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COMPARATIVE SUSCEPTIBILITY OF WHITEFLY STRAINS TO CERTAIN INSECTICIDES

Hanan S. Taha
Central Agricultural Pesticides Laboratory, Dokki, Giza, Egypt.

ABSTRACT

The rate of population growth is one reason that the sweet potato whitefly has become such a noxious pest. The effectiveness of an insecticide depends on the methods, the rate and the frequency of application. It is apparent that the degree of effectiveness of insecticides in the field correlate with the resistance status of *Bemisia tabaci*. Resistance to Organophosphorous , carbamates and pyrethroids is well established and involves a suit of mechanisms. In recent years, the need for a greater diversity of different groups or classes of insecticides for whitefly control having different mode of action become a must. Bioassays of whitefly field strains by leaf dip were performed with the susceptible strain as well. Determination of the effectiveness of 20 insecticides typical of three foregoing year belonging to 7 classes revealed that Insect Growth Regulators were in the first potency arrangement, carbamate derivatives still effective and imidacloprid come up to the development of resistance. In addition to all insecticides resistance levels tend to arise than before, fenitrothion, chlorpyrifos-methyl and pirimiphos-methyl supposed to be neglect from the future control.

INTRODUCTION

The tobacco whitefly or sweet potato whitefly *Bemisia tabaci* (Genn.) can develope problem to various crops such as cotton lint stickiness, (Hector and Hodkinson,1989; Naranjo *et al.*,1998), tomato irregular ripening disorder (Schuster 2002) and squash silver leaf disorder (Chen *et al.*, 2004), adding up, a potential vector of over 70 different plant viruses as well as causes yield loss. Intensive use of pesticides caused build-up of resistance (Prabhaker *et al.*, 1989). Then detecting insecticide resistance is very significant and providing an early warning or some indication of the genetic potential for resistance occurs (Roach and MC-kenzie, 1987). Also determining changes in the distribution or severity of resistance is very important to make a recommendation for pesticides least affected. Since decision aides for insecticide use based on efficient sampling methods and action thresholds have been applicable. The successful Integrated Resistance Management depends on modifying the way that insecticides are deployed and reducing the total number of treatments applied. Looking at the insecticides shifts within the years and regions can infer how and when specific insecticide works. In regarding the whitefly stage specific mortality from insecticides it clearly identify the mode of action of the respective chemistries used however conventional chemistries was capable of killing younger instars while IGRs important for regulate the population density below the thresholds (Ellsworth *et al.*,1995; Naranjo *et al.*,1998).

MATERIALS AND METHODS

The whitefly adults of *Bemisia tabaci* were tested for the susceptibility to 20 insecticides, names profenofos (Selecron-Curacron 72% EC), chlorpyrifos-methyl (Reldan 50% EC), pirimiphos-methyl (Actellic 50%EC), fenitrothion (Sumithion 50%EC), methomyl (Lannate 90%SP), Fenvalerate (Sumicidin 20% EC), Lambda-cyhalothrin (Karate 2.5% EC), fenpropathrin (Meothrin 20%EC), Imidacloprid (Confidor 20%SL), thiamethoxam (Actara 25%WG), pyriproxyfen (Admiral 10%EC), flufenoxuron (Cascade 10%DC), lufenuron (Match 5%EC), pymetrozine (Chess 25%WP), chlorfenapyr (Challenger 36% SC), thiocyclam (Evisect 50%WP), Savona (M-Pede 49 %) , KZ-oil 95% EC, and CAPL-2 96.62% EC.

The resistance survey was conducted in August–September when large number of insects was present in fields. Adults were collected in the field with a custom-made battery operated suction sampler (Dittrich *et al.* 1990, and Ayoub 2001). Adults were collected randomly across each field from two or more fields, randomly selected in a representative vegetables growing area. The samples were pooled in one or two wide mouth glass jars, which were kept in an ice box during the transport from the field to the laboratory. Before bioassay tests, the jars were taken out of the cool box and inverted upside down on a table for 10 min , so that the healthy individuals would move to the top of the jar due to positive light. Weak and dead individuals were discarded (Ayoub, 2001).

Survey of whitefly strains collected from four governorates: (Behera, Dakahlia, Beni-suef and Fayoum) was done in three successive years in summer was carried out. Results of whitefly adult responses from the studied areas in Egypt were compared with each others within the same year.

The bioassay method as adopted by Dittrich and Ernst (1983), and Prabhaker *et al.*, (1985) whitefly adults exposed to cotton leaf discs which were dipped in solutions of the formulated materials for 10 seconds then after drying placed on a thin layer 1.0 ml of 2% agar-agar in Petri dishes. The tested concentrations were prepared by diluting the formulated insecticides with local tap water to the appropriate concentration. [A series of 10 insecticide concentrations were used at 0.5 fold, a constant volume of water 250 ml was measured]. Untreated cotton leaves were transferred to the laboratory, cleaned with paper towels. Adults SPWF were carefully immobilized with carbon dioxide, placed on a wax paper, and then transferred to a clear plastic Petri-dish 50 mm Ø. Each Petri dish had 4 holes covered with metal screen for good ventilation. About 50 ± 10 adults were placed in each Petri-dish; a rubber band was used to fasten the two parts of the Petri dish together. Each treatment was replicated four times. The control was tested with water only. The insects were maintained at temperature of 25 ± 2 C° and 70 ± 5 % RH. Mortality counts were made after 24 hours for all insecticides except for the 5 used IGR: pyriproxyfen, chlorfenapyr, lufenuron, pymetrozine, and flufenoxuron for which the mortality counts were made after 48 hours. Natural mortality never exceeded 10% in the untreated check.

The unselected strain were reared and tested similarly for resistance ratios estimation. The data subjected to computer program for analysis of the LC_{50} calculation. The results were corrected for natural mortality using Abbott's formula (Abbott, 1925) before subjecting for the statistical analysis. The resistance ratio (RR) for each insecticide in each governorate was calculated by dividing the LC_{50} of the selected field strain by the LC_{50} of the lab strain, and divided to 4 categories beginning from 0 to 5 means susceptible, 5 to 10 law resistance, 10 to 100 moderate resistance and 100 to 1000 high resistance .

RESULTS AND DISCUSSION

All susceptibility testes for all collected whitefly populations were carried out in laboratory according to the leaf dip bioassay technique. The obtained LC_{50} values are listed in Table (1).

According to the control breakdown occurred apparently when resistance ratio were >20 fold. It could be position the insecticides competence with reference to disregard or desire for future control.

Generally IGRs were in the initial category followed by thiamethoxam which was more potent insecticide than the other classes except for novels, followed with profenofos, methomyl, fenvalerate, fenpropathrin. Also lambda-cyhalothrin considered has potential of effective control except that resistance ratio detected in Dakahlia 2003.

From the preceding data it could be concluded that CAPL-2 oil was the most resistance insecticides when recorded high resistance ratios in all candidate populations except for Beni-suef and Fayoum 2001. While the only recorded M-Pede resistance ratio was the Fayoum 2003 strain. Clearly, from the first and the third year, advance of resistance to imidacloprid were more than thiamethoxam.

There is awareness that the newly introduced insecticides exhibit extremely resistance, lufenuron and pyriproxyfen since RR were Beni-suef, 1500 and 933 in 2002 respectively, Fayoum and Dakahlia1386 and 3033. It was found that chlorfenapyr was the most effective compound. In addition to the apparent fluctuation in LC_{50} of this class of insecticides from the beginning and the end of the susceptibility test which represent the presence of slight increase in resistance levels. Regarding the assessment between whitefly field seasons there is development of resistance to all insecticides from level of resistance to another in each insecticide and in each class. There is slight differences between tested sits. In general Fayoum governorate was contain the most resistant population.

Fenitrothion the OP insecticide show evidence of high resistance ratio followed by chlorpyrifos-methyl but pirimiphos-methyl recorded few resistance ratio only with three collected whitefly population. Variation in susceptibility to OPs compounds fluctuated in consistency within the population in which the susceptibility increased in full–in addition highly significant correlations were observed among responses to OPs.

Resistance management tactic other than substitution of an alternative control are often most effective when implemented at very low resistance frequencies, after less far than 1% would repeatedly by cause control failures because it depends on density, age structure, and resistance frequencies. The pesticide efficacy threshold concept will be most useful only when it is defined in upward scale of pest density and the frequency of appropriate life stages.

Table (1): The insecticides LC_{50} of the different whitefly strains and the susceptible.

LC_{50}	Lab.	Beni-suef			Fayoum			Dakahlia			Behera		
Insecticides tested		2001	2002	2003	2001	2002	2003	2001	2002	2003	2001	2002	2003
Profenofos	0.935	0.115	0.2	0.79	0.12	0.69	11.3	0.053	3.802	1.3	0.457	0.276	0.37
Profenofos-Q	2.72	1	0.25	0.046	0.71	0.731	217	0.065	1.66	4.43	0.536	0.75	67.2
Pirimiphos-methyl	2.59	12	21.6	79	5.67	61.2	58	13.93	8.31	0.96	39.7	4.76	9.98
Fenitrothion	7.99	3.9	57.47	408	215.14	490.66	580	0.14	161.87	19.9	55.6	85.90	48.1
Chlorpyrifos-methyl	12.37	3.6	181	278	7.7	50.81	521.34	12.1	173.95	11.6	34.16	117.46	1590.7
Methomyl	4.2	3.3	2.2	19.9	3.8	6.18	24.2	1.55	7.96	16	16.88	2.648	11.7
λ-cyhalothrin	1.37	0.003	0.69	9.5	3.8	0.003	9.2	0.01	1.98	30	0.02	0.567	4.4
Fenpropathrin	1.24	0.03	0.025	1.9	5.8	29.4	1.67	0.06	0.206	21.4	0.018	1.66	0.83
Fenvalerate	2.66		0.088	5.96	0.018	0.004	5.17		2.47	2.7		0.95	23.34
Thiamethoxam	0.54	0.014	0.186	4.5	0.022	1.1	4.27	0.03	1.31	0.436	0.49	0.5980	0.54
Imidacloprid	0.085	0.223	0.536	1.2	0.00003	0.801	4.9	0.534	1.82	0.164	1.47	0.625	3.2
Lufenuron	0.00003	0.0001	0.045	0.000071	0.00002	0.041624	0.000487	0.0001	0.091064	0.0006	0.000001	0.000038	0.000083
Chlorfenapyr	0.002	0.0000058	0.001	0.0041	0.042	0.015837	0.00289	0.00024	0.003285	0.0038	0.00003	0.000017	0.00038
Pyriproxyfen	0.0003	0.000018	0.28	0.00149	0.00006	0.004035	0.0163	0.00005	0.004912	0.00037	0.00002	0.0013	0.00076
Pymetrozine	0.000024	0.0000038	0.002	0.0028	0.053	0.00034	0.000003	0.0001	0.024317	0.00022	0.00015	0.000253	0.00234
Flufenoxuron	0.00019	0.00001	0.059	0.00369	0.00003	0.001771	0.00078	0.00002	0.00381	0.00008	0.00001	0.0015	0.00047
Thiocyclam	0.115	1.1	3.1	9.8	0.435	3.3	6.08	0.03	1.4	0.716	0.042	2.22	2.6
KZ-oil	192.7	25	226	1061	2045.6	107	12112	18.3	355	0.0006	93	1376.4	907
CAPL-2 oil	1.15	3.4	40	308.5	3.87	516.6	1296	270	135	0.0038	61	61.4	287
M-Pede	523.9	60.2	50.4	26	48	60.7	13657	59b	351b	0.00037	225	30	154.5

Table (2): The insecticides resistance ratios of the different whitefly strains.

Resistance ratios	Beni-suef			Fayoum			Dakahlia			Behera		
Insecticides	2001	2002	2003	2001	2002	2003	2001	2002	2003	2001	2002	2003
Profenofos	0.123	0.2	0.84	0.13	0.73	12	0.056	4	1.4	0.48	0.295	0.395
Profenofos-Q	0.37	0.09	0.017	0.26	0.27	80	0.023	0.6	1.7	0.196	0.275	25
Pirimiphos-methyl	4.6	8.34	30.5	2.18	23.6	22.4	5.4	3.2	0.37	15.3	1.837	3.85
Fenitrothion	0.49	7.2	51	27	61.3	72.6	0.0175	20.3	2.5	6.95	10.75	6
Chlorpyrifos-methyl	0.29	14.6	22.4	0.62	4.1	42	0.978	14	0.9	2.76	9.49	128.6
Methomyl	0.78	0.52	4.76	0.9	1.47	5.76	0.38	1.9	3.8	4	0.63	2.8
λ-cyhalothrin	0.002	0.5	6.93	2.8	0.002	6.7	0.007	1.44	22	0.014	0.413	3.2
Fenpropathrin	0.024	0.02	1.53	4.6	23.3	1.34	0.048	0.166	17.25	0.0145	1.338	0.64
Fenvalerate		0.033	2.24	0.03	0.0015	2	0.055	0.9	1	0.9	0.36	8.8
Thiamethoxam	0.0259	0.34	8.3		2	7.9	6.28	2.4	0.79	17.6	1.1	1
Imidacloprid	2.6	6.3	14.1	0.25	9.4	57.6		21.4	1.9		7.35	37.6
Lufenuron	3.3	1500	2.36	1	1386	16.6	3.3	3033	20	0.03	1.26	2.676
Chlorfenapyr	0.0029	0.5	2	0.01	7.9	1.5	0.12	1.64	1.9	0.015	0.0085	0.19
Pyriproxyfen	0.06	933	5	140	13.3	54	0.16	16.37	1.2	0.06	4.3	2.6.3
Pymetrozine	0.1583	83.3	11.6	2.5	14.16	0.125	4.16	1012.5	9.16	6.25	10.54	0.96
Flufenoxuron	0.052	310	19.4	279	9.3	4	0.105	20	0.42	0.0526	7.9	2.47
Thiocyclam	9.56	26.9	85.2	3.78	28.69	52.8	0.26	12.17	6.22	0.34	19.3	22.6
KZ-oil	0.13	1.2	5.5	10.6	0.55	62.85	0.094	1.8	1.52	0.48	7.14	4.7
CAPL-2 oil	2.95	35	268.2	3.36	449	1126.9	235	117.4	5.48	53	53.39	249.5
M-Pede	0.1149	0.096	0.05	0.09	0.115	26	0.11	0.669	4.56	0.43	0.057	0.295

Pesticide alternations should be implemented is irrespective of population density because these actions must be taken many generations before control failure are likely to occur, (Mani 1985).The results agree with Roach and Miller (1986) mentioned that when R gene frequencies>10%, resistance is already established in the population. Despite this, alternation of compounds from different chemical classes remains an entirely viable resistance management technique since such a practice will always minimise selection pressures. Horowitz *et al.*, (1994) found that at LC_{50}, the resistance ratio value after three successive applications of pyriproxyfen for suppression of egg-hatch was 554 for adult emergence failure, the resistance ratio was 10.

Similar results attained by (El-kady and Devine, 2003) where reported that the strains of whiteflies in Egyptian fields were little resistant to OP's profenofos and pirimiphos-methyl when compared with Sudanese strain. And when they studied the resistance of *B.tabaci* to various insecticides of some populations in Egypt, λ-cyhalothrin gave (10-27 folds) which was less than other Pyrethroids. All fields' whitefly populations were resistant to Carbamate (20-50 folds) and aldicarb (40-80 folds). Carbamates were widely used in Egypt and accounted for 31% from the total insecticides used.

All these changes of LC_{50}'s values indicated high resistance of field strains of whiteflies exposed to heavy exposure of pesticides. OP and carbamate insecticides resistance may be due to modification to their common acetylcholine esterase target site, but in current study the temporal pattern of resistance suggest that carbamate and OP resistance are unconnected.

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مقارنه حساسيه سلالات الذبابه البيضاء لبعض المبيدات

حنان صلاح الدين طه دياب

المعمل المركزي للمبيدات ، دقي، جيزه، مصر.

من الضروري دراسه الخساره الكبيره للنبات سواء نتيجه للتعداد الهائل من الذبابه البيضاء والافات الاخري اولانتشار الفيروسات النباتيه المنقوله بالحشرات والتي تسبب تقريبا انعدام المحصول لذا تعتبر الذبابه البيضاء من الافات الهامه علي كثير من الخضروات والمحاصيل. وحيثما تصاعدت المقاومه للمبيدات تجاه هذه الافه. فمن الضروره عمل حصر شامل لفعاليه لمبيدات المستخدمه في المكافحه علي المستوي الحقلي لبعض المحافظات علي مده ثلاث سنوات متمثله في عشرون مبيد من مختلف المجموعات الاباديه المعروفه (البيريثرويدذ ، الكاربامات، الفوسفوريه العضويه) والموصي بها حديثا في المكافحه لهذه الافه (الايميداكلوبريد، الثياميثوكسام، ومنظمات النمو). تتحصر اهميه هذا الحصر في معرفه ترتيب الفعاليه للمبيدات المختلفه في موضع فعلها الابادي وكذلك تحديد التركيز الذي يقتل ٥٠% من الاعداد المختبره والذي اذا زاد باستمرار استعمال المبيد يؤدي الي زياده المقاومه من الافه له. لتحديد ذلك تم عمل التقييم الحيوي المعملي للمبيدات علي الحشرات التي تم جمعها من الحقول وحساب التركيز النصفي ، وتم اجراء المقارنه مع السلاله الحساسه المرباه معمليا وحساب درجه المقاومه لكل منهما. اكدت النتائج اتجاه الحساسيه في النقصان في بدايه الاختبار عن نهايته لجميع المبيدات.اثبتت ايضا نتائج الحساسيه العاليه لجميع السلالات الحقليه المختبره لمنظمات النمو، مثل الكلورفينابير، فلوفنوزيورون، بيريبروكسيفين، لوفنيورون و بيمتروزين.يلي ذلك مبيد الميثوميل الكارباماتي مايزال فعال ،بينما تتجه المقاومه في الزياده لمبيد الايميداكلوبريد، بينما تزيد ايضا درجات المقاومه للمبيدات الفوسفوريه المستخدمه في الاختبارات عن سابقه مما يضعها في مقدمه المبيدات المستبعده.