Impact of Certain Pesticides on Urease and Dehydrogenase Enzymes in Soil during the Cotton Bollworms Control

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ABSTRACT

The present study was carried out on soil cultivated with cotton variety Giza 70 during the season of 2011 to determine the side effects of certain pesticides i.e.; chlorpyrifos, profenofos, cypermethrin and alpha-cypermethrin which were used against the cotton bollworms on soil enzymes of urease and dehydrogenase. Three sprays for each insecticide were done and the spraying is carried two weeks after the previous spray.

The average of urease activity for the three sprays were expressed as unconverted urea to NH_4-N (%).The results showed high enzyme activity in all treatments, while, the mean enzyme activity was significantly decreased after treatment with profenofos.

For the average of enzyme dehydrogenase activity for the three sprays that expressed part per million (ppm) Formazan were determined. The results showed higher enzyme activity after application with chlorpyrifos, while, the activity was significantly decreased after application with Cypermthrin and profenofos, but, alpha-cypermethrin had mild effect on the enzyme.

It concluded that profenofos reduced urease and dehydrogenase activities. While cypermthrin decreased dehydrogenase activity . On the other hand, chlorpyrifos increased urease and dehydrogenase activities.

INTRODUCTION

In Egypt, the cotton crop occupies the most important place among agriculture strategy. The cotton production suffers from the injury of numerous pests. Hence, different chemical groups of pesticides are applied every season to control these pests particularly the cotton bollworms. The impact of pesticides on plants and soil attracted the attention of many investigators (EL-Shahaat *et al.*, 1987, Ramadan, 1991, El- Shahaat and Edrisha, 1993 and Ahmed, 2002 and EL-Shahaat *et al.*, 2007).

Therefore, the present study was conducted to evaluate the side effects of chlorpyrifos, profenofos, cypermethrin and alpha-cypermethrin insecticides on the soil enzymes activity as urease and dehydrogenase during the application of these insecticides against the cotton bollworms.

MATERIALS AND METHODS

1- Experiments

The field experiments were started on Aug the 17th - 2011 in cotton field (Giza 70 variety) at Beheira governorate. The evaluated treatments as well as a check treatment were distributed in a complete block randomized design.

2 - Pesticides used:

A- Chlorpyrifos, 48 % EC (Pyriban®) as an organophsphorus insecticide. Its recommended rate of application is 1 L / feddan .

B- Profenofos 72 % EC (Cord®) as an organophsphorus insecticide. Its recommended rate of application is 750 cm^3 / feddan

C- Cypermethrin 25 % EC (Sparkil®) as a pyrethroid insecticide. Its recommended rate of application is 250 cm^3 / feddan.

D- Alpha-cypermethrin 15 % EC (Pestox KZ®) as a pyrethroid insecticide. Its recommended rate of application is 165 cm^3 / feddan.

Three sprays for each insecticide were done and the spraying is carried two weeks after the previous spray.

3 - Assay of soil enzymes

A. Soil treatment

Samples of clay loam soil that previously planted with cotton was air-dried and sieved. Soil samples (500g-each) were taken weekly and transferred into plastic pots. The commercial formulations (EC) of chlorpyrifos, profenofos, cypermethrin and alpha-cypermethrin pesticides were applied at the recommended rates according to the Ministry of Agriculture, Egypt. The soil moisture content was brought to 60 % of its field capacity and maintained constant through certain experimental periods.

B. Dehydrogenase activity assay:

The soil dehydrogenase enzyme activity can be considered as an indicator to the oxidative biological activities (Casida *et.al.,* 1964) and soil respiration (Stevenson, 1959). Dehydrogenase activity in soil was determined according to the reduction of 2, 3, 5-tripheneyltetrazolium chloride (T.T.C) to triphenyl formazan (T.P.F) which is extracted and measured spectrophotometrically (Casida *et al.*, 1964).

To assay this enzyme activity, triphenyl tetrazolium chloride (TTC) was used as a substrate that is enzymatically converted to triphenyl formazan (TPF). The obtained formazan calibration curve shows an

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extinction coefficient "K" as 33 x 10^{-4} with a maximum absorbance at 485 nm.

C. Urease activity

It is known that urea is used as a source of nitrogen fertilizer that requires an enzymatic hydrolysis to make its nitrogen content available to plants. Urease enzyme in soil is the enzyme that can convert urea to NH_4-N that is considered as start material can be oxidized to produce nitrate. Thus, a serious problem may arise when urea fertilizer was added to soil having low urease activity (Lieoyd and Sheaffe, 1973 and Lethbridge *et al*., 1981). The urease activity is spectrophotometrically determined according to Watt and Chrisp (1954). Urea contents were expressed as micrograms urea / gm air-dried soil.

The urease activity was determined as the following formula:

$$\text{Urease activity \%} = \frac{A - B}{A} \times 100$$

Where:

A: the original urea added (ppm).

B: the remaining urea (residues) in ppm.

A- B = the converted amount of urea in ppm.

D. Statistical analysis:

The obtained results were expressed on the base of the air dried soil. The analysis of variance of treated and untreated soils with 3 replicates x 3 determinations was carried out. The means of treatments were compared for significance by the least significant difference (L.S.D) measure at the probability level of 0.05.

RESULTS AND DISCUSSIONS

1. Effect on urease enzyme:

Urease enzyme is microbially released in soil to catalyse the hydrolysis of urea fertilizer to ammonical nitrogen, NH_4-N. The later is the starting substance for the nitrification process; oxidation of NH_4-N to nitrite-N; NO_2-N and nitrate-nitrogen (NO_3-N). Therefore, there is a negative correlation between unconverted urea amount and the urease activity.

The results shown in Table, 1 appeared that urease activity was highly decreased in profenofos – treated soil (66.24 %) compared with the untreated check (74.67 %), while, the highest urease activity was recorded with the treatment of Chlorpyrifos (81.72). There were no significant differences between the 1st and 2nd spray for all treatments. In the 3rd spray, the urease activity % showed to be the highest decreased activity value with profenofos (44.7%), while, cypermthrin and chlorpyrifos caused the highest increase in urease activity (887 and 86.4, in respect).

2. Effect on Dehydrogenase enzyme:

The influences of the tested pesticides on soil dehydrogenase activity are shown in Table, 2. The mean activities of the enzyme were highly decreased where formazan content are 24.3, 27.2 and 30.2 ppm for the treatments of cypermthrin, profenofos and alpha-cypermethrin, respectively in comparison to untreated control; 36.7 ppm. The dehydrogenase activity had the highest decreasing value in the 1st spray (18.1 & 22.5 ppm) with cypermthrin and alpha-cypermethrin, respectively, while, the activity was decreased in the 2nd spray of profenofos, alpha-cypermethrin and cypermthrin (32.9, 34.9 and 35.9, in respect).

Table 1. Effect of certain pesticides on soil urease enzyme activity in cotton crop field during season of 2011

Intervals	Urase activity %				
	Treatments				
	Untreated check	Alphacypermethrin EC 15%	Chlorpyrifos EC 48%	Profenofos EC 72%	Cypermethrin EC 25%
The 1st spray (Aug., 17,2011)	67.3 b	79.2 a	78.0 a	76.2 a	76.5 a
$LSD_{.05}$	**4.132**				
2nd spray (2weeks post the 1st spray)	78.3 a	77.8 a	80.8 a	77.8 a	77.7 a
$LSD_{.05}$	**2.87**				
3rd spray (2weeks post the 2nd spray)	78.4 b	79.1 b	86.4 a	44.7 c	87.0 a
$LSD_{.05}$	**6.36**				
Mean	74.67 c	78.72 b	81.72 a	66.24 d	80.43 ab
$LSD_{.05}$	**2.359**				

* The values having the same letter(s) are not significant differed

Table 2. Effect of certain pesticides on soil dehydrognase enzyme activity in cotton crop field during season of 2011

Intervals	Dehydrognase enzyme (formazan, ppm)				
	Treatments				
	Untreated check	Alphacypermethrin EC 15%	Chlorpyrifos EC 48%	Profenofos EC 72%	Cypermethrin EC 25%
The 1st spray (Aug., 17,2011)	21.4 bc	22..5 bc	48.9 a	32.8 b	18.1 c
$LSD_{.05}$			11.73		
2nd spray (2weeks post the 1st spray)	60.6 b	34.9 c	143.5 a	32.9 c	35.9 c
$LSD_{.05}$			22.37		
3rd spray (2weeks post the 2nd spray)	28 abc	33.2 ab	39.4 a	15.9 c	19.0 bc
$LSD_{.05}$			15.78		
Mean	36.7 b	30.2 bc	77.3 a	27.2c	24.3 c
$LSD_{.05}$			9.440		

** The values having the same letter(s) are not significant differed

In the 3rd spray, the treatments of profenofos and cypermthrin decreased the activity values as 15.9 and 19.00, respectively. On the other hand, the enzyme activity was increased by chlorpyrifos; 77.3 ppm formazan. The dehydrogenase activity increased after application of chlorpyrifos in the three successive sprays with dehydrogenase activity (48.9, 143.5 & 39.4 ppm, respectively).

The results indicated that urease and dehydrogenase enzymes were affected by the tested pesticides. These findings are in agreement with those reported by many investigators; El-Shahaat *et a*l. (1989) when they found that cypermethrin and fenvalerate pyrethroids inhibited dehydrogenase activity in a sandy clay loam soil. Nevertheless, certain pyrethroids appeared to affect the urease activity with a positive correlation as reported by Chapman *et a*l. (1981). The depression of soil enzyme activities by a pesticide could be attributed to the detrimental influence or its degradation products on enzyme-producing microorganisms (Kuseske *et a*l., 1974 and Richey *et a*l., 1977). El-Shahaat *et a*l. (1989) found that the dehydrogenase and urease activity were mainly affected by the pesticides; and not by the type mineral or/and fertilization.

The obtained reducing effect on urease activity may be desirable where the heavy use of urea as fertilizer can produce certain problems encountered in the use of urea. These problems resulted from rapid hydrolysis of this fertilizer to ammonium carbonate, in the presence of soil calcium carbonate, leading to increase soil pH and liberation of NH_4-N. The obtained adverse effect can induce damage to germinating seedlings and young plants as well as inducing nitrite (NO_2-N) and / or ammonium-toxicity and gaseous loss of urea nitrogen as NH_3-N (Kiss *et al*., 1973 and Lethridge *et al*., 1981).

In contrast, the stimulatory effect that may be occurred by a pesticide on soil enzymes may be due to the utilization of this chemical compound by soil microorganisms as explained by many investigators (Vaankateswarlu and Sethunathan, 1979 & Tu, 1980).

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الملخص العربي

تأثير بعض المبيدات على أنزيمات اليوريز والدهيدروجينيز فى التربة خلال مكافحة ديدان اللوز على القطن

على زكريا النجار

تم إجراء الدراسة لهذا البحث على التربة المنزرعة بصنف قطن جيزة 70 فى موسم 2011 وذلك بهدف دراسة تأثير بعض المبيدات المستخدمة في مكافحة ديدان اللوز مثل الكلوروبيرفوس، والبروفينوفوس، والسيبرمثيرن، وألفا-سيبرمثرين على أنزيمات التربة (اليوريز والدهيدروجينيز) بعد معاملة النباتات بثلاث رشات من كل مبيد على فترات زمنية أسبوعين بعد كل رشة.

ويمكن تلخيص النتائج المتحصل عليها كالأتى:

تم تقدير نشاط أنزيم اليوريز على أساس قياس نسبة اليوريا المتحولة بالنسبة لليوريا المضافة. فأنه بالنسبة لمتوسط الرشات الثلاثة فقد أوضحت النتائج إرتفاع نشاط الأنزيم فى جميع المعاملات بينما إنخفض متوسط نشاط الأنزيم معنويا بعد المعاملة بمركب البروفينوفوس.

أما أنزيم الدهيدروجينيز والتى يعبر عنها بجزء في المليون فورمازان. فقد أوضحت النتائج إرتفاع نشاط الأنزيم كمتوسط العام للرشات الثلاثة بعد تطبيق مركب الكلوربيرفوس بينما إنخفض نشاط الأنزيم معنويا بعد المعاملة بكل من بروفينوفوس، سيبرمثرين.

ونستخلص من النتائج أن نشاط كل من أنزيمات اليوريز والدهيدروجينيز إنخفض بعد تطبيق مركب البروفينوفوس. أما مركب السيبرمثرين فقد خفض نشاط أنزيم الدهيدروجينيز. ومن ناحية أخرى إرتفع نشاط كلا الأنزيمين زاد بعد تطبيق مركب الكلوربيرفوس.