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PERSISTENCE AND FATE OF FENITROTHION AND CHLORPYRIFOS-METHYL RESIDUES IN SUGAR-BEET PLANTS AND SOIL

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Abstract

These studies were carried out to investigate the residual behaviour of fenitrothion and chlorpyrifos-methyl organoghosphorus insecticides on sugar-beet (vegetative parts and roots) and the contamination of soil under these plants. The residue half-life values (RL_{50}) determined on vegetative parts and soil were 16.8 and 134.4 hours for fenitrothion and 14.4 and 118.8 hours for chlorpyrifos-methyl, respectively.

In vegetative parts, the initial amount detected for fenitrothion (28.843 ppm) was higher than the initial amount found for chlorpyrifos-methyl (5.170 ppm), while the initial concentration detected in sugar-beet roots was very low (0.012 ppm and 0.019 ppm) for fenitrothion and chlorpyrifos-methyl, respectively. The vegetative parts did not have any detectable residues of fenitrothion and chlorpyrifos-methyl at 16 days from application. No detectable amount of fenitrothion and chlorpyrifos-methyl residues were found in the roots after 9 days from treatment. Fenitrothion and chlorpyrifos-methyl were found to be short persistent in the vegetative parts, but they were more stable in the soil.

INTRODUCTION

Sugar-beet plant (*Beta vulgaris*) is an important and fundamental crop for sugar production in Egypt. The high sucrose content of sugar-beet roots accounts for the extraction of sugar from them and the high nutritive value of its leaves suggests using them as an extra source as forage for farm animals.

This crop is attacked with various insects. The cotton aphid (*Aphis gossypii* Glover, the beet-weevil (Lixus junci Boh.), the beet-fly (*Pegomyia mixta* Vill.), the beet moth (*Scrobipalpa ocellatella* Boyd.) and the cotton leafworm (*Spodoptera littoralis* Boisd.) are the most economically important insect pests infesting sugar beet plants. Fenitrothion (0,0-dimethyl 0-4-nitro-m-tolyl phosphorothioate) and chlorpyrifos-methyl (O,O-dimethyl 0-3, 5, 6-trichloro-2-pyridyl phosphorothioate) insecticides are recommended for controlling these pests in Egypt.

The present study was carried out to investigate the residual behaviour of fenitrothion and chlorpyrifos-methyl insecticides in sugar-beet plants (vegetative parts and roots) and the contamination of the soil under these plants.

MATERIALS AND METHODS

The experimental work was conducted in Kafr El-Sheikh region at Sakha Experimental Station from November 1997 to May 1998. Sugar-beett seeds of the Pleno variety were planted on November 23th, 1997.

Fenitrothion (Sumithion E.C. 50%) and chlorpyrifos-methyl (Reldan E.C. 50%) were applied on April 13th 1998, at rates of 500 and 250 ml from the commercial product, each per 100 L of water (recommended dose), respectively, using a knapsack sprayer equipped with one nozzle.

Samples of 5 plants each were taken at intervals of one hour after application (zero time), 1,3,6,9,13,16,20,37 days after spray time. Then, sub-samples of 50 and 100 g. from vegetative parts and roots, respectively were taken for residue analysis.

Soil samples of 500 g. each from area under the sprayed plans were taken at 5 cm depthes at intervals of one hour (zero time) then after 9, 20, 37 days after application.

Analytical procedures

A. Extraction

1. Vegetative samples: The extraction procedure used is the general method suitable for organophosphorus compounds (Ministry of Welfare, Netherlands, 1988). Fifty gram of homogenized sample was mixed with 50g. anhydrous sodium sulphate and 100 ml ethylacetate. The mixture was blended for 3 min. and the extract was filtered.

2. Root samples: Methanol was found to be the best solvent for extraction of the two insecticides from roots. One hundred gram sample of the roots was placed in the blender cup and a constant amount of methanol (2 ml/gram root) was added, then blended for 3 minuts and filtered. Extracts were shaken successively with 70, 70 and 50 ml of methylene chloride in separatory funnel after adding 40 ml of sodium chloride solution (20%); then the water phase was discarded. The combined methylene chloride phases were dried by filtration through anhydrous sodium sulphate. Then, it was evaporated just to dryness using a rotary evaporator at 40^{o}C and the residues were ready

for chromatographic determination without clean-up.

3. Soil samples: Soil samples (clay) were ground. Then, 100 g. were placed in 500 ml conical flasks containing 50 g. anhydrous sodium sulphate and 200 ml methylene chloride. The flasks were shaken for one hour using an electrical shaker. Then, the methylene chloride layers were filtered through anhydrous sodium sulphate, then evaporated just to dryness using a rotary evaporator at 40°C and the residues were ready for chromatographic determination without clean-up.

B. Clean-up of extracts: The clean-up procedure was done according to the method of Al-Samariee *et al.* (1988). The extract was mixed with 3g. of activated charcoal, then shaken for 2 min. The mixture was filtered through filter paper and the supernatant rinsed with an additional 50 ml ethylacetate and collected just to dryness using a rotary evaporator at 40°C and the residues were ready for chromatographic determination.

C. Gas liquid chromatography determination: A Pye Unicam 4500 gas chromatograph equipped with a flame photometric detector operated in the phosphorus mode (526 nm filter) was used for fenitrothion and chlorpyrifos-methyl determination. The column (1.5 m x 4 mm i.d. pyrex) was packed with 4% SE-30+6% OV-210 on gas chromosorb Q (80-100 mesh); temperature degrees were 230°C for column, 240°C for detector and 235°C for injector and gas flow was 30, 30, 30 ml/min. for nitrogen, hydrogen and air, respectively. Retention times for fenitrothion and chlorpyrifos-methyl under these conditions were 5.77 and 4.57 min., respectively.

Results were corrected according to the rates of recovery which were determined in fortified untreated samples. Following the techniques previously mentioned, the rates of recovery for fenitrothion were 85.06, 88.61 and 81.37% and for chlorpyrifos-methyl were 91.76, 87.99 and 86.21% in vegetative parts, roots and soil, respectively.

RESULTS AND DISCUSSION

Results in Table 1 represent the residues of fenitrothion and chlorpyrifos-methyl on and in sugar-beet plants (vegetative parts and roots). The data showed that the concentration of the initial deposits were 28.843 ppm and 5.170 ppm for fenitrothion and chlorpyrifos-methyl on and in vegetative parts, respectively, one hour after application. The amount of residues was decreased sharply to 8.672 ppm and 0.627 ppm, respectively, within the first 24 hours after spraying. The residues of two insecticides

Table 1. Residues of fenitrothion and chlorpyrifos-methyl on and in sugar beet plant.

Time after application (days)	Residues (ppm)			
	Fenitrothion		Chlorpyrifos-methyl	
	Vegetative parts	Roots	Vegetative parts	Roots
Zero Time*	28.843	0.012	5.170	0.019
1	8.672	0.023	0.627	0.025
3	0.427	0.004	0.085	0.017
6	0.053	0.001	0.031	0.008
9	0.029	UND	0.017	UND
13	0.009	UND	0.003	UND
16	UND	UND	UND	UND
20	UND	UND	UND	UND
37	UND	UND	UND	UND
RL_{50} in hours	16.8		14.4	

* One hour after application

dropped to 0.427, 0.053, 0.029 & 0.009 ppm and 0.085, 0.031, 0.017 & 0.003 ppm after 3, 6, 9 and 13 days from treatment, respectively. The vegetative parts did not have any detectable residues of fenitrothion and chlorpyrifos-methyl after 16 days from application. The half-life values of fenitrothion and chlorpyrifos-methyl were 16.8 and 14.4 hours in vegetative parts, respectively.

The vegetative part of sugar-beet plants was sprayed by fenitrothion and chlorpyrifos-methyl. The solution could however reach the sugar-beet roots through seeping on the aerial part of the plant, moving through soil. The initial concentration detected in sugar beet roots was very low, 0.012 ppm and 0.019 ppm for fenitrothion and chlorpyrifos-methyl, respectively. The amount of residues reached 0.001ppm and 0.008 ppm, respectively, within the first 6 days spray time. No detectable amount of fenitrothion and chlorpyrifos-methyl residues were found in the roots at 9 days from treatment.

The present results agreed with the findings of Hegazy *et al.*, (1989) who found that no detectable amount of malathion residues in the roots of sugar-beet plants at all the intervals of study, while very small amounts of pirimiphos-methyl and methamidophos were detected. The initial concentration of fenitrothion in garlic heads was low (1.11 ppm) and decreased sharply during the first three days to reach 0.23 ppm (Abdel Rahman, 1996).

The present study confirmed that initial deposits of fenitrothion and chlorpyrifos-methyl was 28.843 and 5.170 ppm in vegetative parts, respectively. Such difference could be attributed to the higher rate of application of fenitrothion 500 ml (i.e. 250 g a.i.)/100 L water than chlorpyrifos-methyl 250 ml (i.e. 125 g a.i.)/100 L water.

The fast disappearance of fenitrothion and chlorpyrifos-methyl may be due to its higher vapor pressure (18 mPa at 20^{o}C) for fenitrothion and (5.6 mPa at 25^{o}C) for chlorpyrifos-methyl and also to other factors such as weathering, metabolic conversions or other degradation processes. However, the first day following application is critical in the sense of sharply decreases to reach 69.93% for fenitrothion and 87.87% for chlorpyrifos-methyl from the initial deposit.

On the other hand, reduction of insecticide residues from leaves of the plant probably resulted from dilution by plant growth and the effect of volatilization from the plant tissue surface due to meteorological conditions for the duration of the experiment such as temperature, humidity, rainfall and UV-light.

The loss of chlorpyrifos-methyl from the plant surfaces is mainly occurred by volatilization (Anonymous, 1972), while fenitrothion gets onto a plant, rapidly penetrate into its tissues (over 50% of the total amounts in 24 hours), but does not migrate along the vascular system, exhibiting only a penetrating effect (Gruzdyev *et al.*, 1983).

The obtained data indicated that fenitrothion and chlorpyrifos-methyl had short persistences on the vegetative parts of sugar-beet plants. These results are in agreement with those of Shokr (1997), who studied the residues of fenitrothion on and in some vegetable crops and found that the half-life values of this insecticide were 10.6, 26.1, and 8.2 hours on moloukhia leaves, green beans pods and cucumber fruits, respectively. Abdel-Rahman (1996) found that disappearance rate of chlorpyrifos-methyl in lettuce leaves was decreased rapidly within the first three days after application and then gradually decreased to 15 days. The initial deposits of chlorpyrifos-methyl on clover plants were 3.84 ppm and they decreased gradually to 2.28 and then to 0.01 ppm after 3 and 9 days from treatment, respectively (El-Sayed *et al.*, 1977).

The data obtained in Table 2 show that the residue levels in soils under sugar-beet plants, one hour after application were 1.190 and 0.143 ppm for fenitrothion and chlorpyrifos-methyl, respectively. The amount of residues decreased to 0.236, 0.015 & 0.006 ppm and 0.014, 0.002 & 0.001 ppm after 9, 20 and 37 days of spraying fenitrothion and chlorpyrifos-methyl, respectively.

Table 2. Residues of fenitrothion and chlorpyrifos-methyl in soil.

Time after application (days)	Residues (ppm)	
	Fenitrothion	Chlorpyrifos-methyl
Zero Time*	1.190	0.143
9	0.236	0.014
20	0.015	0.002
37	0.006	0.001
RL_{50} in hours	134.4	118.8

* One hour after application

The residue half-life values in soils under sugar-beet plants were 134.4 and 118.8 hours for fenitrothion and chlorpyrifos-methyl, respectively.

Generally, the persistence of modern organophosphorus insecticides in the soil does not exceed one month, therefore the danger of their residues contaminating fodder and food products through the roots is reduced to a minimum. On an average, fenitrothion persists in the soil during 10-20 days (Gruzdyev *et al.*, 1983). Fenitrothion and chlorpyrifos-methyl were found to be short persistence in the vegetative parts, but they were more stable in the soil.

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ثبات ومصير متبقيات الفنتروثيون والكلوربيرفوس - ميثيل على وفي نباتات بنجر السكر والتربة

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يهدف هذا البحث لدراسة سلوك متبقيات مبيدي الفنتروثيون والكلوربيرفوس - ميثيل علي وفي نباتات بنجر السكر ودراسة مدي تلوث التربة أسفل النباتات نتيجة عملية الرش. أوضحت الدراسة أن فترات نصف العمر بالنسبة لمبيد الفنتروثيون كانت ١٦,٨ و ١٣٤,٤ ساعة ، ولمبيد الكلوربيرفوس - ميثيل كانت ١٤,٤ و ١١٨,٨ ساعة علي الأجزاء الخضرية والتربة علي التوالي.

المتبقي الأولي علي المجموع الخضري لنبات البنجر كان أعلي في حالة مبيد الفنتروثيون (٢٨,٨٤٣ جزء في المليون) عنه في حالة مبيد الكلوربيرفوس - ميثيل (٥,١٧٥ جزء في المليون). وأيضا كانت كميات المتبقي الأولي التي وجدت علي الجذور لنباتات البنجر قليلة جدا (٠,٠١٢ و ٠,٠١٩ جزء في المليون) بالنسبة لمبيدي الفنتروثيون والكلوربيرفوس - ميثيل علي التوالي.

المجموع الخضري كان لايحتوي علي أي متبقيات يمكن الكشف عنها عند اليوم السادس عشر من المعاملة لكلا المبيدين، أيضا لم تكتشف أي متبقيات لكلا المبيدين علي الجذور عند اليوم التاسع من المعاملة.

أظهر مبيدي الفنتروثيون والكلوربيرفوس ثباتاً قليلاً نسبياً علي المجموع الخضري، وأيضا كان المبيدين أعلي ثباتا في التربة عند مقارنتهما بالثبات علي المجموع الخضري لنباتات البنجر.