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COMPARATIVE TOXICITIES OF SELECTED PESTICIDES TO THE WHITEFLY, *Bemisia tabaci* (Gennad.), INFESTING COTTON PLANTS

Nassef, M. A.
Plant Protection Research Institute, Agricultural Research Center, Dokki, Giza

ABSTRACT

The initial and residual activity of KZ-oil, pyriproxyfen, imidacloprid, triazophos and cypermethrin were evaluated against whitefly infesting cotton plants during 2001 cotton season. Also, a treated-vial technique was used to bioassay insecticide susceptibility of whitefly populations in cotton fields. The tested chemicals could be arranged descendingly according to the general mean percent reduction in whitefly population as follows: imidacloprid, triazophos, KZ-oil, cypermethrin and pyriproxyfen. Tolerance ratios indicate the susceptibility of whitefly populations to KZ-oil and pyriproxyfen, while they were more resistant to the synthetic pyrethroid cypermethrin.

INTRODUCTION

The whitefly, *Bemisia tabaci* (Gennad.), has become a serious cotton pest in Egypt. Control measures are difficult because the immatures develop on the undersides of the leaves and applications are usually ineffective in delivering control agents to the leaf undersides and lower leaf surfaces. Also, there are several generations of *B. tabaci* in a season and its populations appear to build resistance to conventional insecticides quickly (Akey *et al.,* 1992). Damage to cotton is predominately a result of honeydew produced by the insect and associated fungal growth that causes sticky cotton and lint staining which greatly reduces cotton grade (Perkins, 1987). Several authors studied the effect of different products, conventional insecticides, insect growth regulators, fertilizers or mineral and plant-derived oils on whitefly population density (Butler *et al.,* 1991; Salem and Khalafalla, 1992; Ellsworth *et al.,* 1997; Hamid and Korkor, 1998; Korkor *et al.,* 1998; Korkor, 1999 and Nassef, 1999).

Prabhaker *et al.* (1989) described results of a laboratory evaluation of the relative tolerance by immature and adult stages of susceptible and resistant *B. tabaci* strains to a number of insecticides including a growth regulating compound. They observed that comparisons of resistance in the various life stages indicate that insecticide use has operated mainly against whitefly adults and not the immature stages. This fact is illustrated in the high resistance levels of *B. tabaci* adults that show a steady increase.

The objective of a resistance monitoring program is to detect resistance before a control failure occurs. The vial residue assay technique would be an excellent resistance monitoring method, it is a simple, reliable, inexpensive and quick technique (Plapp *et al.,* 1990). Selection of a narrow concentration range for vial bioassays may help to determine the effectiveness of concentrations for establishing a precise LC value (Robertson *et al.,* 1984).

The present work aimed to study the effect of five compounds belong to five chemical groups, mineral oils, juvenile hormone mimics, dinitro methelin derivatives, organophosphates and synthetic pyrethroids on whitefly, *B. tabaci*, populations in cotton fields. Also, changes in response of the adult stage to those chemicals was investigated using treated-vial technique.

MATERIALS AND METHODS

Field and laboratory experiments were conducted during 2001 cotton growing season at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, to determine the efficiency of certain chemical treatments against whitefly infesting cotton plants and the changes in susceptibility to chemicals following field application.

The fields were cultivated with Giza 86 cotton variety and arranged in complete randomized blocks with 4 replicates for each treatment. Each replicate was 1/48 of a feddan. Plots were isolated from each other by unplanted corridors (1 m width).

The chemicals used and their rates of application were as follows:

1- KZ-oil: 95%, EC, a mineral oil, at 2 liters/fed.
2- Pyriproxyfen (Admiral): 10%, EC, a juvenile hormone mimic (JHM), = 4-phenoxyphenyl (RS)-2-(2-pyridyloxy) propyl ether, at 150 ml/fed.
3- Imidacloprid (Confidor): 40%, EC, a dinitro methelin derivative, = 1-(6-chloro-3-pyridinyl) methyl-4, 5-dihydro-N-nitro-1H-imidazole-2-amine, at 150 ml/fed.
4- Triazophos (Hostathion): 40%, EC, an organophosphate compound, = 0, 0- diethyl 0-1-phenyl-1 H-1, 2, 4-triazol-3-yl phosphorothioate, at 1 litre/fed.
5- Cypermethrin (Cymbush): 10%, EC, a synthetic pyrethroid compound, = (RS)-α-cyano-3-phenoxybenzyl (1 RS, 3 RS; 1 RS, 3 SR)-3-(2,2-dichlorovinyl)-2,2- = dimethylcyclopropanecarboxylate, at 600 ml/fed.

These chemicals were sprayed once on August 12th, 2001 using a knapsack sprayer with one nozzle (model CP_3). The volume of spray solution was 200 liter/feddan. Samples of 25 cotton leaves were collected at random from the inner rows of each plot including the untreated check to estimate the population counts of whitefly. The upper and lower surfaces of the leaf were inspected immediately in the field and the number of the adults were recorded. The same samples were taken to the laboratory to count the number of alive immature stages of whitefly using binocular microscope. Sampling and counting were made just before treatment, then after 2, 5, 10 and 15 days of spraying. Percent reduction in infestation was estimated, using Henderson and Tilton (1955) equation, to determine the initial effect (after 2 days of spraying) and the residual effect (after the next dates) of the tested compounds. Also, the toxicity index was calculated according to the method of Sun (1950), to compare the relative toxicity of the tested compounds.

The laboratory experiments were carried out in order to study the rate of response of whitefly adults after field application. The inside surfaces of 20 ml, screw-cap, glass vials supplied by A and M University of Texas were coated with a concentration of tested chemicals as described by Sivasupramaniam *et al.* (1992).

Desired chemical residues of 8 concentrations for each chemical were achieved by evaporating 0.5 ml of the given concentration in acetone and rotating the vial horizontally to provide uniform coverage. Vials were prepared in advance in the laboratory. After 2 weeks of field spraying, 25 to 30 unsexed whitefly adults were aspirated from isolated treated and untreated fields, and directly transferred to the vial coated with the same treated chemical. The vials were capped and held out of direct sunlight for 6 hours. Both moribund and dead insects were considered as responding to various treatments. The insects were scored as moribund if they could not fly or walk even short distances when the vial was held horizontally and gently taped (Sivasupramaniam *et al.,* 1992).

Concentration-probit lines were plotted according to Litchfield and Wilcoxon (1949) to determine the level of resistance in whitefly populations. Tolerance ratio was calculated by dividing the LC_{50} or LC_{90} of the tested toxicant applied to the treated field strain by the LC_{50} or LC_{90} of the same toxicant applied to the untreated field strain.

RESULTS AND DISCUSSION

A.Control of the whitefly *B. tabaci* on cotton:

Data in Table (1) show the effect of the five tested compounds, sprayed on cotton plants, against adult and immature stages of *B. tabaci*. Wide range in percent reduction (33.03 to 84.40) in the insect population was observed among the tested materials according to the chemical group, the treated stage and the time elapsed after spray.

Table (1): Percent reduction in the population of the whitefly, *B. tabaci* infesting cotton plants during 2001 season.

Treatments	Adult stage			Immature stages			Combined Effect
	Pretreatment population on 100 leaves	Percent reduction		Pretreatment population on 100 leaves	Percent reduction		
		Initial effect	Residual * effect		Initial effect	Residual * effect	
1. KZ-oil	796	60.20 b	53.46 b	489	63.41 a	49.15 c	56.56
2. Pyriproxyfen	568	33.03 c	62.84 a	377	40.68 b	60.46 b	49.25
3. Imidacloprid	756	80.95 a	64.61 a	369	39.02 b	77.21 a	65.45
4. Triazophos	629	83.40 a	47.75 b	372	41.39 b	63.19 b	58.93
5. Cypermethrin	652	71.14 b	50.25 b	354	35.12 b	57.83 b	53.59
6. Control	749	-	-	492	-	-	-

By Duncan's multiple range test, means followed by the same letter are not significantly different at 5% level.
*** Average of 3 sampling dates.**

Concerning the initial effect on adult stage (during the first two days after spraying), triazophos was the most effective toxicant giving 83.40% reduction in infestation. The other chemicals induced 80.95 to 33.03%

reduction and could be arranged descendingly according to their initial activity as follows: imidacloprid (80.95%), cypermethrin (71.14%), KZ-oil (60.20%) and pyriproxfen (33.03%). On the other hand, imidacloprid and pyriproxyfen showed the longest residual effect (during the next 13 days post treatment) recording 64.61% and 62.84% reduction in adult population. The descending order of the residual activity of the rest toxicants was KZ-oil (53.46%), cypermethrin (50.25%) and triazophos (47.75%).

Regarding the effect against the immature stages, KZ-oil recorded the highest initial reduction (63.41%) followed descendingly by triazophos (41.39%), pyriproxyfen (40.68%), imidacloprid (39.02%) and cypermethrin (35.12%). Meanwhile, imidacloprid recorded the highest residual activity (77.21% reduction) followed descendingly by triazophos (63.19%), pyriproxyfen (60.46%), cypermethrin (57.83%) and KZ-oil (49.15%). The decrease in numbers of immature forms could be attributed to the combined effect of both the tested insecticides and the decrease of adults numbers.

Also, data in Table (1) show the combined initial and residual activity of the tested compounds against adult and immature stages of whitefly. The tested chemicals could be arranged descendingly according to the combined effect as follows: imidacloprid (65.45%), triazophos (58.93%), KZ-oil (56.56%), cypermethrin (53.59%) and pyriproxyfen (49.25% reduction). In general, it should be mentioned that all the tested compounds have moderate to low effect on whitefly population. Among all the tested chemicals, imidacloprid was the only one that induced over 65% reduction in population of adult and immature stages during a period of 15 days and could be recommended to reduce the population of whitefly in cotton fields.

Table (2) presented the toxicity index of the tested chemicals. The values indicate that triazophos induced the highest initial effect against the adult stage followed closely by imidacloprid (97.06% as toxic as triazophos). On the other hand, imidacloprid recorded the highest residual effect against both adult and immature stages, while it occupied the fourth class of initial effect against immature stages, recording 61.54% as toxic as KZ-oil. Considering the combined effect, imidacloprid induced the highest toxicity index, while pyriproxyfen occupied the last class, recording 75.25% as toxic as imidacloprid. Nassef (1999) found that pyriproxyfen treatment recorded unsatisfactory result against whitefly on cotton, while using primbet (a mixture of pyriproxyfen and fenpropathrin) gave the best result.

Table (2): The toxicity index of the tested chemicals against *B. tabaci.*

Compounds	Toxicity index				
	Adult stage		Immature stages		Combined Effect
	Initial effect	Residual effect	Initial effect	Residual effect	
1. KZ-oil	72.18	82.74	100.00	63.66	86.42
2. Pyriproxyfen	39.60	97.26	64.15	78.31	75.25
3. Imidacloprid	97.06	100.00	61.54	100.00	100.00
4. Triazophos	100.00	73.90	65.27	81.84	90.04
5. Cypermethrin	85.30	77.77	55.39	74.90	81.88

B.Changes in response of whitefly *B. tabaci* in treated cotton fields:

Table (3) shows the response of the field strain of whitefly adults, collected from treated and untreated fields, to certain chemicals. Tested compounds, toxicity data (LC_{50}s, LC_{90}s and slopes of the dosage-mortality lines) and tolerance ratios of the insects at LC_{50} and LC_{90} levels to each compound were listed.

Table (3): Changes in response of *B. tabaci* adults collected from treated and untreated cotton fields.

Compounds	Treated field strain			Untreated field strain			Tolerance ratio	
	LC_{50} (ppm)	LC_{90} (ppm)	Slope	LC_{50} (ppm)	LC_{90} (ppm)	Slope	LC_{50}	LC_{90}
1. KZ-oil	1550	27500	1.03	1450	23500	1.13	1.07	1.17
2. Pyriproxyfen	80	750	1.27	77	720	1.41	1.04	1.04
3. Imidacloprid	48	320	1.56	31	240	1.60	1.55	1.33
4. Triazophos	340	2950	1.32	190	1700	1.37	1.79	1.74
5. Cypermethrin	280	3400	1.41	130	1450	1.52	2.15	2.34

Resistance to KZ-oil and pyriproxyfen at either LC_{50} or LC_{90} is low. As the LC_{90}s are the most important from economic point of view, tolerance ratios were 1.17 and 1.04, respectively. Resistance to the synthetic pyrethroid cypermethrin was high (tolerance ratio 2.34 at LC_{90}), while it was moderate to imidacloprid and triazophos (tolerance ratios 1.33 and 1.74, respectively). The greater tolerance to cypermethrin as compared with the other chemicals suggests that resistance may eventually become a problem with synthetic pyrethroids. Comparing the slope value of the toxicity line of each compound for the treated and untreated field strains (Table 3), it could be seen that the two LC-probit lines of the same toxicant are considered parallel.

In summary, alternative insecticides or that belonging to new chemical group (dinitro methelin derivatives) were effective for controlling whitefly resistant to pyrethroids. The results of Williams *et al.* (1997) indicated that *B. tabaci* populations throughout Arizona are susceptible to imidacloprid during 1995 and 1996 cotton seasons. Also, Akey *et al.* (1997) used several insecticide regimes to find out new strategies for integration in true IPM application to promote biological control of whitefly by beneficial arthropods and prevent insecticide resistance from occurring.

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التأثير السام لبعض المركبات على الذبابة البيضاء فى حقول القطن

محمد عبد الفتاح ناصف
معهد بحوث وقاية النباتات ـ مركز البحوث الزراعية ـ الدقى ـ الجيزة

أختير خمس مركبات تتبع خمسة مجاميع كيميائية مختلفة لدراسة التأثير الإبادى الفورى والأثر الباقى لتلك المواد على أعداد الأطوار الكاملة وغير الكاملة للذبابة البيضاء فى حقول القطن موسم ٢٠٠١. أوضحت النتائج التفوق النسبى لمركب كونفيدور (أحد مشتقات الداينتروميثيلين) على باقى المواد المختبرة حيث كان المركب الوحيد الذى أعطى متوسط نسبة خفض فى تعداد الحشرة يزيد عن ٦٥% خلال فترة خمسة عشر يوما من الرش يليه مركب هوستاثيون من مركبات الفوسفور العضوية ثم كزد ـ أويل (احد الزيوت المعدنية) فمركب سيمبوش من البيرثرويدات وأخيرا مركب أدميرال (احد مشابهات هرمون الحداثة).

وفى نفس الدراسة تم استخدام تقنية الزجاجات المعاملة لتتبع التغيرات التى حدثت فى حساسية الأطوار الكاملة للذبابة البيضاء تجاه مجموعة المركبات السابق ذكرها لنجد أن النتائج توضح حساسية الحشرة لمادتى كزد ـ أويل وأدميرال بينما أبدت الحشرة أعلى درجة مقاومة تجاه مركب سيمبوش.