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INTERSPECIFIC DIVERSITY AND EQUITABILITY OF BIOLOGICAL AGENTS AFTER APPLICATION OF PESTICIDES IN COTTON ECOSYSTEM.

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ABSTRACT

Influence of certain insecticides, Avermectin, Spinosad, Imidacloprid, Acetameprid, and the biocide i.e. (*Bacillus thuringiensis*) in altering the organization of entomophagous complexes were studied on cotton ecosystem at Minia region, Egypt during 2006 and 2007 growing seasons. Two ecological parameters were used i.e. interspecific diversity and equitability.

Values of diversity and equitability were calculated to embrace the way in which individuals were disturbed, the relative abundance of systemic groups after application of insecticides also the stability percent of natural enemy population in cotton ecosystem after application of the tested compounds. Diversity index after application of Spinosad, Avermectin and *B. thuringiensis* were higher for the two applications in the two successive years 2006 and 2007, followed by Imidacloprid and Acetameprid. The result reflected the tendency of Spinosad and *B. thuringiensis* for selectivity when compared with the other insecticides. The highest values of equitability were shown in the

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treatment of Spinosad and *B. thuringiensis* especially after 3 weeks post treatment, the value of equitability reached an environmental maximum as control treatments. The result indicated the high selectivity properties of these insecticides. The toxicity of different compounds against pests such as, *spodoptera littoralis*, *Pectinophora gossypiella* and *Earias insulana* and the predator *Coccinella undecimpunctata* and their selectivity were studied also.

The results suggested that Spinosad, *B. thuringiensis* and Avermectin having toxic effect on bollworms with little effect on the beneficial insects in cotton and Spinosad gave the highest effect. Therefore, Spinosad is considered a good element especially in successful release of some schemes of cotton integrated control program.

INTRODUCTION

Chemical control tactics have been and will continue to be a predominant method of cotton protection in Egypt. Massive application of pesticides in last years resulted in the build up of pest resistance and adverse effects on the environment. The adverse effects include acute and chronic hazards to humans and non target organisms in cotton ecosystem.(Sadof and Raupp, 1999, Peck and McQuate, 2000 and Tillman and Mulrooney, 2000). So, the suitable selective insecticide is that one giving maximum effect against pests without adverse effect on the environmental components and in this case can be used as a good element on cotton pest management.

The present study was performed to examine the following points:-

1- Toxicological studies on certain pesticides against cotton leaf-worm *Spodoptera littoralis* (Boisd).
2- Selectivity of the tested compounds on the adult of the ladybird beetle *Coccinella undecimpunctata* L.
3- Behaviour of these compounds in cotton ecosystem by studying their effect on cotton bollworm, diversity and equitability of the community in cotton ecosystem after applying these pesticides. It is hoped that the obtained results might exhibit more information

that could help to select one selective compound which can maximize cotton pest control, minimize the side effect on the naturally biological control agents in cotton ecosystem, and serve as a guide in order to design an integrated pest management program on cotton.

MATERIALS AND METHODS

Chemical structure of the tested insecticides:-

1-**Acetamiprid** (E)-N^1-[(6-chloro-3-pyridyl)methyl]-N^2-cyano-N^1-methyl acetamidine Trade name: Cetam 20 %SL (Neonicotinoid Insecticide)

2-**Imidacloptid:** [1]*N*-[1-[(6-Chloro-3-pyridyl)methyl]-4,5-dihydroimidazol- 2- yl]nitramide
Trade name : Emidor 35%SC.

3-**Avermectin :** $C_{48}H_{72}O_{14}$ (Avermectin B_{1a}) + $C_{47}H_{70}O_{14}$ (Avermectin B_{1b})
Formulations: 1.8%EC
Common name: Avermectin /abamectin

4-**Spinosad : Chemical Names:** The name of Spinosad is derived from combining the characters of spinosyn **A** and spinosyn **D**. **Spinosyn A** is 2-[(6-deoxy-2,3,4-tri-O-methyl-*alpha*-L-annopyranosyl)oxy)-13-[(5-dimethylamino)tetrahydro-6-methyl-2H-pyran-2-yl)oxy)-9-ethyl-2,3,3a,5a,5b,6,9,10,11,12,13,14,16a,16 btetradecahydro-14-methyl-1H-as-indaceno 3,2- d)oxacyclododecin-7,15-dione. **Spinosyn D** is 2-((6- deoxy-2,3,4-tri-o-methyl-*alpha*-L-mannopyranosyl)oxy)-13-((5-(dimethylamino)tetrahydro-6-methyl-2H- pyran- 2-yl)oxy)-9-ethyl-2,3,3a,5a,5b,6,9,10, 11,12,13,14,16a,16b tetradecahydro-4,14-dimethyl-1H-as-indaceno(3,2-d) oxacyclododecin-7,15-dione (Dow 1997; Jacheta 2001) Characterization

The spinosyn component is about 85% spinosyn A and 15% spinosyn D with other spinosyns as minor impurities.
Spinosyn A, Formula $C_{41}H_{65}NO_{10}$; MW 731.98
Spinosyn D, Formula $C_{42}H_{67}NO_{10}$, MW 745.99
Trade Names: Tracer, (Spinosad is an aerobic fermentation product of the soil bacterium, *Saccharopolyspora spinosa.*

Bacillus thuringiensis

Trade name : Agerin
Biological insecticide from *Bacillus thuringiensis* (Bt) 32000IU /mg, Wettable powder. This compound was produced under license from Agricultural Genetic Engineering Research institute ARC, EGYPT.
Rate / fed. 500g/fed.

Laboratory studies:

Tested insects:-

Cotton leaf worm strain *Spodoptera littoralis* (Bosid):-

The Egyptian cotton leaf worm, *S. littoralis* were obtained as egg masses from the cotton fields at Sids experimental and research station during 2006 and 2007 cotton growing seasons.
Egg-masses were placed on leaves of castor bean, *Ricinus communis* (L.) on cylindrical glass jars (1Kg). The jars were covered with muslin cloth held with a rubber band. Following eggs hatching, the first instar larvae were transferred into larger rearing jars (2Kg) provided with filter paper at the bottom of the jar to absorb any excess of moisture.

The natural enemy: the ladybird beetle *(Coccinella undecimpunctata*).

The adults of the natural enemy including *C. undecimpunctata,* were collected from the clover fields during March and April 2007 by using an insect sweep net and transferred to the laboratory and where the adults of *C. undecimpunctata* which have the same size were used in the experiments directly.

Determination of the toxicity of certain pesticides on cotton leaf worm and *C. undecimpunctata* using film technique:

Film technique was used with the 4th instar larvae of *S. littoralis* and adults of *C. undecimpunctata* to test the selective effect of Acetameprid, Spinosad, Avermectin, *B. thuringiensis* and Imidacloprid as contact poison. Six concentrations were prepared for each compound, three replicates and 10 larvae/each replicate were used for each concentration. One ml was taken from each concentration and put in Petri dish. Petri dishes were moved right and left for distribution and formation of a thin film. Petri dishes were left under laboratory conditions at 25±2 °C and 65-75% R.H to dry for 30 minutes before being offered to the larvae. The 4th instar larvae of *S. littoralis* were allowed to move on the petri dishes for 24 hours of each concentration. After 24 hours the larvae were allowed to feed on untreated leaves of castor bean, *Ricinus communis* (L.). The same technique was used with the adults of *C. undecimpunctata.*

Mortality counts were recorded at 24, 48, 72 and 96 hours. The corrected mortalities at different concentration were subjected to probit analysis according to Finney (1971) using computer program (COSTAT) and the variance in LC_{50} between compounds were determined by comparing the 95% Fudicial Limits. The X^2 was used to determine the statistical significance of heterogeneity of the response.

The selective ratio (S.R.) of the compounds was calculated as:

$$S.R = \frac{LC_{50} \text{ of the compound against the predator}}{LC_{50} \text{ of the same compound against the pest}} \times 100$$

Field studies

Sampling technique:

Field experiments were carried out in a farm located at Edowa district, Minia governorate. The experimental area was divided into small plots (1/100 fed) each plot was separated from each other by 1 meter of bare ground. Randomized complete block design was followed in the whole experiment and each treatment was repeated three times. Two sprays were applied during the experiment first spray on the 5th August (2006) and the second spray on the 1st August (2007).

Determination of bollworms infestation in bollworm population after the application of insecticides in cotton fields.

Samples of 50 green bolls were collected at two random from both diagonals of each plot to asses the cotton bollworm infestation and the numbers of pink and spiny bollworms larvae. A total of 150 green bolls / treatment were externally and internally examined at 7, 14 and 21 day post treatments in the two treatments. Percentage reduction in infestation was calculated according to Henderson and Telton (1955).

Determination of beneficial arthropods population after application pesticides in cotton fields.

The following methods were used to determine the effect of tested compounds on the populations of beneficial arthropods in cotton ecosystem.

1- Sticky traps: yellow-chrome visual traps, glued with the adhesive "TemoBi" obtained from Kollant Industrial Chemical S.P.A., Italy were used. Colored plastic plates 10 x 15cm, on which a thin layer of adhesive was applied. Traps were mounted on a wooden support, 50cm above the soil surface. A single trap was used for each plot. The traps were examined pretreatment and 7,14 and 21 days after application. Identification was made up to genus and in some cases at species level.

2- Sweep net catch : sweep net (37 cm diameter was used to collect arthropod predators in cotton fields (4 double sweep / plot at pre treatment and 7, 14, and 21 days post treatment intervals were carried out. Samples were inspected using a binocular microscope for later identification and the fauna was sorted. Counts were calculated and expressed as total of insects from the two methods / plot.

Percentage reduction in beneficial insects populations were made according to Henderson and Telton (1955). In order to determine the selective effect of different pesticides in the field against useful arthropods complex, Metcalf Scheme (1973) was adopted.

Interspecific diversity and equitability of entomophagous cyanosis after application of insecticides in cotton ecosystem:

In order to asses the degree of the influence by different insecticides in alternating the organization of entomophagous complex. Two ecological parameters were used; the interspecific diversity and the equitability.

The diversity is a complex index of the structure of a system including the quantitave relationship between the numbers of species and number of individuals available within them. A commonly used index of diversity is (H\) known as the Shannon -winner index (1959)

$$(H^{\backslash}) = \sum_{1-i} pi \log_e Pi$$ where:

$H^{\backslash}$ = diversity index, Pi = n / N where, n = number of individuals of one species, N = number of individuals of all species.

To express the way of individual's distribution in various components of the entomophagous cyanoses co-existing the tested variant, the second structure index, i.e. the equitability (E) was used and calculated according to Lioyd and Gheraldi, (1964) as follows:

$\mathbf{E = S^{\backslash} / S \times 100}$, where:

E = size of equitability

$S^{\backslash}$ = theoretical numbers of species S = number of observed species.

RESULTS AND DISCUSSION

Toxicity of the compounds against the 4th instar larvae of *S. littorals*

Data in Tables 1 and 2 show the superior activities of chemical insecticides than biocides in their toxicity and their acute effect which were appeared after 24 hours. Also chemical synthetic insecticides i.e. Acetameprid and Imidacloprid were rapid and highly toxic than the biocides and where these two compounds gave their LC50 values after 24 hours. While biocides (Spinosad and Avermectin) gave results calculated LC50 after 48 hours and Agrien results recorded after 96 hours.

2. Selective toxicity of certain compounds against the adult of *C. undecimpunctata:-*

Data in Table 3 show that Acetameprid was the most toxic compound (5.23μg/cm^2) followed by Imidacloprid (6.92 μg/cm^2) followed by Avermectin (24.55 μg/cm^2) followed by Spinosad (26.94 μg/cm^2). Acetameprid, Imidacloprid, Spinosad, Avermectin and *B. thuringiensis* respectively. The tested compounds revealed that all compounds differed significantly in their LC50 values except Spinosad and Imidacloprid.

Table 1: Toxicity of some insecticides against 4^{th} instar larvae of *S. littoralis* using a thin film technique

Insecticides	LC50 ±Se μg/cm²	Fiduicial limits		Toxicity Index μg/cm²	LC90 ±SE μg/cm²	Fiduicial limits		Slope	X^2
		Upper μg/cm²	Lower μg/cm²			Upper μg/cm²	Lower μg/cm²		
Spinosad	10.92 ±02.90	14.25	08.37	041.02	132.04 ±035.18	172.711	101.43	1.18	0.17
Avermectin	17.78 ±0 4.10	22.39	14.13	025.20	151.36 ±034.81	190.55	120.23	1.37	0.29
Imidacloprid	11.00 ±02.53	13.80	08.71	040.72	603.70 ±138.85	760.33	479.73	0.72	1.80
Acetameprid	04.48 ±01.16	05.81	03.46	100.00	053.32 ±013.79	069.08	041.17	1.19	0.48

Table 2: Toxicity of some insecticides against adult of C. *undecimpunctata* using film technique.

Insecticidess	LC50 ±SE µg/cm²	Fiduicial limits		Toxicity Index µg/cm²	LC90±SE µg/cm²	Fiduicial limits		Slope	X^2
		Upper µg/cm²	Lower µg/cm²			Upper µg/cm²	Lower µg/cm²		
Spinosad	26.94 ± 7.43	35.48	20.42	019.41	189.73 ± 5.3	250.19	143.93	1.51	1.3
Avermectin	24.55 ±4.54	39.29	19.49	021.3	136.59 ±6.8	218.60	85.33	0.73	0. 4
Acetameprid	05.23 ±2.38	06.74	4.06	100.00	069.19 ±17.5	089.13	53.7	1.14	0.8
Imidacloprid	06.92 ± 1.60	08.72	05.50	075.58	082.4 ±18.95	103.73	65.45	1.19	0.7

Table 3: Selective ratio of some insecticidess to *C. undeciumpunctata*

Insecticidess	LC50±SE *C. undeciumpunctata* ug/cm^2	LC50±SE (*S .littoralis*) ug/cm^2	Selective ratio	Relative Susceptibility
Spinosad	26.94	10.92±2.90	246.65	0.41
Avermectin	24.55±11.54	17.78± 4.09	138.08	0.72
Imida-cloprid	06.92 ± 1.60	11.00 ± 2.53	062.91	1.59
Aceta-meprid	0 5.23	04.48±1.159	116.74	0.86
B. thuringinsis	-	-	-	-

B. thuringiensis had no effect on the adult of *C. undecimpunctata*. The values of the selective ratio (Table 3) showed that Spinosad, Avermectin, acetampride and Bt had significant selective effect with selective ratio 246.65; 138.08: 116.47 respectively and Bt has no any effect against the predator. While, Imidacloprid has no selective effect against *C. undeciumpunctata* with selective ratio = 62.91. These results are in agreement with those reported by other workers on the relation between selectivity and toxicity of certain compounds to some agents such as adult of *C. undecimpunctata* and many beneficial insects. Mallah and Korejo (2005) found that Spinosad and indoxacarb were safes to beneficial insects when sprayed in cotton field.

Also the application of Avermectin can protect the major natural enemies in cotton fields including *Tricogramma chilonis, Coccinella septempunctata* and *ErigonuHum gramimcolum* (Cai *et al.*, 1997, Elzen, 2001). Salama and Zaki, (1984) found that *B. thuringiensis* could be safely recommended for the control of *Spodoptera littoralis* with no obvious harmful effects on its predators.

In spite of Avermectin caused some mortality among the adults of the three common parasitoids *Hemiptarsenus varicornis Gerault, Opius* sp and *Gronotoma micromorpha Perkins*, but it was less toxic than Imidacloprid (Prijono *et al.,* 2004). Moreover, Young *et al.,* (1997) evaluated the survival of predators *(Araneae* spp., *Coccinella geocoris* and *Orius insidiosus)* after treatments with *B. thuringiensis,* Thiodicarb and Cyhalothrin on cotton. They found that predator's density in the *B. thuringiensis* treatment alone was similar to the untreated control (Table 4).

Table 4: Average numbers of beneficial agents in cotton ecosystem /plot collected by two methods and their reduction percentage during 2006and 2007 growing seasons at Minia governorate.

Insecticides used	Season 2006			Season 2007			Degree selectivity (Avge %)
	Pre – treatment count	Aveg. Post Tret. count	Red. %	Pre- treat. count	Aveg. Post Tret. count	Red. %	
Spinosad	33.3	24.13	43.73	21.3	15.79	13.08	28.4 Selective
Avermectin	22.0	15.7	41.50	15.5	7.98	39.63	40.57 Selective
B. thuringinsis	18.75	16	29.11	15.6	6.5	31.14	30.12 Selective
Imidacloprid	37.5	13	71.58	46.6	10.2	74.33	72.96 medium selective
Acetameprid	23.77	13.00	55.16	56.6	24.7	48.69	51.92 Selective
Check	21.6	26.35	-	34	29	-	-

Field studies

Results of survey of insect pests and natural enemies associated with cotton plants showed that: The following pests spread widely throughout the whole growing season and had economic injury level of infestation on the cotton plant. Egyptian cotton leafworm *S. littoralis;* Jassids, *Empoasca* spp, cotton white Fly *Bemisia tabaci* pink boll worm *Pectinophora gossypiella,* Cotton aphis *Aphis gossypii*, the spiny boll worm *Earias insulana*, the amarican bollworm *Heliothis* spp, the grean cotton bug *Nezara viridula* and the bug of cotton seeds *Oxycarenus hyalinipenni.* It is worth mentioning that cotton leaf worm *S. littoralis,* and the bollworms spread widely and a very important species which caused an economic loss on the cotton crop (Table 5)

Natural enemies: Results revealed the presence of the following predators: *Paederus alfierii, Coccinella undecimpunctata ,Cydonia vicina isis, Chrysoperla carnea, Chrysopa vulgaris, Cueta variegate, Orius* spp. *Syrphus* spp., *Mantis religiosa,Gonia capitata Polistes sp.* and the parasitoids were *Bracon brevicornis, Brachymeria* sp., *Trichogramma. Chelonus* sp. and *Tachina larvarum.* Also many species of true spiders (Table 5). However, Salama *et al.*,(1990) and Moawad *et al.*, (1992) found these pests and natural enemies in cotton ecosystem.

Table 5: Survey of insect pest and natural enemies encountered on cotton plants during 2006 and 2007 seasons in Idwa district, Minia governorate.

Order	Family	Species	Status	Degree
Arachnidae		*True spiders*	**	++
Hymenoptera	Trichogrammatoidae	*Trichogramma spp*	**	++
Homoptera	Aleyrodidae	*Bemisia tabaci*	**	++
	Cicadelidae	*Empoasca spp.*	*	++
	Aphididae	*Aphis gossypii*	**	++
Diptera	Syrphidae	*Syrphus corollae*	**	++
	Tachinidae	*Tachina larvarum*	*	p
		Gonia capitata	*	p
Lepidoptera	Noctuidae	*Spodoptera littoralis*	**	+
		Spodoptera exigua	*	P
		Helicoverpa armigera	*	P
		Earias insulana	*	p
	Gelechiidae	*Pectinophora gossypiella*	**	++
Neuroptera	Chrysopidae	*Chrysoperla carnea*	**	++
		Chrysopa vulgaris	**	++
Hemiptera	Anthoceridae	*Orius* spp.	**	++
	Pentatomidae	*Nezara viridula*	*	p
	Lygaeidae	*Oxycarenus hyalinipennis*	**	++
Coleoptera	Coccinellidae	*Coccinella undecimpunctata*	*	+
	Staphylinidae	*paederus alfierii*	*	+
Dictyoptera	Mantidae	*Mantis religiosa*	*	+
		Calidomantis savigny	*	+

Table 6: Diversity and equitability of entomophagous cyanosis after first application of Insecticides in Minia cotton filed during 2006 and 2007 growing seasons.

Year	2006								2007							
Insecticides	Pre-treatment		Post treatment intervals						Pre-treatment		Post treatment intervals					
			7 day		15 day		21day				7 day		15 day		21 day	
	M(S`)	E	M(S`)	E	M(S`)	E	M(S`)	E	M(S`)	E	M(S`)	E	M(S`)	E	M(S`)	E
Spinosad	3.19	100	2.72	72.6	2.8	86.23	2.99	100	3.3	100	2.69	69.86	2.89	85.65	2.97	100
Imidacloprid	3.33	100	2.65	66.3	2.73	74.5	2.78	82.13	3.12	100	2.63	61.18	2.72	78.63	2.83	86.91
Acetameprid	3.4	100	2.61	68.25	2.7	69.87	2.75	80.2	3.18	100	2.64	60.46	2.76	76.65	2.81	85.89
Avermectin	3.21	100	2.7	70.89	2.8	81.32	2.89	91.61	3.36	100	2.73	65.89	2.84	80.12	2.90	92.33
B.thuringeinsis	3.1	100	2.73	71.63	2.89	90.64	2.95	100	3.27	100	2.81	76.23	2.97	87.69	3.11	100
Control	3.17	100	3.22	100	3.35	100	3.4	100	3.22	100	3.25	100	3.33	100	3.4	100

Effect of application of tested compounds against bollworms in cotton fields.

Data in Fig 1 indicate that the average reduction percentages for the two sprays was 67% and 61.1% for Spinosad, 64.22 % and 61.9 % for acetampride, 55.27% and 52.4% for Imidacloprid 35.83 % and 35.746% for Avermectin, 31.66 % and 24.597% *for B. thuringiensis* during the two growing seasons respectively.

In general, results showed that Spinosad significantly reduced the infestation of bollworms in cotton.

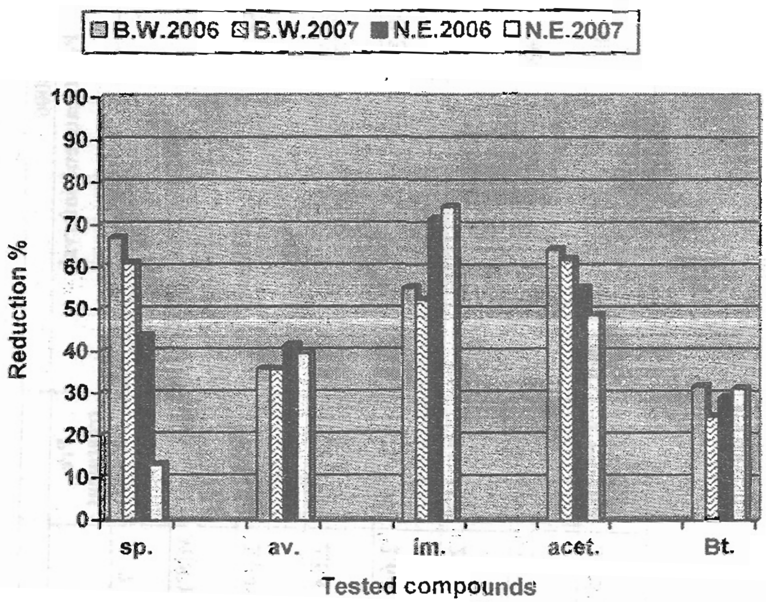

Fig. 1: Effect of the tested insecticides against boll worms and natural enemies in 2006 and 2007 seasons in Minia governorate.

Interspecific diversity and equitability of biological agents

Reduction in beneficial arthropods in cotton fields treated with tested compounds and their selectivity in cotton ecosystem.

The average reduction in the two seasons ranged between 28.4 and 72.96 %. Spinosad exhibited the least effect recording average reduction % 28.4 % followed by Bt (31.12), Avermectin (40.57) and Acetameprid (48.69). With degree of selectivity according to Metcalf scheme is selective. Imidacloprid which was more toxic and results in 72.69 was medium selective when it was applied in the field.

Interspecific diversity and equitability of entomophagous after application of compounds:-

The diversity index after application of Spinosad and *B. thuringiensis* were higher in the two application of the two successive years 2006 and 2007, respectively, followed by Avermectin, Imidacloprid and Acetameprid. The results reflected the tendency of Spinosad and *B .thuringiensis* for selectivity when compared with the other pesticides. As for as equitability is concerned, it is obvious that the highest values of equitability were shown in the treatment of Spinosad and *B .thuringiensis* especially after 3 weeks post treatment, the value of equitability reach an environmental maximum. The results indicated the selectivity properties of these two insecticides (Table 6).

Hussein (1984) reported that, mixture of pesticide which produced high values of diversity in the biological agents and equitability in their treatments will be selective compounds against the biological agents in the ecosystem under study. Heijmbroek *et al.* (1980) showed some decrease in the diversity of species of arthropod after treatment with aldicarb. Jonston, (1994) showed the selectivity of Spinosad against many predators and parasites in cotton. Sadof and Raupp. (1999), Young *et al.*, (1997) evaluated the survival of predators *(Araneae, Coccinellidae, Geocoris* spp and *Orius insidiosus)* after treatments *B. thuringiensis* Thiodicarb and Cyhalothrin on

cotton. Result indicated that the predator density in the *B. thuringiensis* alone treatment was similar to the untreated control. All treatments contained conventional chemical insecticides, including Thiodicarb and Cyhalothrin at the ovicidal rate, reduced predator densities to low numbers. such result were obtained by Cai *et al.*, (1997); Prijono *et al.*, (2004) and Hussein *et al.*, (2004).
Chemical control is still an important component of integrated pest management systems. As indicated in this study, Spinosad, Avermectin and acetampride can be powerful tools for managing principal cotton pests i. e. cotton leaf worm and bollworms.

These pests consider that the bollworms have already developed resistance to some conventional insecticides such as Dursban, pyrethroids, in Egypt (Hussein and abdel Aziz 2004). Introducing and alternating these chemicals on cotton in a defined way will be strategic to combat the potential risk of cotton pest resistance to these insecticides. Spinosad is toxic to target insect pests including cotton leaf worm and bollworms and relatively safe to beneficial insects and other organisms. It fit well in an integrated cotton management programs. Therefore, Spinosad with a rate of 60cc a.i. /fed, is consider a good element in successful release of some schemes of cotton integrated control.

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التنوع والثبات البيئي للأنواع في الأعداء الحيوية بعد تطبيق المبيدات في الوسط البيئي للقطن

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درس تأثير بعض المبيدات (الأميداكلوبريد- الأسيتا مبريد – الأفرميكتين – السبينوساد والمبيد الحيوي بكتريا البسيلس ثيوريجنسس) علي تنوع وتوزيع الأعداء الحيوية وتباينها وثبات مجموعها بيئيا بعد تطبيق المبيدات في القطن في موسمي ٢٠٠٦ و٢٠٠٧ وذلك عن طريق حساب مقياسين بيئيين هما التنوع البيئي للأنواع Interspecific diversity والثبات البيئي Equitability. وقد درس في البحث سمية هذه المركبات علي دودة ورق القطن وكذلك قدرت نسبة الاختيارية Selective ratio لهذة المركبات ضد العدو الحيوي ابوالعيد ١١ نقطة في المعمل عن طريق المعاملة بطريقة الفيلم ودرست درجة الاختيارية Selective degree للمركبات في الحقل أيضا ضد الأعداء الحيوية عن طريق حساب نسبة الموت وحساب درجة الاختيارية علي مجموع الأعداء الحيوية في الوسط البيئي للقطن بعد تطبيق هذه المبيدات وكذلك تأثيرها علي نسبة الخفض لمجموع ديدان اللوز في القطن.

وأظهرت النتائج أن معدل التنوع البيئي للأنواع لمبيد الأسبينوساد والأفرمكتين والمبيد البكتيري بسيلس ثيورينجسس كان عاليا في كلا الموسمين و ٢٠٠٧ و ٢٠٠٦ كما أظهرت النتائج أن هذين المركبين لهم نسبة اختيارية عالية في المعمل ودرجة اختيارية عالية في الحقل بالمقارنة بباقي المبيدات المختبرة. كما أعطوا اعلي قيمة في قيمة مقياس الثبات البيئي. ووصلت إلي اعلي قيمة للثبات البيئي بعد ٣ اسابيع من المعاملة. وأظهرت النتائج أن لهذين المركبين خصائص اختيارية كما أظهرت النتائج أن لمركب الأسبينوساد ذو تأثير عالي علي ديدان اللوز في حقول القطن ودرجة اختيارية عالية علي أعداد وتنوع الأعداء الحيوية مما يمكن اعتبار هذا المركب أحد العناصر الهامة في تصميم برامج المكافحة المتكاملة للآفات في حقول القطن.