Pesticidal Activity of Certain Pesticides Against The Cowpea Pod Borer *Etiella zinckenella* Treitschke (Lepidoptera : Pyralidae)

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ABSTRACT

In a field experiment in El-Sharkya Governorate , the activity of four insecticides against *Etiella zinckenella* Treits. was evaluated and expressed as the reduction in larval infestation and damaged seeds during two dates: 45 and 60 days post- plantation and in each date two sprays were carried out in summer 1999 and 2000 seasons .The percent reduction in larval infestation due to use of the organophosphorous compound Fenitrothion, was decreased by the end of 14 days from 70.3 , 71.2 , 79.8 and 77.4 % for the 1^{st} and 2^{nd} early , 1^{st} and 2^{nd} late applications of 1999 season , respectively , to 8.8 and 7.8% for the 1st early and 1st late applications , respectively. A higher reduction in damaged seeds was observed in the 1st and 2nd late applications of the two seasons . A quick and high mortility was recorded for the two tested organophosphorous compounds. The higher reduction percentage of the damgaed seeds (95%) was achieved using diflubenzuron (Dimilin) (IGR) in the first season of 1999. Nevertheless, the highest reduction perentage of larval infestation that recorded 14 days post-application was only about 49.6%. Larvae that inspected from those plants treated with diflubenzuron were found to be unable to moult and they stopped feeding as a result of being affected by the insect growth regulator .The application of the bio-insecticide Xentari (toxin of *B. thuringiensis)* gave a percentage of reduction averaging from 4.0 to 63.3% that increase from the 1st inspection (7 days after applications) to 14 days . The pathogen attacked the insect gut and larvae died by starvation . For this reason a high reduction in damaged seeds was observed . Higher reductions were recorded during 2000 than 1999 season .

INTRODUCTION

Etiella zinckenella (Treitschke) the cowpea or lima bean pod-borer is widely distributed in the tropics, subtropics and in temprate zones. It attacks legume pods, especially of lima bean, cowpea and sunn hemp. The insect have been reported to be a hardly controlled pest in cowpea fields because of its larval stage that being hidden in the green seed consuming it till pupation. Larvae leave almost no outside evidence of their presencef until at a very late stage (Abul- Nasr and Awadalla, 1957) . These investigators mentioned that larvae migrate to new pods for available seeds to reach their fully grown size. Moreover, one or two generations are attacking cowpea pods cultivated early in summer (May). Marketable yield demands numerous insecticide applications (early during the seedling stage for protecting floral parts subjected to oviposited eggs or late to hinder the newly hatched larvae boring the developing pods) .

Conventional insecticide for immediate mortality are not cost-effective and proper timing may reduce additional applications and avoid environmental contamination (Bijjur and Verma, 1997 and Sweeden *et al.* ,1994). Regarding the pod borer complex (moth oviposition, plant flowering and performance of pesticides) an alternation of a broad spectrum (i.e ovicidal effect) with new mode of action is needed .

The use of the bio-insecticides is a promising tool as a result of a selection of specific insect pathogens and formulations (Morris *et al.*, 1996 and Ridgway *et al*, 1996).

Insect growth regulators deal with some physiological aspects of pests when they are ingested with plant parts, most of them inhibiting chitin synthesis (Pszczolkowiski *et al* , 1994).

The present study was carried out to quantify the efficacy of two organophosphorous insecticides, a bio-insecticide and an insect growth regulator on the pod borer population in relation to the seed damage .

MATERIALS AND METHODS

The cowpea (variety Fetreyat) was cultivated at El Salheya, Sharkia Governorate in the 1st week of May of 1999 and the last week of April of 2000 seasons (summer plantation) to evaluate the performance of certain insecticides against the cowpea pod-borer *E.zinckenella* in relation to its damage on cowpea pods and seeds. The experiment was carried out in plots of 6 meters long with eight rows each and the rows were 0.8 m apart from each other. Five treatments were applied (two organo phosphorous insecticides , an insect growth regulator and a bio-insecticide plus the untreated check) at 45 (early application) and 60 days (late application) post- plantation. For this purpose plots were conducted in two blocks comprising the 1st application date as an early treatment at seedling stage and the 2nd one at the blooming and podding sstages. Each treatment was replicated three times in a randomized block design The tested pesticides were as follow :

1- Sumithion 48 % EC (Fenitrothion) : a contact oragnophosphorous compound [*O* , *O* dimethyl *O* - 4 – nitro- m- tolyl phosphorothioate] was used at the rate of 3.7 cm^3 / litre.

2- Tokuthion 50 % EC (Prothiofos) : a contact oragnophosphorous compound [*O*- 2,4 – dichlorophenyl *O*, ethyl – *S*– propyl phosphorodithioate] was used at the rate of 2.5 cm^3 / litre.

3- Dimilin 25% W.P. Diflubenzuron [1-(4- chlorophenyl) 3- (2,6 difluorobenzoyl) urea] was used at the rate of 0.7 gm/litre .

4- Xentari: a bio-insecticide that contain *Bacillus thuringiensis (B.t)* subsp. *aizawai*,
lepidopteran active toxins (35.000 diamond back moth units/ mg) was used at the
rate of 1 gm / litre.

Plants received two sprays at 15 day intervals while the usual horticultural practices were done . Fifteen pods from each plot were dissected before sprays and 7, 10 and 14 days after spraying for counting the larvae and damaged seeds. Reduction percentages were calculated according to Henderson and Telton 's equation (1955). Statistical analyses were performed at 5% level using *F* test.

RESULTS AND DISCUSSION

Data illustrated in Fig (1) showed that those plants early treated with fenitrothion were infested during the 1999 season by a mean number of 11.7 larvae/ treatment during the three inspections 7 , 10 and 14 days post-treatment. That average mean number of the larvae was higher than that in those plants treated with prothiofos (7.7 larvae / treatment) indicating the least average among the four tested compounds during the 1st spray with significant differences between the treatments and the untreated check. The treatment with the tested IGR diflubenzuron exhibited the highest infestation of 13.0 larvae / treatment, while the bio-insecticide Xentari (*B.t*) resulted in an intermediate infestation (9.3 larvae / treatment). The same trend was observed during the 2nd early application and the 1st and 2nd late applications (Fig 1). It is noticed that during the time of the second late application a higher infestation was recorded and causing higher average of larvae in treated and untreated plots. The infestation increased probably while plants grew and larvae bore more flowers and developing pods as the favorable conditions of both the temperature and humidity are being presented.

Data in Table (1) showed that the higher reduction percentage of the infestation occurred 7 days after the 1st spray that early applied in 1999 season for the two organophosphorus compounds fenitrothion and prothiofos (70.3 and 62.0%, respectively) and declined to 8.8 and 19.7% for the previous compounds, respectively, 14 days post-applications. The decrease in reduction was due to the probable degradation by sunlight or humidity showing that the prothiofos was more persistent. The 2nd spray gave more reduction and that probably induced by the accumulation of insecticide residues and its efficiency.

During the 1st late spray, the reduction percentages were increased and they were higher than those calculated from the 1st early spray. A decline of the activity of the two applied organophosphorates was occurred 14 days

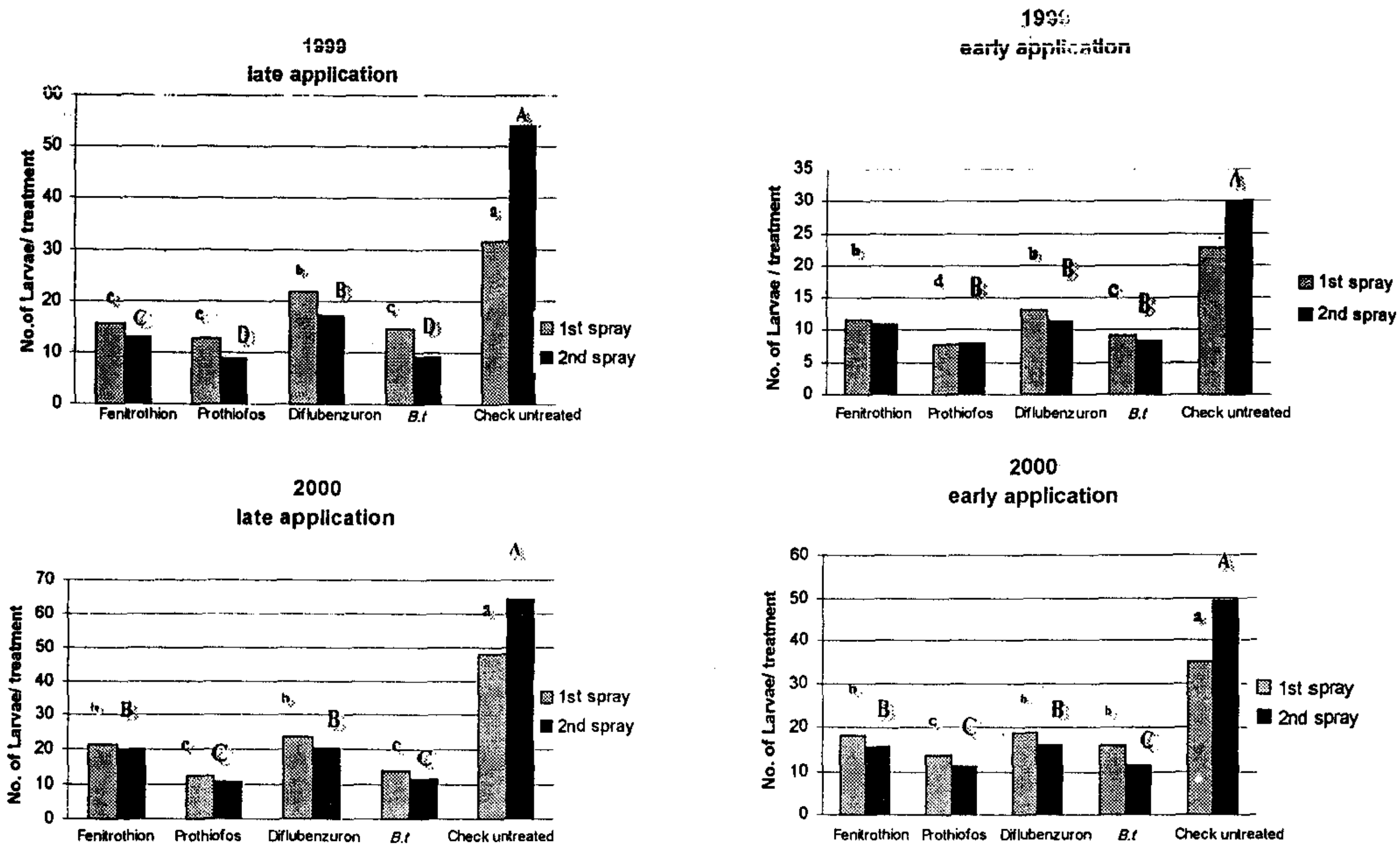

Fig. 1 Average of infection in cowpea pods in the three inspections (7, 10 and 14 days) after treatments with different compounds at El Salheya, El Sharkeya Governorate during 1999 and 2000 seasons.
-Means fellowed by the same letter are not significantly different.

post- treatment during the 1st spray and that was happened again during the 2nd one and that might because of the high temperature that enhancing more movable neonate larvae on the treated plant parts to reach an adequate amount of insecticide. The higher percentage of reduction was observed for the Fenitrothion treatment in 1999 season. In Table 2, the activity of the used insecticides on larval infestation during the early and late applications (1st and 2nd sprays) was conformed with the results of 1999 season .

The reduction of damaged seeds increased for the early Fenitrothion application and for prothifos during the late application of 1999 season (Table 1) . The 2nd spray showed higher reduction in the damaged seeds showing that an amelioration in yield occurred by the end of the two applications of the organophosphates employed . The 2nd early and late applications showed the highest percentage of reduction in damaged seeds for the 2000 season (Table 2) .

These results were in agreement with those of Abdallah *et al*, 1994 who found that prothiophos exhibited a good reduction after 15 days and the 2nd spray (after 15 days) elevated the percent reduction in infested pods and number of larvae.

In a field trial, Rinkleff *et al*. (1995) found that methyl-parathion (an organophosphate insecticide) demonstrated high levels of residual toxicity to neonates giving 55.9 and 51.7% mortality for eggs and neonates 7 days post-treatment, respectively). At day 3 , 51.3% egg mortality with 8.6% neonate mortality were found at 7-14 days post- treatment . The authors contributed the decrease of neonate mortality as a result of the exposure of larvae to lesser residues than those hatched from egg masses and moved across plant surfaces . This suggestion assured our findings in the early application (low moth population and single egg oviposition boring the pods without receiving the maximal residues). Early stage reduction may reduce additional insecticide application or prevent damage if larvae were already within the plant. The authors recommended the applications would be better to be done earlier to peak oviposition . Sweeden *et al*. (1994) found that the pod borer *Helicoverpa zea* (Boddie) controlled on cowpea early before first bloom and that resulted in higher yield and less insect damage (20-97% seed weight increase over control and 78% decrease in seed damage) . Bijjur and Verma (1997) found that 81% *Etiella* reduction occurred by Chloropyrifos due to a high level of persistence on crops until harvest and a maximum avoidable loss of 47% was obtained by 3 sprays .

The plots treated with diflubenzuron (an IGR) showed that the percentage reduction of larval infestation initiated by 5.0 % (7days post-application) during the 1st early application and it was increased to 37.0%

when it was calculated 14 days post- application (Table 1) . This reduction was approximately similar to the 2nd early spray . The 1st late application indicated a poor reduction (2.4% 7 days post-application) and raised to 49.6% (14 days post-application) and this possibly due to the higher temperature that accelerating the physiological process of insect moulting but settling captive in the old cuticle until dying. The lowest reduction observed during the 2nd late spray which was the result of higher temperature that enhancing the higher larval population to invade pods without optimum amount of insecticidal residues available in higher concentrations after the 2nd application The same trend was observed for the 2000 season . From Tables 1 and 2, reduction in seed damage indicated that larval feeding on seeds was decreased by the 7th day post-application.

Results reported and confirmed the present findings were that of Trisyono and Chippendale (1997) who found that no mortality was obtained at day 4 in the newly hatched larvae of *Ostrinia nubilalis* (Hubern) tunnelling in maize stalk treated by diflubenzuron incorporated in the diet in the laboratory then increased to 2.1% by the 14 and 18 days after treatment .

A nonsteroidal ecdysone agonist methoxiphenozide was also used in the diet and was found to delay the ecdysis of 4th instar larvae and caused 10, 50, 80 and 100 % mortality within 5, 44, 68 and 132 hours of post feeding initiation with a decrease in larval weight gain. The same findings were indicated by Root and Dauterman (1996) using cyromazine (a hormonal component) on the lepidopteran tobacco hornworm . Elongation, increased turgor pressure,

fluid filled vesicles and lesions on the cuticle are recorded. The moderate reduction in larval infestation if treated by diflubenzuron was explained by the inhibition of larval growth, pupation delay and feeding stop (Trisyono and Chippendale *et al* , 1997). The authors also suggested an ovicidal effect causing subsequent larval mortality. Larvae fed with diflubenzuron underwent additional molts resulting in additional deaths. Late instars were less susceptible . For this reason if these survivals migrate to anther pods they would caused more damage. The progressive reduction in larvae treated by diflubenzuron was attributed to the stability in the body or the continuous of the compound by the larvae whole the accumulation of pesticide residues was enough to induce a lethal moulting cycle (these findings assured the higher reduction of larvae during the 2nd late application) . Root and Dauterman (1996) reported that the ruptured larvae did not die quickly and mortality was not used as an endpoint and this explained the lower reduction in some dates of inspection . On the other hand, starvation can affect the compound toxicity by increasing or decreasing its metabolism .

Table 1. Percent reduction of infestation caused by *E. zinckenella* larvae and damaged seeds after application with four tested insecticides on cowpea plants cultivated in El Salheya, El Sharkeya Governorate during 1999 summer season.

Treatment		First application: Days after application 7	10	14	Average	Second application: Days after application 7	10	14	Average	Seasonal mean
Fenitrothion	(A)	70.3	46.3	8.8	41.8	71.2	47.8	40.8	53.3	47.5
		(35.8)*	(66.5)	(7.1)	(36.5)	(64.0)	(61.0)	(59.6)	(61.5)	(49.0)
	(B)	79.8	48.4	7.8	45.3	77.4	45.2	33.5	52.0	48.7
		(90.5)	(92.7)	(93.1)	(92.1)	(94.8)	(96.9)	(97.1)	(96.3)	(94.2)
Prothiofos	(A)	62.0	31.2	19.7	37.6	65.1	28.8	21.0	38.3	38.0
		(37.0)	(27.9)	(1.8)	(22.2)	(85.6)	(76.9)	(71.3)	(77.9)	(50.1)
	(B)	66.6	33.4	17.1	39.0	71.2	44.1	32.2	49.2	44.1
		(94.2)	(98.9)	(95.5)	(96.2)	(92.3)	(96.8)	(93.3)	(94.1)	(95.2)
Diflubenzuron	(A)	5.0	20.1	37.4	20.8	4.0	20.3	27.6	17.3	19.1
		(85.4)	(89.1)	(30.7)	(68.4)	(93.6)	(60.3)	(65.9)	(73.3)	(70.8)
	(B)	2.4	21.9	49.6	24.6	2.0	18.6	40.6	20.4	22.5
		(95.0)	(82.8)	(87.4)	(88.4)	(94.5)	(82.2)	(86.8)	(87.8)	(88.1)
B.t	(A)	13.6	29.6	40.3	27.8	4.0	22.7	29.8	18.8	23.3
		(95.5)	(81.8)	(80.4)	(85.9)	(40.0)	(70.6)	(87.0)	(65.9)	(75.9)
	(B)	11.0	41.5	63.3	38.6	9.5	34.2	48.3	30.7	34.6
		(85.5)	(87.4)	(87.9)	(86.9)	(83.6)	(85.5)	(85.9)	(85.0)	(86.0)

A: early treatment (seedling stage) and B: : late treatment (blooming and podding set) .

* Numbers in parentheses represented percent reduction in damaged seeds.

Table 2. Percent reduction of infestation caused by *E. zinckenella* larvae and damaged seeds after application with four tested insecticides on cowpea plants cultivated in El Salheya, El Sharkeya Governorate during 2000 summer season.

Treatment	First application Days post-application 7	10	14	Average	Second application Days post-application 7	10	14	Average	Seasonal mean
Fenitrothion (A)	77.3	46.8	9.7	44.6	79.5	53.4	51.2	61.4	53.0
	(33.1)*	(68.8)	(2.9)	(34.9)	(63.6)	(60.7)	(58.8)	(61.0)	(48.0)
(B)	78.0	47.6	16.0	47.2	68.5	52.0	44.7	55.1	51.1
	(92.9)	(93.0)	(93.3)	(93.1)	(92.8)	(94.9)	(95.1)	(94.3)	(93.7)
Prothiofos (A)	59.4	28.0	15.1	34.2	71.3	52.0	43.2	55.5	44.8
	(34.4)	(25.3)	(0.6)	(20.1)	(84.7)	(76.5)	(71.1)	(77.4)	(48.8)
(B)	68.6	34.5	13.5	38.9	67.1	49.2	44.2	53.5	46.2
	(92.6)	(97.3)	(94.0)	(94.6)	(93.1)	(97.7)	(94.4)	(95.1)	(94.9)
Diflubenzuron (A)	8.4	28.0	40.1	25.5	9.0	28.5	36.5	24.7	25.1
	(84.3)	(87.7)	(32.9)	(68.3)	(92.6)	(59.2)	(63.8)	(71.9)	(70.1)
(B)	15.0	23.2	17.9	18.7	20.0	31.3	37.0	29.4	24.1
	(93.5)	(85.9)	(81.7)	(87.0)	(94.8)	(86.2)	(89.0)	(90.0)	(88.5)
B.t (A)	7.6	32.5	41.4	27.2	9.0	40.3	53.7	34.3	30.8
	(98.6)	(84.8)	(83.4)	(88.9)	(41.3)	(71.7)	(88.0)	(67.0)	(78.0)
(B)	3.5	32.8	27.2	21.2	20.0	33.5	43.8	32.4	26.8
	(98.1)	(85.7)	(77.2)	(87.0)	(86.8)	(84.0)	(78.0)	(82.9)	(85.0)

A: early treatment (seedling stage) and B: late treatment (blooming and podding set) .

* Numbers in parentheses represented percent reduction in damaged seeds.

The *B.t* application (Tables 1 and 2) showed that larval infestation was reduced in increasing levels from 7 to 14 days post-application for the 1st early and late applications with higher percentages of late treatment . The 2nd spray showed lower reduction whether early or late during 1999 season . The reduction of 13.6% (7 days post-application) in the 1st early application reached 40.3% at 14 days post-application but the reduction dropped to 22.5% at the same inspection of the 2nd application) (possibly due to the low susceptibility of neonates in subsequent generations as suggested by Morris *et al*, 1996 . who indicated that death due to the insect starvation was the last stage of the toxin poisoning . The reduction of the late application reached 63.3% , 14 days post-application due to the higher populations in the late application date but that percetage was decreased to 48.3% in the same inspection for the 2nd late application . In contrast more susceptibility was observed in 2000 season in the 1st and 2nd early application, while it decreased with the late one. Ridgway *et al*, (1996) reported that the increased mortality 3.3 – 60.0% was recorded 1-2 days post-application using Dipel® 10 G (*B.t*) on the European corn borer versus 0.0 to 1.7% for the control and 14.5 to 47.6% of mortality from day 5 to 10, respectively . Morris *et al*, (1996) and Behle *et al* (1997) reported the decrease of mortality by the end of the 1st week (48.0 % of larval mortality with 56% of survivor weight gain and 92% of larval mortality at day 1 to 24% at day 7 post-application , Behle *et al* , 1997) . Amro (1999) using Delfin (*B.t*) against *E. zinckenella* in cowpea pods reported a reduction of 66.5 and 62.4% for the 1st and 2nd week after application . The second spray decreased the reduction to 50.0% . The entomopathology of the Xentari® is restricted to the gut epithelium that led to the starvation . For this reason a high reduction in damaged seeds was recorded in the four applications during the two successive seasons.

It could be concluded that the highest seasonal mean of larval infestation reduction 48.7% was obtained by the late application of fenitrothion while the lowest 19.1% was for the late diflubenzuron application with significant differences among treatments in average reduction of larval infestation while the highest seasonal mean of damaged seed reduction (95.2%) was observed for the late prothiofos application and the lowest (47.5%) was for the early Fenitrothion application.

It could be recommended that changing the timing of insecticide application is required, control was enhanced when applications are initiated early during the oviposition peak or much better to be earlier than that (Rinkleff *et al*, 1995).. Pszczolkowiski *et al.* (1998) suggested that the users of IGR_s should consider the proper circadian timing and dosage of application in the field. Prolonged exposure of pupating populations to active predator, parasitoids and fungi would be considered carefully. A management strategy against insect resistance would include combinations of endotoxins of *Bacillus thuringiensis* with IGR_s Products including microbial spores and toxins would contain phagostimulants to accelerate a high ingestion with the use of the granular matrix formulation that increase efficacy by protecting from photodegradation or reducing in cost for replacement of conventional insecticides. However the transfer and spread of *B. thuringiensis* from granules to the plant requires the optimum moisture (Ridgway *et al* , 1996). In the same time, sunlight and rain degrade and decrease the insecticidal activity of *B. thuringiensis* , It should be possible to use clear plastic or erected tents as a shelter in rainy times, if they are not expensive (Behle *et al* , 1997) . The gene manipulation of *B. thuringiensis* strain to broaden their spectrum of activity is required. Conventional insecticides safely applied till the flowering stage are important for the higher and immediate mortality of larvae.

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الملخص العربي

كفاءة بعض المبيدات ضد دودة قرون اللوبيا

Etiella zinckenella Treitschke (Lepidoptera: Pyralidae)

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مركز البحوث الزراعية – الدقى – الجيزة – معهد بحوث وقاية النباتات

لاختبار فعالية أربعة مركبات ضد دودة قرون اللوبيا *Etiella zinckenella Treits.* والتى قيمت على أساس الإنخفاض فى الإصابة باليرقات والبذور المصابة أثناء ميعادين للمعاملة ٤٥ ، ٦٠ يوم بعد الزراعة ويشمل كل ميعاد رشتين وذلك خلال الموسم الصيفى لعام ١٩٩٩ و٢٠٠٠ تم زراعة صنف اللوبيا Fetreyat فى تجربة فى محافظة الشرقية مع إجراء تطبيقات المبيدات المختبرة. قلت النسبة المئوية فى الإنخفاض بالإصابة اليرقية عند معاملة النباتات بالمبيد الفسفورى Fenitrothion فى نهاية اليوم ١٤ من ٧٠,٣ ، ٧١,٢ ، ٧٩,٨ ، ٧٧,٤% للمعاملة المبكرة الأولى والثانية والمتأخرة الأولى والثانية لموسم ١٩٩٩ على التوالى الى ٨,٨ ، ٧,٨ % فى المعاملة المبكرة الأولى والمتأخرة الأولى ععلى التوالى . كما وجد إنخفاض عالى فى نسبة البذور المصابة فى المعاملة المتأخرة الأولى والثانية لموسمى ١٩٩٩ و ٢٠٠٠ . وسجلت نسبة عالية وسريعة من الإبادة للمركبين الفسفوريين المختبرين وهما الفينوتروثين والبروثيوفوس. أما بالنسبة لمركب الداىفلوبنزيرون (الديميلين) (منظم نمو حشرى) كان أعلى إنخفاض فى الإصابة اليرقية تم تسجيله فى اليوم ١٤ بعد المعاملة حيث وصلت إلى ٤٩,٦% وفى الوقت نفسه أعطى أعلى نسبة فى إنخفاض البذور المصابة وصلت الى ٩٥,٠% بفعل فشل اليرقات فى الانسلاخ والتوقف عن التغذية . أما معاملة المبيد الحيوى (الزنتارى) (يحتوى على بكتريا الباسيلس ثيروجينسيس) فقد أعطت إنخفاض تراوح بين ٤,٠–٦٣,٣% ويزيد من الفحصة الأولى (٧ أيام بعد المعاملة) الى اليوم ١٤ . هذه البكتيريا تهاجم القناة الهضمية حيث تموت اليرقة من الجوع ولذلك لوحظ إنخفاض عالى فىنسبة البذور المصابة حيث كان الأنخفاض أعلى فى موسم ٢٠٠٠ عنه فى موسم ١٩٩٩ .