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Efficiency of certain insecticides and insect growth regulators alone or in mixture with chlorpyrifos for the integrated control of the Egyptian cotton leafworm

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ABSTRACT

The scientists of pest control and environmental protection oriented their activities to control or at least to limit the environmental pollution. Alternative pest control methods represent the major target of many research programs all over the world because of its impact on decreasing the manipulation of pesticides which led to environmental pollution. The efficiency of certain insecticides and insect growth regulators (IGRs) alone or in combinations with chlorpyrifos against the cotton leafworm, *Spodoptera littoralis* (Boisd.) for integrated management was carried out under field conditions. The results revealed that the acute insecticide, chlorpyrifos was highly effective (100% initial kill) while, the tested IGRs have low initial effect but relative high residual effect. The mortality percentages were increased by increasing factor about 1.7 and 1.3 after mixing of chlorpyrifos with chlorfluazuron according to residual effect and general effect, respectively. Also, the increasing factor was about 1.2 for (oxymatrine/prosuler) and chromafenozide. The insecticidal efficiency (initial, residual and general effect) was improved by Tank-mixing of half recommended rate of the insecticide, chlorpyrifos with that of IGR, chlorfluazuron or chromafenozide. Therefore, the mixture of chlorpyrifos (500 ml/Fed.) with either chlorfluazuron (200 ml/Fed.) or chromafenozide (12.5 g/Fed.) can be integrated in an IPM program on cotton crop against the Egyptian cotton leafworm, *S. littoralis*.

Key words: Insecticides, Chlorpyrifos, IGRs, IPM, *Spodoptera littoralis*

INTRODUCTION

The cotton leafworm, *Spodoptera littoralis* Boisd. (Lepidoptera: Noctuidae), is one of the most important economic pests attacking cotton in Egypt (Farrag and Noussier, 1996). Therefore, one single larva is able to destroy 66 cm^2 of cotton leaves (Scarpellini, 2001). Also, it is widely

distributed in the Mediterranean region, Africa, Asia and Europe (El-AW, 2006). Synthetic insecticides are often a part of management programs to control cotton leafworm in Egypt. The use of synthetic pesticides resulted in potential hazards for mammals, disturbances of the environment, pest resistance to pesticides and mall effects on non-target organisms, natural enemies and agro ecosystems (Prakash and Rao, 1987). Therefore, now it has become necessary to search for alternative means of pest control which can minimize the use of these synthetic chemicals (Abo-Arab and Salem, 2005). Also, to prevent the resistance phenomenon, there is a need for different compounds having different modes of action (Aydin and Gurkan, 2006).

Nowadays, the scientists of pest control and environmental protection oriented their activities to control or at least to limit the environmental pollution. Alternative pest control methods represent the major target of many research programs all over the world because of its impact on decreasing the manipulation of pesticides which led to environmental pollution (Ragab and Ismail, 2001). Implementation of integrated pest control tactics will help to reduce pests and environmental hazard problems (El-Aswad, 2003). Integrated pest management (IPM) is the most logical and ecological sound approach to insect population control (Graves *et al.,* 1991). Much interest has been developed in the use of modern approaches for controlling insect pests. The efficiency of insecticides and their mixture with the IGRs against the cotton leafworm attracted several investigators (Bakry *et al.,* 1973; Aly and Zeid, 1987; Kassem and Zeid, 1987; Eldoksch *et al.,* 1990; Ravi and Verma, 1997; El-Aswad *et al.,* 2001 and Moftah and El-Awami, 2004).

The present investigation aimed to study the efficiency of some insecticides and insect growth regulators alone and in blends with chlorpyrifos against the cotton leafworm, *S. littoralis*.

MATERIALS AND METHODS

This work was carried out during 2006 cotton growing season at Alexandria University Experiment Station at Abees area. The cotton variety, Giza 70 was obtained from the Agronomy Department. Cultural practices were applied as recommended for commercial production of cotton.

Chemicals: Eight formulated compounds were tested and obtained from local companies.

Insecticide :

- Chlorozan (chlorpyrifos), o,o-diethyl-o-(3,5,6-trichloro-2-pyridyl) phosphorothioate, 48% EC at a rate of 1.0 L/Fed., supplied by KZ Co., Kafer El-Zayat city.

- Chloroban (chlorpyrifos), 48% EC at a rate of 1.0 L/Fed., supplied by EGD Co., Giza Governorate.

- Marshal (carbosulfan), 2,3-dihydro-2,2-dimethyl-7-benzofuranyl [(di-butyl amino) thio] methyl carbamate, 25% WP at a rate of 600 g/Fed., supplied by Delta Co., Giza Governorate.

Insect growth regulators:

- Capris (chlorfluazuron), 1-[3,5-dichloro-4-(3-Chloro-5-trifluoro-methyl -2-pyridyloxy) phenyl]-3-(2,6-difluorobenzyl), 5% EC at a rate of 400 ml/Fed., supplied by Help Co., New Domiat city.

- Topron (chlorfluazuron), 5% EC at a rate of 400 ml/Fed., supplied by Agrochem Co., Alexandria.

- Kingbo (oxymatrine/prosuler), $C_{15}H_{24}N_2O_2$ and $C_{11}H_6O_2$. It is a natural plant extract, refined and produced from several wild Chinese medicines such as *Sophora japonica*, *Sophora flavescens* and *Veratrum nigrum*. It belongs to tetracyclo-quinolizindine alkaloids, 0.6% SL at a rate of 100 mL/Fed., supplied by EGD Co., Giza Governorate.

- Virto (chromafenozide), 2'-tert-butyl-5-methyl-2'-(3,5-xyloyl) chromane-6-carbohydrazide, 80% WP at a rate of 25 g/Fed., supplied by NM Agro Egypt Ltd, Cairo.

- Dimeuron (hexaflumuron), 1-[3,5-dichloro-4-(1,1,2,2-tetrafluoro-ethoxy) phenyl]-3-(2,6-difluorobenzoyl) urea, 10% EC at a rate of 200 ml/Fed., supplied by Agrochem Co., Alexandria.

Mixtures:

Before application immediately, half of the recommended rate of insect growth regulator; Capris, Kingbo or Virto was tank-mixed with half of the recommended rate of Chlorozan.

Tested insect: The culture of Egyptian cotton leafworm *S. littoralis* (Boisd.) started with egg-mass introduced from the Plant Protection Research Center, Dokki, Giza Governorate. A laboratory culture was reared on castor bean leaves according to Eldefrawi et al. (1964).

Field experiments: An experimental area of about one feddan was used for studying the efficiency of tested insecticides against cotton leafworm. The treatments were arranged in a complete randomized block design. Four replicates (42 m^2 per each) were used for each treatment including the check. The insecticides were sprayed by Knapsack sprayer equipment (CP3) at the rate of 200 liters of spray per feddan on August 15 and 30, in the 1^{st} and 2^{nd} spray, respectively. Samples of the untreated and treated leaves were taken 0, 3, 6, 9 and 12 days post-treatment. The treated leaves by the tested IGRs and their mixtures with Chlorozan were collected at intervals of 0, 1, 5, 6, 10 and 11 days after application. The leaves were transferred to the laboratory in perforated paper bags.

Laboratory evaluation: The laboratory evaluation was carried out according to Anonymous (1993). Two leaves of each sample were placed in a glass Jar containing 10 larvae of cotton leafworm (laboratory colony). Five replicates were made for each field replicate. The pre-treated cotton leaf samples with insecticides were exposed to the second and the fourth instar larvae for 24 hours at the different sampling time. While, the pre-treated cotton leaf-samples with the IGRs and their mixtures with chlorozan were exposed to the second and the fourth instar larvae for 48h, then the same larvae were fed three days by untreated leaves and the mortality counts of larvae were recorded daily. Also the same was repeated twice, 15 days.

Statistical analysis: The percentage mortality data were corrected by using the Abbott formula (Abbott, 1925). Data were analyzed by analysis of

variance (breakdown one way ANOVA) and followed by a least significant difference, LSD test (Anonymous, 1990).

RESULTS AND DISCUSSION

Tested insecticides: Mortality percentages of the second instar larvae exposed for 24h to cotton leaves treated with tested insecticides at different sampling intervals post-treatment were recorded in Table (1). Average of initial kill (mortality percentage at zero time), residual effect (the average of mortality percentage at different intervals; 3, 6, 9 and 12 days after application) and general effect (the average of mortality percentage at all intervals) were presented for the two sprays and also their average. The insecticide chlorpyrifos (Chlorozan and Chloroban) showed the highest insecticidal efficiency against the second instar larvae statistically for initial kill (100% mortality), residual effect (about 54% mortality) and general effect (about 63% mortality) in the average of two sprays.

Table (1): Effect of some insecticides against 2nd instar larvae of *Spodoptera littoralis*.

Compounds		Time (days)					Residual effect	General effect
Common name	Trade name	0	3	6	9	12		
		First spray						
Chlorpyrifos	Chlorozan	100.0[a]	97.5	60.0	36.5	17.5	52.9 [a]	62.3 [a]
Chlorpyrifos	Chloroban	100.0[a]	97.5	65.0	25.0	13.5	50.3 [a]	60.2 [a]
Carbosulfan	Marshal	36.3[b]	27.6	28.2	37.0	40.8	33.4 [b]	34.0 [b]
Control		1.3[c]	2.5	2.5	1.3	0.0	1.6 [c]	1.5 [c]
$LSD_{0.05}$		3.359					4.662	4.098
		Second spray						
Chlorpyrifos	Chlorozan	100.0[a]	87.5	60.0	52.5	25.0	56.3 [a]	65.0 [a]
Chlorpyrifos	Chloroban	100.0[a]	97.5	63.3	42.5	25.0	57.1 [a]	65.7 [a]
Carbosulfan	Marshal	30.3[b]	29.9	36.2	38.6	52.6	39.3 [b]	37.5 [b]
Control		2.5[c]	0.0	1.3	3.8	1.3	1.6 [c]	1.8 [c]
$LSD_{0.05}$		2.899					8.548	6.938
		Average of two sprays						
Chlorpyrifos	Chlorozan	100.0[a]	92.5	60.0	44.5	21.3	54.6 [a]	63.7 [a]
Chlorpyrifos	Chloroban	100.0[a]	97.5	64.1	33.8	19.3	53.7 [a]	62.9 [a]
Carbosulfan	Marshal	33.3[b]	28.8	32.2	37.8	46.7	36.4 [b]	35.8 [b]
Control		1.9[c]	1.3	1.9	2.5	0.6	1.6 [c]	1.6 [c]
$LSD_{0.05}$		2.722					5.781	4.852

Values within the same column having the same letters are not statistically different from each other, $P<0.05$

The results indicate significant differences of mortality percentage for initial kill, residual effect and general effect between chlorpyrifos (Chlorozan or Chloroban) and carbosulfan (Marshal). No significant differences were obtained between the mortality percentage of Chlorozan and Chloroban. The carbamate compound, Marshal induced 36.3% and 30.3% initial kill while 33.4% and 39.3% residual effect for the 1st and 2nd spray, respectively. Concerning the general effect, Marshal caused about 35.8% mortality as an average of two sprays.

Data presented in Table (2) including the effect of tested insecticides against 4th instar larvae of cotton leafworm *S. littoralis*. The data showed significant differences in initial activity of Marshal compared to Chlorozan and Chloroban. In addition, Chlorozan and Chloroban were highly effective (100% mortality) while, Marshal was less effective (34.4%) for the average of two sprays. The mortality percentages of Chlorozan and Chloroban were decreased with the sampling intervals, 3, 6, 9 and 12 days after application. This finding could be due to the degradation of insecticides under field condition. El-Sebae *et al.,* (1980) found that the insecticide thanite was rapidly degraded on cotton foliage; about 55% of the initial deposit was degraded within 24h from treatment. The highest residual effect was obtained by Marshal which differs statistically compared to other tested insecticides. Regarding to general effect, no significant differences of mortality percentage were observed among Chlorozan, Chloroban and Marshal in the case of 1st and 2nd spray.

The results indicated that the insecticide, chlorpyrifos in both commercial products; Chlorozan and Chloroban showed the highest efficiency against the 2nd and the 4th instar larvae of *S. littoralis* particular for initial kill (100% mortality) and general effect (about 65% mortality). Similar results were achieved by El-Aswad *et al.*, (2001) who found that the insecticides, chlorpyrifos (Chlorozan) and chlorpyrifos-methyl (Perban) were the most effective tested compounds against the cotton leafworm. Also, Kassem and Zeid (1981) reported that the efficiency of the same active ingredient was affected by the percentage of active ingredient in the formulation which plays an important role for toxicity. However, the commercial products, chlorozan and chloroban are the same formulation (EC) and containing 48% chlorpyrifos. A complete decline in mortality was recorded (not exceeding 35%) for the tested insecticides except for Marshal which induced 46.7% and 72.3% mortality for the 2nd and the 4th instar larvae after 12 days. In

addition, Nabil and Barakat (1992) showed about 24% mortality for the 4th instar larvae of *S. littoralis* with the organophosphorus insecticide, Curacron after 10 days of spray. In general, the results clearly indicated that the insecticide chlorpyrifos has rapid effect but low residual effect. These results are in good agreement with the results of El-Aswad *et al.,* (2001). The decrease of the residual effect for insecticides might be due to the effects of environmental factors on these insecticides (Shawir, 2000).

Table (2): Effect of some insecticides against 4th instar larvae of *Spodoptera littoralis*

Compounds		Time (days)					Residual effect	General effect
Common name	Trade name	0	3	6	9	12		
		First spray						
Chlorpyrifos	Chlorozan	100.0[a]	90.0	51.0	45.0	27.5	53.4 [b]	62.7 [a]
Chlorpyrifos	Chloroban	100.0 [a]	95.0	65.0	50.0	10.0	55.0 [b]	64.0 [a]
Carbosulfan	Marshal	33.0 [b]	69.0	74.3	41.4	68.0	63.2 [a]	57.1 [a]
Control		1.9 [c]	0.0	0.0	2.5	1.3	0.9 [c]	1.1 [b]
$LSD_{0.05}$		3.933					7.824	6.242
		Second spray						
Chlorpyrifos	Chlorozan	100.0 [a]	82.5	66.0	60.0	35.0	60.9 [b]	68.7 [a]
Chlorpyrifos	Chloroban	100.0 [a]	97.5	57.5	47.5	30.8	58.3 [b]	66.7 [a]
Carbosulfan	Marshal	35.8 [b]	84.2	86.1	32.0	76.6	69.7 [a]	62.9 [a]
Control		1.3 [c]	0.0	0.0	1.9	2.5	1.1 [c]	1.1 [b]
$LSD_{0.05}$		3.017					5.685	4.808
		Average of two sprays						
Chlorpyrifos	Chlorozan	100.0 [a]	86.3	58.5	52.5	31.3	57.1 [b]	65.7 [a]
Chlorpyrifos	Chloroban	100.0 [a]	96.3	61.3	48.8	20.4	56.7 [b]	65.3 [a]
Carbosulfan	Marshal	34.4 [b]	76.6	80.2	36.7	72.3	66.5 [a]	60.0 [a]
Control		1.6 [c]	0.0	0.0	2.2	1.9	1.0 [c]	1.1 [b]
$LSD_{0.05}$		2.336					6.018	4.855

Values within the same column having the same letters are not statistically different from each other, $P<0.05$

Insect growth regulators: The efficiency of tested insect growth regulators (IGRs) against the second cotton leafworm instar larvae is presented in Table (3). All insect growth regulators gave low mortality percentages, did not exceed 11.7% (initial kill) and no significant differences were obtained among all compounds and control. According to the average of two sprays, the data at the end of all periods, residual effect and general effect revealed

that, significant differences were found between hexaflumuron (Dimeuron) or chlorfluazuron (Topron), highest effective and other tested compounds. The high observed toxicity of benzoylphenyl urea, hexaflumuron (Dimeuron) is similar to the finding reported by (Hammock and Quistad, 1981). The mortality percentages of chlorfluazuron (Capris) and oxymatrine/prosuler (Kingbo) were decreased by about 32 % and 23% between 5th day of the first and second period and by about 41% and 36% between 5th day of second and third period, respectively. Regarding the residual effect and general effect, the tested insect growth regulators were arranged into three categories according to the statistical analysis. The compounds that had a high toxic effect (1st category) are hexaflumuron (Dimeuron) and chlorfluazuron (Topron). The compound that had a considerable effect (2nd category) is chromafenozide (Virto). While, the compounds that had low effect (3rd category) are chlorfluazuron (Capris) and oxymatrine/prosuler (Kingbo).

Data presented in Table (4) show the efficiency of tested IGRs against the fourth cotton leafworm instar larvae after two sprays. The results of the 1st spray are slightly different from the 2nd spray. In the two sprays, cumulative mortality was increased with increasing time within each period. These results agree with those obtained by El-Dahan *et al.,* (1985). The latest effect of IGRs is due to its effect in disturbing the function of insect physiology. Concerning the average of two sprays, the insect growth regulators, Topron and Dimeuron gave a high mortality for the general effect at the end of the three periods followed by Virto. The lower effects were obtained from Capris and Kingbo particularly at the end of the 2nd and 3rd periods. According to the statistical analysis, the insect growth regulators were classified to four categories. The first one has a high effect, gave residual effect or general effect more than 87% (Dimeuron and Topron). The second category has a considerable effect, caused residual toxicity and general effect for about 69% and 77%, respectively (Virto). The third category has a moderate effect, which ranged 42-61% mortality (Capris). The 4th category has a low toxicity, lower than 32% and 48% for residual and general effect, respectively (Kingbo). It was observed that tested IGRs have low initial effect but relative high residual effect. These results are in agreement with those of Kassem *et al.,* (1988), Eldoksch *et al.,* (1990), and Abdel-Salam *et al.,* (1999).

Table (3): Efficiency of some insect growth regulators against 2[nd] instar larvae of *Spodoptera littoralis*

Compounds		First five days					Second five days					Third five days					Residual effect	General effect
Common name	Trade name	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5		
							First spray											
Chlorfluazuron	Capsis	10.0 a	40.0	76.7	100.0	100.0 a	6.7	26.7	46.7	46.7	56.7 c	3.3	6.7	26.7	26.7	36.7 b	46.7 c	64.4 b
Chlorfluazuron	Topron	0.0 a	20.0	50.0	96.7	100.0 a	0.0	16.7	36.7	56.7	93.3 a	0.0	53.3	63.3	83.3	93.3 a	93.3 a	95.6 a
Oxymatrine /psoralen	Kingbo	10.0 a	33.3	50.0	66.7	83.3 a	3.3	30.0	53.3	63.3	63.3 bc	6.7	20.0	30.0	30.0	40.0 b	51.7 bc	62.2 b
Chromafenozide	Virtu	0.0 a	36.7	46.7	70.0	83.3 a	3.3	23.3	53.3	73.3	76.7 b	0.0	10.0	20.0	33.3	46.7 b	61.7 b	68.9 b
Hexaflumuron	Dimention	0.0 a	26.7	40.0	96.7	100.0 a	0.0	30.0	50.0	76.7	96.7 a	0.0	63.3	76.7	93.3	96.7 a	96.7 a	97.8 a
Control		0.0 a	3.3	3.3	3.3	3.3 b	0.0	0.0	3.3	3.3	3.3 d	0.0	3.3	3.3	3.3	3.3 c	3.3 d	3.3 c
$LSD_{0.05}$		7.243				12.579					14.525					11.840	11.483	11.278
							Second spray											
Chlorfluazuron	Capsis	3.3 ab	23.3	50.0	96.7	100.0 a	6.7	33.3	66.7	76.7	80.0 ab	10.0	16.7	33.3	33.3	43.3 b	61.7 c	74.4 bc
Chlorfluazuron	Topron	23.3 a	46.7	66.7	90.0	96.7 a	3.3	13.3	53.3	96.7	96.7 a	10.0	30.0	53.3	83.3	93.3 a	95.0 a	95.6 a
Oxymatrine /psoralen	Kingbo	10.0 ab	40.0	70.0	86.7	86.7 a	6.7	43.3	60.0	63.3	66.7 b	10.0	23.3	33.3	33.3	43.3 b	55.0 c	65.6 c
Chromafenozide	Virtu	10.0 ab	43.3	63.3	93.3	96.7 a	10.0	36.7	66.7	76.7	93.3 a	3.3	16.7	26.7	43.3	60.0 b	76.7 b	83.3 ab
Hexaflumuron	Dimention	16.7 ab	40.0	80.0	93.3	96.7 a	3.3	6.7	16.7	33.3	80.0 ab	0.0	16.7	63.3	73.3	86.7 a	83.3 ab	87.8 a
Control		0.0 b	0.0	3.3	3.3	3.3 b	0.0	0.0	0.0	3.3	3.3 c	0.0	0.0	0.0	3.3	3.3 c	3.3 d	3.3 d
$LSD_{0.05}$		14.525				11.840					15.119					18.752	14.676	10.370
							Average of two sprays											
Chlorfluazuron	Capsis	6.7 ab	41.7	63.3	98.3	100.0 a	6.7	30.0	56.7	61.7	68.3 b	6.7	11.7	30.0	30.0	40.0 b	54.2 c	69.4 bc
Chlorfluazuron	Topron	11.7 a	33.3	58.3	93.3	98.3 a	1.7	15.0	45.0	76.7	95.0 a	5.0	41.7	58.3	83.3	93.3 a	94.2 a	95.6 a
Oxymatrine /psoralen	Kingbo	10.0 ab	36.7	60.0	76.7	85.0 b	5.0	36.7	56.7	63.3	65.0 b	8.3	21.7	31.7	31.7	41.7 b	53.3 c	63.9 c
Chromafenozide	Virtu	5.0 ab	40.0	55.0	81.7	90.0 b	6.7	30.0	60.0	75.0	85.0 a	1.7	13.3	23.3	38.3	53.3 b	69.2 b	74.1 b
Hexaflumuron	Dimention	8.3 ab	33.3	60.0	95.0	98.3 a	1.7	18.3	33.3	55.0	88.3 a	0.0	40.0	70.0	83.3	91.7 a	90.0 a	92.8 a
Control		0.0 b	1.7	3.3	3.3	3.3 c	0.0	0.0	1.7	3.3	3.3 c	0.0	1.7	1.7	3.3	3.3 c	3.3 d	3.3 d
$LSD_{0.05}$		7.243				6.290					12.579					12.924	10.690	8.340

Values within the same column having the same letters are not statistically different from each other, P<0.05

Table (4): Efficiency of some insect growth regulators against 4th instar larvae of *Spodoptera littoralis*

Compounds		First five days					Second five days					Third five days					Residual effect	General effect
Common name	Trade name	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5		
							First spray											
Chlorfluazuron	Cajeir	3.3 ^{c}	13.3	50.0	76.7	100.0 ^{a}	3.3	13.3	30.0	33.3	46.7 ^{c}	3.3	16.7	20.0	33.3	43.3 ^{c}	45.0 ^{c}	63.3 ^{c}
Chlorfluazuron	Tejeon	13.3 ^{ab}	26.7	40.0	76.7	96.7 ^{a}	13.3	43.3	56.7	86.7	96.7 ^{a}	13.3	20.0	53.3	70.0	90.0 ^{a}	93.3 ^{a}	94.4 ^{a}
Novaluron	Kingbo	10.0 ^{ab}	40.0	56.7	80.0	96.7 ^{a}	0.0	13.3	13.3	23.3	26.7 ^{c}	6.7	6.7	6.7	16.7	16.7 ^{c}	21.7 ^{c}	44.7 ^{c}
Chromafenozide	Virto	3.3 ^{c}	26.7	50.0	63.3	93.3 ^{a}	16.7	36.7	50.0	66.7	83.3 ^{a}	13.3	13.3	26.7	33.3	36.7 ^{b}	60.0 ^{b}	71.1 ^{b}
Hexaflumuron	Dimilin	20.0 ^{a}	63.3	90.0	100.0	100.0 ^{a}	30.0	50.0	80.0	90.0	100.0 ^{a}	10.0	30.0	40.0	60.0	80.0 ^{a}	90.0 ^{a}	93.3 ^{a}
Control		0.0 ^{c}	0.0	0.0	0.0	0.0 ^{c}	0.0	0.0	3.3	3.3	3.3 ^{c}	0.0	0.0	3.3	3.3	3.3 ^{c}	3.3 ^{c}	2.2 ^{c}
LSD$_{0.05}$		10.271				10.271					15.689					19.648	10.284	7.444
							Second spray											
Chlorfluazuron	Cajeir	3.3 ^{c}	3.3	43.3	90.0	100.0 ^{a}	10.0	16.7	23.3	53.3	60.0 ^{bc}	0.0	3.3	6.7	20.0	20.0 ^{c}	40.0 ^{b}	60.0 ^{b}
Chlorfluazuron	Tejeon	16.7 ^{c}	33.3	53.3	90.0	93.3 ^{a}	16.7	36.7	56.7	83.3	93.3 ^{a}	16.7	36.7	66.7	90.0	93.3 ^{a}	93.3 ^{a}	93.3 ^{a}
Novaluron	Kingbo	13.3 ^{ab}	23.3	30.0	40.0	63.3 ^{c}	6.7	13.3	20.0	43.3	43.3 ^{c}	0.0	0.0	3.3	23.3	40.0 ^{b}	41.7 ^{b}	48.9 ^{c}
Chromafenozide	Virto	26.7 ^{c}	36.7	60.0	93.3	96.7 ^{a}	6.7	23.3	40.0	60.0	80.0 ^{ab}	10.0	20.0	30.0	63.3	76.7 ^{a}	78.3 ^{a}	84.4 ^{a}
Hexaflumuron	Dimilin	13.3 ^{c}	33.3	50.0	73.3	76.7 ^{b}	6.7	20.0	46.7	66.7	80.0 ^{ab}	23.3	40.0	66.7	80.0	90.0 ^{a}	85.0 ^{a}	82.2 ^{a}
Control		0.0 ^{c}	0.0	0.0	0.0	0.0 ^{c}	0.0	0.0	3.3	3.3	3.3 ^{c}	0.0	0.0	0.0	3.3	3.3 ^{c}	3.3 ^{c}	2.2 ^{c}
LSD$_{0.05}$		20.110				11.094					20.542					14.525	13.240	9.445
							Average of two sprays											
Chlorfluazuron	Cajeir	3.3 ^{c}	8.3	46.7	83.3	100.0 ^{a}	6.7	15.0	26.7	43.3	53.3 ^{b}	1.7	10.0	13.3	26.7	31.7 ^{c}	42.5 ^{c}	61.7 ^{c}
Chlorfluazuron	Tejeon	15.0 ^{c}	30.0	46.7	83.3	95.0 ^{a}	15.0	40.0	56.7	85.0	95.0 ^{a}	15.0	28.3	60.0	80.0	91.7 ^{a}	93.3 ^{a}	93.9 ^{a}
Novaluron	Kingbo	11.7 ^{c}	31.7	43.3	60.0	80.0 ^{b}	3.3	13.3	16.7	33.3	35.0 ^{c}	3.3	3.3	5.0	20.0	28.3 ^{c}	31.7 ^{c}	47.8 ^{c}
Chromafenozide	Virto	15.0 ^{c}	31.7	55.0	78.3	95.0 ^{a}	11.7	30.0	45.0	63.3	81.7 ^{a}	11.7	16.7	28.3	48.3	56.7 ^{b}	69.2 ^{b}	77.8 ^{b}
Hexaflumuron	Dimilin	16.7 ^{c}	48.3	70.0	86.7	88.3 ^{ab}	18.3	35.0	63.3	78.3	90.0 ^{a}	16.7	35.0	53.3	70.0	85.0 ^{a}	87.5 ^{a}	87.8 ^{a}
Control		0.0 ^{c}	0.0	0.0	0.0	0.0 ^{c}	0.0	0.0	3.3	3.3	3.3 ^{c}	0.0	0.0	1.7	3.3	3.3 ^{c}	3.3 ^{c}	2.2 ^{c}
LSD$_{0.05}$		12.044				9.139					12.579					14.825	10.483	7.424

Values within the same column having the same letters are not statistically different from each other, P<0.05

IGR-Chlorozan combinations: The results of the combinations between some IGRs and chlorpyrifos (Chlorozan) against the 2nd instar larvae of cotton leafworm, *S. littoralis*, are summarized in Table (5). The results showed that the mortality percentage was more pronounced and consistently higher at the first period (0-5 days) than the other periods, i.e. the cumulative mortality was 100% for the 1st period and ranged from 95 to 78% and 78 to 58% for the second and third feeding periods, respectively. Moreover, the initial percent mortality was 100% for the mixture of Chlorozan with Virto and about 97% and 88% for Capris-Chlorozan and Kingbo–Chlorozan combination, respectively. No significant differences were recorded among all treatments at the end of the first period except the untreated check. These results supported by Kassem and Zeid (1987) who found the chlorpyrifos mixture with IGR, diflubenzuron caused 100% initial kill of *S. littoralis*. In the present study, the lowest average of the two sprays was obtained by Kingbo–Chlorozan mixture for the second and third five days. According to statistical analysis, the highest residual effective and general effective on the 2nd instar larvae of cotton leafworm were recorded by (Capris + Chlorozan) and (Virto + Chlorozan) mixtures. Consequently, the lowest residual effective and general effective were obtained by (Kingbo + Chlorozan) mixture.

Concerning the efficiency of tested combinations (Tank mixing) against the 4th instar cotton leafworm larvae, the data are presented in Table (6). Statistical analysis revealed that there were no significant differences among the mortality percentages for initial kill and the end of the first period while, significant differences were recorded between the mixture of chlorpyrifos with Virto or Capris and that with Kingbo for the end of second and third period, residual effect and general effect. The lowest percent mortality was obtained by the mixture (Kingbo–Chlorozan), it was 90%, 43% and 62% for initial kill, residual effect and general effect, respectively. Although the percent mortalities were increased within each period, the mortality percentages were decreased by increasing the experiment time. All treatments gave 100% mortality in the first period but nothing reached 70% mortality in the third period. This is consistent with the finding of El-Dahan *et al.,* (1985).

Table (5): Efficiency of some mixtures against 2nd instar larvae of *Spodoptera littioralis*

Compounds	Initial kill	First five days				Second five days					Third five days	Residual effect					General effect
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5		
						First spray											
Capsis + Chlorosan	100.0 ^{a}	100.0	100.0	100.0	100.0 ^{a}	56.7	83.3	100.0	100.0	100.0 ^{a}	36.7	56.7	66.7	73.3	80.0 ^{a}	90.0 ^{a}	93.3 ^{a}
Kingbo + Chlorosan	96.7 ^{a}	100.0	100.0	100.0	100.0 ^{a}	33.3	46.7	66.7	76.7	83.3 ^{a}	20.0	43.3	50.0	56.7	66.7 ^{a}	75.0 ^{b}	83.3 ^{b}
Vito + Chlorosan	100.0 ^{a}	100.0	100.0	100.0	100.0 ^{a}	56.7	70.0	83.3	86.7	96.7 ^{a}	13.3	20.0	53.3	56.7	66.7 ^{a}	81.7 ^{ab}	87.8 ^{ab}
Control	0.0 ^{b}	3.3	3.3	3.3	3.3 ^{b}	0.0	0.0	3.3	3.3	3.3 ^{b}	0.0	3.3	3.3	3.3	3.3 ^{b}	3.3 ^{c}	3.3 ^{c}
$LSD_{0.05}$	5.435				5.435					14.301					23.040	9.013	7.243
						Second spray											
Capsis + Chlorosan	93.3 ^{a}	100.0	100.0	100.0	100.0 ^{a}	6.7	46.7	66.7	86.7	90.0 ^{a}	16.7	46.7	60.0	70.0	76.7 ^{a}	83.3 ^{a}	88.9 ^{a}
Kingbo + Chlorosan	80.0 ^{a}	100.0	100.0	100.0	100.0 ^{a}	13.3	46.7	56.7	66.7	70.0 ^{b}	6.7	23.3	36.7	46.7	50.0 ^{b}	60.0 ^{b}	73.3 ^{b}
Vito + Chlorosan	100.0 ^{a}	100.0	100.0	100.0	100.0 ^{a}	20.0	36.7	50.0	60.0	83.3 ^{a}	13.3	30.0	50.0	70.0	80.0 ^{a}	81.7 ^{a}	87.8 ^{a}
Control	0.0 ^{b}	0.0	3.3	3.3	3.3 ^{b}	0.0	0.0	0.0	3.3	3.3 ^{c}	0.0	0.0	0.0	3.3	3.3 ^{c}	3.3 ^{c}	3.3 ^{c}
$LSD_{0.05}$	21.741				5.435					12.154					12.154	8.153	6.031
						Average of two sprays											
Capsis + Chlorosan	96.7 ^{ab}	100.0	100.0	100.0	100.0 ^{a}	31.7	65.0	83.3	93.3	95.0 ^{a}	26.7	51.7	63.3	71.7	78.3 ^{a}	86.7 ^{a}	91.1 ^{a}
Kingbo + Chlorosan	88.3 ^{b}	100.0	100.0	100.0	100.0 ^{a}	23.3	46.7	61.7	71.7	76.7 ^{b}	13.3	33.3	43.3	51.7	58.3 ^{b}	67.5 ^{b}	78.3 ^{b}
Vito + Chlorosan	100.0 ^{a}	100.0	100.0	100.0	100.0 ^{a}	38.3	53.3	66.7	73.3	90.0 ^{a}	13.3	25.0	51.7	63.3	73.3 ^{ab}	81.7 ^{a}	87.8 ^{a}
Control	0.0 ^{c}	1.7	3.3	3.3	3.3 ^{b}	0.0	0.0	1.7	3.3	3.3 ^{c}	0.0	1.7	1.7	3.3	3.3 ^{c}	3.3 ^{c}	3.3 ^{c}
$LSD_{0.05}$	9.013				5.435					9.013					15.131	5.765	5.088

Values within the same column having the same letters are not statistically different from each other, P<0.05

Table (6): Efficiency of some mixtures against 4th instar larvae of *Spodoptera littioralis*.

Compounds	Initial kill	First five days				Second five days					Third five days					Residual effect	General effect
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5		
								First spray									
Capis + Chlorosan	100.0^{a}	100.0	100.0	100.0	100.0^{a}	6.7	43.3	66.7	86.7	86.7^{a}	13.3	23.3	30.0	63.3	66.7^{a}	76.7^{a}	84.4^{a}
Kingbo + Chlorosan	93.3^{a}	100.0	100.0	100.0	100.0^{a}	0.0	20.0	36.7	50.0	53.3^{b}	6.7	6.7	10.0	33.3	36.7^{b}	45.0^{b}	63.3^{b}
Virto + Chlorosan	100.0^{a}	100.0	100.0	100.0	100.0^{a}	46.7	70.0	83.3	86.7	96.7^{a}	13.3	20.0	53.3	56.7	66.7^{a}	81.7^{a}	87.8^{a}
Control	0.0^{b}	0.0	0.0	0.0	0.0^{b}	0.0	0.0	3.3	3.3	3.3^{c}	0.0	0.0	3.3	3.3	3.3^{c}	3.3^{c}	2.2^{c}
LSD$_{0.05}$	10.871				0.544					31.493					19.597	17.412	11.750
								Second spray									
Capis + Chlorosan	93.3^{a}	100.0	100.0	100.0	100.0^{a}	3.3	26.7	46.7	83.3	86.7^{a}	13.3	23.3	43.3	50.0	53.3^{b}	70.0^{a}	80.0^{a}
Kingbo + Chlorosan	86.7^{a}	100.0	100.0	100.0	100.0^{a}	20.0	23.3	23.3	56.7	60.0^{b}	0.0	6.7	10.0	16.7	23.3^{c}	41.7^{b}	61.1^{b}
Virto + Chlorosan	86.7^{a}	96.7	96.7	100.0	100.0^{a}	36.7	60.0	76.7	96.7	93.3^{a}	23.3	40.0	46.7	60.0	70.0^{a}	81.7^{a}	87.8^{a}
Control	0.0^{b}	0.0	0.0	0.0	0.0^{b}	0.0	0.0	3.3	3.3	3.3^{c}	0.0	0.0	0.0	3.3	3.3^{d}	3.3^{c}	2.2^{c}
LSD$_{0.05}$	31.223				0.544					16.306					13.314	13.314	8.859
								Average of two sprays									
Capis + Chlorosan	96.7^{a}	100.0	100.0	100.0	100.0^{a}	5.0	35.0	56.7	85.0	86.7^{a}	13.3	23.3	36.7	56.7	60.0^{a}	73.3^{a}	82.2^{a}
Kingbo + Chlorosan	90.0^{a}	100.0	100.0	100.0	100.0^{a}	10.0	21.7	30.0	53.3	56.7^{b}	3.3	6.7	10.0	25.0	30.0^{b}	43.3^{b}	62.2^{b}
Virto + Chlorosan	93.3^{a}	98.3	98.3	100.0	100.0^{a}	41.7	65.0	80.0	91.7	95.0^{a}	18.3	30.0	50.0	58.3	68.3^{a}	81.7^{a}	87.8^{a}
Control	0.0^{b}	0.0	0.0	0.0	0.0^{b}	0.0	0.0	3.3	3.3	3.3^{c}	0.0	0.0	1.7	3.3	3.3^{c}	3.3^{c}	2.2^{c}
LSD$_{0.05}$	14.435				0.544					19.408					14.435	13.174	8.748

Values within the same column having the same letters are not statistically different from each other, $P<0.05$

The average percent mortality values for two sprays by certain insect growth regulators and their mixtures with Chlorozan are recorded in Table (7). Taking the average of both means of percent mortality for second and fourth instar larvae, the results showed that chlorpyrifos alone (Chlorozan) gave 100% initial kill followed by chlorpyrifos–Capris and chlorpyrifos–Virto (96.7%) then chlorpyrifos–Kingbo (89.2%). However, the initial effect of all tested insect growth regulators was negligible (not exceeding 11%). Therefore, it is clear from these results that the mixtures of chlorpyrifos with any tested insect growth regulator were more effective (initial kill) than an insect growth regulator alone. Similar results were obtained by Kassem *et al.,* (1986). They found that the mixture of diflubenzuron with chlorpyrifos was effective (initial kill) than diflubenzuron alone. The mixing of half recommended rate of chlorpyrifos with the half recommended rate of insect growth regulators increased the mean residual toxicity for all tested compounds. Concerning to the average of residual effect and general effect, the tested compounds were classified to four groups according to the statistical analysis, the decreasing order of these groups was; (Virto + Chlorozan and Capris + Chlorozan) > (Virto alone) > (Kingbo + Chlorozan, Capris alone and Chlorozan alone) > (Kingbo alone). Furthermore, examination of the data clearly indicated that the mortality percentages were increased by increasing factor about 1.7 and 1.3 after mixing of Chlorozan with Capris according to residual effect and general effect, respectively. Also, the increasing factor was about 1.2 in the case of residual effect and general effect for IGRs, Kingbo and Virto.

The insecticide, chlorpyrifos gave high initial kill. In contrast, the IGRs have low initial kill. Moreover, the mixtures of IGRs, Virto and Capris with chlorpyrifos gave high initial kill, high residual effect and high general effect compared to that for Chlorpyrifos, Virto or Capris alone. These results are in agreement with those of Kassem and Zeid (1987); Kassem *et al.,* (1988) and Abdel–Salam *et al.,* (1999). Therefore, the insecticidal efficiency was improved by Tank-mixing of Chlorpyrifos (Chlorozan) with Capris or Virto. Furthermore, many advantages could be obtained by using these mixtures against *S. littoralis*, such as; improvement of insect control (Abdel-Salam *et al.,* 1999), reduction of the amount of insecticide active ingredient which would furnish better environmental protection (El-Dahan *et al.,* 1985), increasing the effectiveness against the resistant strains (El-doksch *et al.,* 1990), delaying the resistance phenomenon (Aydin and Gurkan, 2006) reducing the cost of pest control, reducing the deleterious side effects and protection of the natural enemies (El-Aswad, 2003).

Table (7): Efficiency of tested compounds and their mixtures against the Egyptian cotton leafworm

Compounds	Initial kill	Residual effect	General effect
Chlorozan	100.0 [a]	55.8 [c]	64.7 [c]
Capris	5.0 [b]	48.3 [cd]	65.6 [c]
Kingbo	10.8 [b]	42.5 [d]	55.8 [d]
Virto	10.0 [b]	69.2 [b]	77.0 [b]
Capris + Chlorozan	96.7 [a]	80.0 [a]	86.7 [a]
Kingbo + Chlorozan	89.2 [a]	55.4 [c]	70.3 [c]
Virto + Chlorozan	96.7 [a]	81.7 [a]	87.8 [a]
$LSD_{0.05}$	9.409	6.712	5.004

Values within the same column having the same letters are not statistically different from each other, $P<0.05$

CONCLUSION

It can be concluded that the insecticidal efficiency (initial kill, residual effect and general effect) was improved by Tank-mixing of half the recommended rate of insecticide, chlorpyrifos (Chlorozan) with half the recommend rate of IGR, chlorfluazuron (Capris) or chromafenozide (Virto). Therefore, the mixture of chlorpyrifos (500 ml/Fed.) with chlorfluazuron (200 ml/Fed.) or chromafenozide (12.5 g/Fed.) can be integrated in an IPM program on cotton crop against the Egyptian cotton leafworm, *S. littoralis*.

REFERENCES

Abbott, W. S. (1925). A method of computing the effectiveness of an insecticide. J. Econ. Entomol., 18: 265-267.

Abdel-Salam, A. H., Saleh, A. A. and Adel-Bakry, N. F. (1999). Field evaluation of three combinations (OP's and IGR's) against certain sucking cotton pests and some non-target organisms in cotton plantations. The 2nd Int. Conf.of pest control, Mansoura, Egypt, Sept., 617-634.

Abo-Arab, R. B. and Salem, A. A. (2005). Efficiency of some plant extracts compared to pirimiphos-methyl as insecticidal and ovicidal agents. Alex. J. Agric. Res., 50 (2): 53-60.

Aly, M. I. and Zeid, M. I. (1987). Effectiveness of two moult inhibiting insect growth regulators and their combinations with selected insecticides against the cotton leafworm *Spodoptera littoralis* (Boisd.). J. Agric. Tanta Univ., 13 (3): 873-881.

Anonymous (1990). Costat Statistical Software, microcomputer program analysis Version 4.20, Cohort Software, Berkeley, CA.

Anonymous (1993). Ministry of Agriculture Protocol, protocol of evaluation of the efficiency of pesticides in Egyptian culture.

Aydin, H. and Gürkan, M. O. (2006). The efficacy of spinosad on different strains of *Spodoptera littoralis* (Boisduval) (Lepidoptera: Noctuidae). Turk J. Biol., 30, 5-9.

Bakry, N., Taman, F. and Zeid, M. (1973). Effect of nutrition age and temperature on toxicity of insecticides to *Spodoptera littoralis* (Boisd). First Egypt Pest Cont. Conf., Assiut, 105-115.

El-Aswad, A. F. (2003). Efficincy of four bioinsecticides and their combinations with chlorpyrifos as a new approach for integrated management of *Spodoptera littoralis*. J. Pest Cont. Environ. Sci., 11 (1): 105-119.

El-Aswad, A. F.; Abdel-Rahman, S. M. and Aly, M. I. (2001). Field evaluation of certain insecticides on sucking insects in cotton and their efficiency in their combination with IGR against cotton leafworm, *Spodoptera littoralis*. Proceedings of the 1st Congress, Integrated Pest Managment, 22-23 April. Special Edition, Part II, Ball. Fac. Agric., Cairo Univ. pp. 243-253.

El-AW, M. A. (2006). Efficacy of two biorational insecticides, emamectin benzoate and Spinosad, against the immature stages of the cotton leafworm, *Spodoptera littoralis* (Boisd.) (Lepidoptera: Noctuidae). Alex. J. Agric. Res. 51 (1): 55-68.

El-Dahan, A. A.; Watson, W. M. and Bakry, N. M. (1985). Effect of five synthetic pyrethroids alone and in mixtures with diflubenzuron (IGR) against cotton leafworm *Spodoptera littoralis* (Boisd.). Alex. J. Agric. Res., 30 (2): 1031-1038.

El-defrawi, M.; Toppozada, A.; Mansour, N. and Zeid, M. (1964). Toxicalogical studies on the Egyptian cotton leafworm *Prodenia littura*. 1-Susceptibility of different larval instars of *Prodenia* to insecticides. J. Econ. Entomol., 57 (4): 591-593.

Eldoksch, H. A.;. Osman, M. O. A and Abdel-Fattah, M. S. (1990). Bio-activity of teflubenzuron, triflumuron and certain insecticides on egg masses, growth and development of *Spodoptera littoralis* (Boisd.). Com. Sci. Dev. Res., 32, 111-127.

El-Sebae, A. H.; Marei, A. S. M.; Abdel Aal, M. and Tantawy, G. (1980). Degradation and mobility of thanite in tissue of laboratory strain of *Spodoptera littoralis*, chicken and cotton leaves. Alex. J. Agric. Res., 28 (3): 685-693.

Farrag, R. M. and Noussier, N. I. (1996). Field studies on the use of *Bacillus thuringiensis* and chemical insecticides to control the cotton leafworm *Spodoptera littoralis* Boisd. Alex. Sci. Exch., 17 (1): 33-41.

Graves, J. R.; Leonard, B. R.; Burries, G.; Cinski, S. M.; Wolong, D. and O'Brien, P. J. (1991). Insecticides resistance management: An integral part of IPM. Proc. Betwide Cotton Conf., V, pp. 23.

Hammock, B. D. and Quistad, G. B. (1981). Metabolizm and mode of action of juvenile hormore, juvenoids and other insect growth regulators. In: Hutson, D. H., Roberts, T. R. (Eds.) Progress in Pesticide Biochemistry, V.1, Wiley, NewYork, pp. 1-83.

Kassem, Sh. M. I. and Zeid, M. I. (1981). Physico-chemical properties, efficiency and persistence of certain synthetic pyrethroids and certain mixtures of cypermethrin with profenophos. Zagazig University, Facalty of Agriculture. Res. Bull., Jan. No. 215.

Kassem, Sh. M. I. and Zeid, M. I. (1987). Comparison of the insecticidal efficiency of certain insecticides and their mixtures with insect chitin inhibitors. Alex. J. Agric. Res., 32 (3): 335-345.

Kassem, Sh. M. I.; Aly, M. I.; Bakry, N.and Zeid, M. I. (1988). Effect of mixing diflubenzuron and triflumuron with certain insecticides on the insecticidal efficiency. Alex. J. Agric. Res., 33 (2): 245-257.

Kassem, Sh. M. I.; Sherby, S. M.; Aly, M. I.; Zeid, M. I. and El-Sebae, A. H (1986). Studies on toxic effects of endotoxin, chitin synthesis inhibitor and mixtures of diflubenzouron with different insecticides on Egyptian cotton leafworm *Spodoptera littoralis* (Boisd.). Alex. J. Agric. Res., 31 (1): 327-336.

Moftah, S. A. and El-Awami, I. O. (2004). Toxicity evaluation of some insecticides to the cotton leafworm, *Spodoptera littoralis* (Boisd) and determination of their residues in the field and greenhouse. Alex. J. Agric. Res., 49 (2): 65-74.

Nabil, I. M. and Barakat, A. A. (1992). Efficiency of some binary mixtures of chitin synthesis inhibitors and conventional insecticides against *Spodoptera littoralis* (Boisd) larvae. Bull. Ent. Soc. Egypt, Econ. Ser, 19 (1): 173-181.

Prakash, A. and Rao, J. (1987). Use of chemicals as grain protectans in storage ecosystem and its consequences. Bull.Grain Tech., 25 (1): 65-69.

Ragab, F. M. A. and Ismail, H. (2001). Biological activity of certain fungal extracts against *Biomphalaria alexandrina* snails. Proceeding of the First Conference on Safe Alternative of Pesticides for Pest Management, Assiut Univ., Egypt, October 28-29, pp. 273-283.

Ravi, G. and Verma, S. (1997). Persistence and dissipation of insecticides against *Heliothis armigera* on chickpea. Indian Journal of Entomology. 59 (1): 62-68.

Scarpellini, J. R. (2001). Effect of emamectin benzoate on several larval stages of cotton leafworm *Alabama argillacea* Hüb. (Lepidoptera: Noctuidae). Arq. Inst. Biol., Sao Paulo, 68 (2): 57-61.

Shawir, M. S. (2000). Residual effectiveness of certain insecticides for controlling whitefly on cucumber plants. J. Pest Cont. and Environ. Sci., 8 (2): 29-44.

دراسة كفاءة بعض المبيدات ومنظمات النمو الحشرية بمفردها وفى مخاليط للمكافحة المتكاملة لدودة ورق القطن

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قسم كيمياء المبيدات – كلية الزراعة – جامعة الإسكندرية

يمثل الحد من تلوث البيئة بالمبيدات هدفا جوهريا للمهتمين بمكافحة الآفات وحماية البيئة ووسيلتهم هى مكافحة الآفات باتجاهات حديثة. لذا تم دراسة كفاءة عدة مبيدات وكذلك عدة منظمات نمو حشرية بمفردها أو فى خلائط مع مركب كلوروبيرفوس ضد دودة ورق القطن بالعمرين الثانى والرابع وذلك خلال موسم القطن لعام 2006 كأحد الاتجاهات الحديثة للتطبيق الحقلي. ولقد أظهرت النتائج أن مركب الكلوربيرفوس كان الأكثر فاعلية فله تأثير فورى مسببا نسبة موت 100% بينما منظمات النمو المختبرة كانت منخفضة التأثير الفورى ولكن لها تأثير متبقى عالى.

ولوحظ أن النسبة المئوية للموت زادت بمعامل 1.7 & 1.3 بعد خلط الكلوربيرفوس بالصورة التجارية الكلورزان مع منظم النمو الحشري كلورفلوازورون (كابرس) فى حالة التأثير المتبقى والتأثير الكلى على الترتيب. أيضا كان معامل الزيادة 1.2 عند الخلط مع منظمات النمو أوكسى ماترين/بروسلر (كينج بو) أو كرومافينوزيد (فيرتو). ويمكن القول أن الكفاءة تحسنت سواء إذا كانت عبارة عن تأثير فوري أو متبقي أو تأثير عام بالخلط فى التنك لنصف المعدل الحقلي للكلورزان مع نصف المعدل الحقلي للكابريس أو الفيرتو.وبصورة عامة فإن مخلوط المبيد الحشري كلورزان بمعدل 500 مل/فدان مع منظم النمو الحشري كابريس 200 مل/فدان أو فيرتو بمعدل 12.5 جم/فدان يمكن أن يطبق كأحد عناصر برنامج المكافحة المتكاملة فى محصول القطن ضد دودة ورق القطن.