to 94.17 % in 2010 season. The two aphicides; thiamethoxam and imidacloprid caused 93.60 % and 95.00 % reduction in 2009 season and 94.24 % and 95.32 % in 2010 season. The pyrethroid insecticides showed unpersuasive aphid control. Regarding the side effect on associated predators, with exception of thiamethoxam and imidacloprid, all the rest evaluated insecticides were ultimately toxic to the predators recording from 82.89 to 94.80 % reduction in 2009 season and from 82.76 to 92.78 % reduction in 2010 season. The two aphicides were the least toxic causing less than 50 % reduction in the two seasons of study.

Keywords: *A. gossypii*, bollworms, insecticides, predators.

INTRODUCTION

During the last few decades, cotton aphid *Aphis gossypii* became one of the major pests of cotton plants. This pest infests cotton plants at different stages of growth, but cotton can fully compensates for aphids infestation during the pre-squaring stage. Rosenheim *et al.* (1997) reported that, the ability of early-season cotton to compensate fully for aphid feeding, and the

generally short duration of infestation (because natural enemies successfully attack them), suggested that early-season aphids should be viewed as non-pest.

Mid and late-season aphid infestations are the most dangerous (Slosser *et al.*, 1989) this due to secretion of honeydew which contaminates green bolls and cotton lint causing problems in picking, ginning and spinning and lowering lint grade. The duration of dangerous infestation with cotton aphid coincides with the period of intensive use of organophosphate, carbamate and pyrethroid insecticides to control bollworms infestation in cotton fields.

Previous investigations studied the effect of various insecticides belong to organophosphate, carbamate and pyrethroid groups on cotton aphids infestation (Ghetiya and Butani, 1996; Kidd *et al.*, 1996; Razaq *et al.*, 1998; Uzma and Muhammad, 1999; Ghoneim, 2002; Praveen and Regupathy, 2003; Jasmine *et al.*, 2005; Jana *et al.*, 2006 and Mushtaq and Arif, 2008). The objective of the present work was to evaluate the effect of six recommended insecticides used to control bollworms and two aphicides on *A. gossypii* and their side effect on associated predators under field conditions.

MATERIALS AND METHODS

I. Insecticides used:

a). Organophosphorus insecticides:

- Profenofos (Sylian 72% EC) obtained from Kafr El-Zayat Pesticides and Chemicals Co., applied at 375 ml/100 L water.
- Chlorpyrifos (Pestban 48% EC) obtained from Agrochem Co., applied at 500 ml/100 L water.

b). Pyrethroid insecticides:

- Alpha-cypermethrin (Alfazed 10% EC) obtained from Kafr El-Zayat Pesticides and Chemicals Co., applied at 125 ml/100 L water.
- Deltamethrin (Decis 2.5% EC) obtained from Cairo Chemicals Co., applied at 175 ml/100 L water.
- Lambda-cyhalothrin (Belarmada 2.5% EC) obtained from Samtrade Co., applied at 375 ml/100 L water.

c). Carbamate insecticide:
Methomyl (Newmeal 90% SP) obtained from Kafr El-Zayat Pesticides and Chemicals Co., applied at 150 gm/100 L water.

d). Neonicotinoid insecticides:
- Thiamethoxam (Actara 25% WG) obtained from Syngenta AG Co., applied at 20 gm/100 L water.
- Imidacloprid (Confidor 35% SC) obtained from Bayer Co., applied at 75 ml/100 L water.

II. Experimental design: The experiments were conducted at the Farm of Sakha Agricultural Research Station in August 2009 and July 2010. In every season, an area of one feddan was selected to be sown on April, 15 with cotton seeds var. Giza 86, received all good recommended agricultural practices throughout the whole season and divided into plots each of 87.5 m^2. Nine treatments, including control, were designed in this area.

Four plots (replicates) were made for every treatment. Irrigation water was used in diluting the tested insecticides at their recommended rates, and the final volume of spray solution was 200 liters per feddan. A knapsack sprayer (CP_3) equipped with one nozzle was used. Unplanted belts (3 m width) were left as barriers between plots to avoid contamination by drifts. The complete randomized blocks design with four replicates was adopted.

III. Representative samples of cotton aphid and some associated predators: From every plot, 50 cotton leaves infested with aphid were chosen and labeled with small white cards. The numbers of aphids individuals (adults + nymphs) on labeled leaves were counted and recorded immediately before spray and at 2, 5, 8, 11 and 14 days after spray. Lens (5x) were used to inspect labeled leaves.

Concerning associated predators, 10 cotton plants were chosen randomly from each plot (replicate) and the number of founded predators was directly recorded using lens (5 x) at the same dates of inspections of aphids infestation (i.e. pre-spray and after spray at 2, 5, 8, 11 and 14 days). The counted predators were *Chrysoperla carnea* larvae, *Scymnus* spp. larvae, *Coccinella* spp. larvae and adults and true spiders.

IV. Statistical analysis of data: Initial kill after two days from application and reduction percentages in the populations of studied insects

were estimated according to Henderson and Tilton (1955) equation as follows:;

$$\% \text{ reduction} = 100\ [1-(B^* \times A)/(A^* \times B)]$$

Where:

A = No. of individuals in control plots before spray.
A* = No. of individuals in control plots after spray
B = No. of individuals in treated plots before spray
B* = No. of individuals in treated plots after spray

All data were subjected to one-way analysis of variance (ANOVA) followed by Duncan multiple range test (Duncan, 1955) to determine the significant differences among treatments means values at 0.05 probability level.

RESULTS AND DISCUSSION

The initial and residual activities of two organophosphorus insecticides (profenofos and chlorpyrifos), three pyrethroids (lambda-cyhalothrin, alpha-cypermethrin and deltamethrin), one carbamate (methomyl) and two neonicotinoids (thiamethoxam and imidaclorprid) were evaluated under field conditions against cotton aphid *A. gossypii* during 2009 and 2010 cotton seasons. Side effect against some associated predators i.e., *Chrysoperla carnea*, *Scymnus* spp., *Coccinella* spp. and true spiders was also determined.

A. Efficiency against *A. gossypii* Glover: The population density of *A. gossypii* (nymphs + adults) before and after application of the tested insecticides during 2009 and 2010 cotton seasons was presented in Table (1). Number of aphids/10 cotton leaves pre-spray ranged between 268 and 392 individuals in 2009 season. While, it ranged from 256 to 341 per 10 leaves in 2010 season. It is conspicuous, the tested insecticides reduced aphid numbers than that in untreated checks, with different degrees depending upon the group to which the insecticide is belonging.

Results presented in Table (2) showed the effect (percent reduction) of the tested insecticides on *A. gossypii* population at 2 (initial kill), 5, 8, 11, and 14 days after spray and mean of effect, mean of percent reduction, during the total experiment period in 2009 and 2010 seasons.

Table (1): Number of *Aphis gossypii* individuals (nymphs + adults)/10 cotton leaves pre and after spraying of the tested insecticides under field conditions in 2009 and 2010 seasons.

Tested insecticides	Rate of application	2009 season						2010 season					
		Number of *A. gossypii*/10 cotton leaves						Number of *A. gossypii*/10 cotton leaves					
		Pre-spray	Days after spray					Pre-spray	Days after spray				
			2	5	8	11	14		2	5	8	11	14
Lambda-cyhalothrin	375 ml/100 L	388	159	179	247	247	292	341	170	128	148	164	165
Alphacypermethrin	125 ml/100 L	322	178	254	350	315	342	256	151	150	170	180	170
Deltamethrin	175 ml/100 L	274	132	164	250	277	328	287	154	135	157	195	200
Methomyl	150 gm/100 L	268	10	3	1	6	5	273	5	10	13	15	17
Profenofos	375 ml/100 L	390	65	76	71	65	63	320	46	38	29	33	35
Chlorpyrifos	500 ml/100 L	392	36	32	27	31	48	294	37	15	20	20	22
Thiamethoxam	20 gm/100 L	360	56	23	18	6	8	312	40	17	8	5	5
Imidacloprid	75 ml/100 L	345	15	15	13	16	33	305	19	13	9	7	9
Control	-	300	243	333	439	313	330	297	269	236	231	221	205

Table (2): Effect of the tested insecticides on *Aphis gossypii* in cotton under field conditions during 2009 and 2010 seasons.

Tested insecticides	Rate of application	2009 season						2010 season					
		% reduction at days after spray					Mean	% reduction at days after spray					Mean
		2	5	8	11	14		2	5	8	11	14	
Lambda-cyhalothrin	375 ml/100 L	49.41 c	58.44	56.50	38.98	31.58	46.98 d	44.96 c	52.76	44.20	35.37	29.90	41.42 c
Alphacypermethrin	125 ml/100 L	31.75 e	28.94	25.72	6.24	3.44	19.22 f	34.88 d	26.26	14.62	5.51	3.79	17.01 e
Deltamethrin	175 ml/100 L	40.52 d	46.08	37.65	3.10	0.00	25.47 e	40.76 c	40.80	29.67	8.69	0.00	23.98 d
Methomyl	150 gm/100 L	95.39 a	98.99	99.75	97.85	98.30	98.06 a	97.98 a	95.39	93.88	92.62	90.98	94.17 a
Profenofos	375 ml/100 L	79.49 b	82.44	87.49	84.08	85.21	83.74 c	84.13 b	85.06	88.35	86.14	84.15	85.57 b
Chlorpyrifos	500 ml/100 L	88.66 a	92.65	95.29	92.42	88.87	91.58 b	86.10 b	93.58	91.25	90.86	89.16	90.19 ab
Thiamethoxam	20 gm/100 L	80.80 b	94.24	96.58	98.40	97.98	93.60 b	85.85 b	93.14	96.70	97.85	97.68	94.24 a
Imidacloprid	75 ml/100 L	94.63 a	96.08	97.42	95.55	91.30	95.00 ab	93.12 a	94.64	96.21	96.92	95.72	95.32 a

In the same column, means followed by the same letter are not significantly different at 5% level by Duncan (1955).

In 2009 season, it is intelligible from data in Table (2) that methomyl, imidacloprid and chlorpyrifos confirmed the highest initial kill recording 95.39, 94.63 and 88.66 % reduction, respectively without significant differences. Thiamethoxam and profenofos ranked the second order. The three pyrethroids were the inferior causing from 31.75 to 49.41 % initial kill. Methomyl, imidacloprid and thiamethoxam gave the highest mean of effect (from 98.06 to 93.60 % reduction) followed by chlorpyrifos (91.58 %) and profenofos (83.74 %). Lambda-cyhalothrin gave unpersuasive mean of effect (46.98 % reduction). Also, deltamethrin and alpha-cypermethrin failed to introduce sufficient control against aphids where they showed very feeble mean of effect recording 25.47 and 19.22 % reduction, respectively.

In 2010 season, the tested insecticides cleared the same trend of efficacy. Methomyl and imidacloprid gave the highest initial kill (97.98 and 93.12 %, respectively) with non-significant differences between them. Chlorpyrifos, thiamethoxam and profenofos resulted in from 86.10 to 84.13 % initial kill, while the tested pyrethroid insecticides provided the least effect. As an endeavor to give an explanation for the deficiency of pyrethroid insecticides in controlling aphids; Kidd and Rummel (1997) mentioned that aphid numbers increased faster to higher levels on lambda-cyhalothrin-treated cotton plants after application and this attributed to a physiological interaction between lambda-cyhalothrin and cotton leaves or aphids which resulted in increase aphid reproductive activity. Regarding the mean of effect, the effective tested insecticides could be arranged descendingly as follows: imidaclorpid (95.32 %), thiamethoxam (94.24 %), methomyl (94.17 %), chlorpyrifos (90.19 %) and profenofos (85.57 %).

The obtained results are in agreement with those of several investigators; Uzma and Muhammad (1999) found that *A. gossypii* was the most susceptible to profenofos, while alpha-cypermethrin was the least effective. Misra (2002) found that imidacloprid and thiamethoxam proved significantly superior in controlling aphids and jassids. Ahmad *et al.* (2003) stated that *A. gossypii* consistently showed lower resistance to deltamethrin than to other tested pyrethroids. El-Zahi (2005) reported that imidacloprid proved to be the most effective against aphids causing 98.17% reduction as general mean of effect, while, lambda-cyhalothrin (Icon) gave only 47.19%. Dhawan *et al.* (2008) mentioned that thiamethoxam was the most effective against cotton aphids under screen house conditions. *A. gossypii* showed very low resistance to profenofos, chlorpyrifos and methomyl (Mushtaq and Arif, 2008).

B. Side effects on some associated predators: The side effects of the tested insecticides on the associated predators, i.e. *Chrysoperla carnea* larvae, *Scymnus* spp. larvae, *Coccinella* spp. larvae and adults and true spiders were evaluated under field conditions during 2009 and 2010 seasons. The obtained data of the two seasons presented in Tables 3 and 4. Table (3) revealed that, the predators were more abundant in 2010 than in 2009 season. The predator populations pre-treatment in 2010 ranged between 44 and 58 individuals/10 cotton plants, while they ranged from 28 to 50 individuals in 2009 season.

Table (3): Number of associated predators*/10 cotton plants pre and after spraying of the tested insecticides under field conditions in 2009 and 2010 seasons.

Tested insecticides	Rate of application	2009 season						2010 season					
		Number of associated predators*/10 cotton plants						Number of associated predators*/10 cotton plants					
		Pre-spray	Days after spray					Pre-spray	Days after spray				
			2	5	8	11	14		2	5	8	11	14
Lambda-cyhalothrin	375 ml/ 100 L	28	8	5	1	9	8	58	13	7	4	8	15
Alphacypermethrin	125 ml/ 100 L	39	13	6	2	4	8	44	15	4	7	6	10
Deltamethrin	175 ml/ 100 L	38	3	12	4	9	13	47	4	5	7	7	12
Methomyl	150 gm/ 100 L	50	4	1	1	6	5	47	5	2	3	4	5
Profenofos	375 ml/ 100 L	48	5	7	6	3	8	44	6	6	5	4	4
Chlorpyrifos	500 ml/ 100 L	35	2	3	6	3	2	56	4	5	8	6	3
Thiamethoxam	20 gm/ 100 L	35	31	25	31	27	27	48	39	31	35	28	30
Imidacloprid	75 ml/ 100 L	45	27	40	29	32	23	45	25	33	22	27	21
Control	-	28	30	38	43	37	42	50	52	55	55	58	60

Associated predators*: *Chrysoperla carnea* larvae, *Scyumnus* spp. larvae, *Coccinella* spp. (larvae + adults) and true spiders

Data presented in Table (4) showed the effect (percent reduction) of the tested insecticides on associated predators populations at 2

(initial kill), 5, 8, 11, and 14 days after spray and mean of effect , mean of percent reduction, during the total experiment period in 2009 and 2010 seasons .Thiamethoxam was the least toxic to the studied predators recording 17.33 and 21.88 % initial kill and 39.44 and 38.90 % mean of effect in 2009 and 2010 seasons, respectively. Imidacloprid ranked the second order of safety where it gave 44.00 and 46.58 % initial kill and 49.73 and 48.97 % mean of effect in 2009 and 2010 seasons, respectively. On the contrary, chlorpyrifos, profenofos, methomyl and deltamethrin proved to be the most toxic, recording initial kill ranged from 90.28 to 94.67 % reduction in 2009 season and from 86.89 to 93.13 % reduction in 2010 season. According to the obtained mean of effect values presented in Table (4), with exception of thiamethoxam and imidacloprid, all the rest tested insecticides were ultimately toxic to studied predators recording from 82.89 to 94.80 % reduction in 2009 and from 82.76 to 92.78 % reduction in 2010 season.

Our findings in this work coincided closely with that of many previous investigators; Badawy and El-Arnaouty (1999) found that carbamates were less toxic than organophosphorus, but still more than biocides which were the safer to *C. carnea*. Omer *et al.* (2002) stated that diazinon and profenofos were more toxic than thiamethoxam to *Coccinella undecimpunctata*, *C. carnea* and *Paederus alfierii*. Vorghese and Beevi (2004) mentioned that chlorpyrifos was the most toxic to *C. carnea* larvae followed by profenofos, while imidaclorpid was the safest. Imidaclorpid under field conditions did not cause any adverse effect on *C. carnea* and *Coccinella* spp.(Ameta and Sharma, 2005). Choudhary *et al.* (2006) reported that the *C. carnea* larvae mortality was maximum (88.46 %) in pyrethroid-treated plots, whereas it was lowest in neem-based biological pesticides. Abida *et al.* (2007) informed that methomyl and fenpropathrin caused 92 % mortality of *C. carnea* second instar larvae. Gnanadhas *et al.* (2009) showed that imidacloprid and diafenthiuron were harmless to *C. carnea*.

Table (4): Side effects of the tested insecticides on associated predators * in cotton under field conditions during 2009 and 2010 seasons.

Tested insecticides	Rate of application	2009 season						2010 season					
		% reduction at days after spray					Mean	% reduction at days after spray					Mean
		2	5	8	11	14		2	5	8	11	14	
Lambda-cyhalothrin	375 ml/100 L	73.33 ^{c}	86.84	97.67	75.68	80.95	82.89 ^{b}	78.45 ^{c}	89.03	93.73	88.11	78.45	85.55 ^{b}
Alphacypermethrin	125 ml/100 L	68.89 ^{d}	88.66	96.66	92.24	86.32	86.55 ^{b}	67.22 ^{d}	81.74	85.54	88.24	81.06	82.76 ^{b}
Deltamethrin	175 ml/100 L	92.63 ^{ab}	76.73	93.15	82.08	77.19	84.36 ^{b}	91.82 ^{ab}	90.33	86.46	87.16	78.72	86.90 ^{ab}
Methomyl	150 gm/100 L	92.53 ^{ab}	98.53	98.70	90.92	93.33	94.80 ^{a}	89.77 ^{ab}	96.13	94.20	92.66	91.13	92.78 ^{a}
Profenofos	375 ml/100 L	90.28 ^{b}	89.25	91.86	95.27	88.89	91.11 ^{a}	86.89 ^{b}	87.60	89.67	92.16	92.42	89.75 ^{a}
Chlorpyrifos	500 ml/100 L	94.67 ^{a}	93.68	88.84	93.51	96.19	93.38 ^{a}	93.13 ^{a}	91.88	87.01	90.76	95.54	91.66 ^{a}
Thiamethoxam	20 gm/100 L	17.33 ^{f}	47.37	42.33	41.62	48.57	39.44 ^{d}	21.88 ^{f}	41.29	33.71	49.71	47.92	38.90 ^{d}
Imidacloprid	75 ml/100 L	44.00 ^{e}	34.50	58.04	46.19	65.93	49.73 ^{c}	46.58 ^{e}	33.33	55.56	48.28	61.11	48.97 ^{c}

In the same column, means followed by the same letter are not significantly different at 5% level by Duncan (1955).
Associated predators*: *Chrysoperla carnea* larvae, *Scyumnus* spp. larvae, *Coccinella* spp. (larvae + adults) and true spiders

CONCLUSION

Since aphids and bollworms infest cotton plant in the same fruiting growth stage, farmers forced to control the two pests together. Unfortunately, efficient insecticides in controlling aphids and also recommended for bollworms (methomyl, profenofos and chlorpyrifos) are very toxic to the associated predators. This procedure will cause outbreak of the two pests and other non-target organisms as a result of killing associated predators on the long run. Programmers in the Ministry of Agriculture should modify recommendations related to applied insecticides against aphids and bollworms.

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التقييم الحقلى للمبيدات الحشرية الموصى بها لمكافحة ديدان اللوز على من القطن وتأثيراتها الجانبية على المفترسات

الزاهى صابر الزاهى ، صفوت عبدالسلام عارف
محطة بحوث سخا - معهد بحوث وقاية النباتات - الدقى - الجيزة - مصر

يظهر من القطن كآفة خطيرة فى نهاية الموسم مسببا خسائر كبيرة فى جودة الألياف وكميتها. ومن ثم أجريت تجارب حقلية فى محطة البحوث الزراعية بسخا موسمى 2009 ، 2010 لتقييم فعالية ستة مبيدات موصى بها لمكافحة ديدان اللوز وهى لمداسيهالوثرين ، ألفاسيبرميثرين ، دلتاميثرين ، ميثوميل ، بروفينوفوس ، كلوربيريفوس ، ومبيدين لمكافحة المن وهما ثياميثوكسام ، إيميداكلوبريد بالمعدلات الموصى بها ضد المن وتأثيرها الجانبى على المفترسات المصاحبة له. أثبتت النتائج أن ميثوميل ، بروفينوفوس ، كلوربيريفوس كانت فعالة جدا ضد المن مسببة نسبة خفض تراوحت بين 83.74 و 98.06% فى موسم 2009 وبين 85.57 و 94.17% فى موسم 2010 وبدون فروق معنوية عن فعالية مبيدان المن المتخصصان. مبيدات البيروثرويد لم تعطى مكافحة كافية للمن. بالنسبه للتأثير الجانبى على المفترسات المصاحبة للمن فباستثناء مركبى ثياميثوكسام ، إيميداكلوبريد فكل المركبات المختبرة الأخرى كانت سامة جدا على المفترسات مسببة نسبة خفض تراوحت بين 82.89 و 94.80% وبين 82.76 و 92.78% فى موسمى 2009 ، 2010 على الترتيب. المركبان المتخصصان لمكافحة المن كانا الأقل سمية على المفترسات حيث سببا أقل من 50% خفض خلال كلا موسمى الدراسة.