

Impact of certain insecticides on chemical composition of greenhouse and open field pepper plants

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ABSTRACT

The effect of four insecticides: pirimiphos-methyl, chlorpyrifos-ethyl, cypermethrin and fenvalerate, on the chemical composition of greenhouse and open field pepper were evaluated. Insecticides were applied at recommended rates that used to control the insect pests. Data showed dramatic effects of the insecticide treatments on moisture and ash contents of greenhouse plants in which slight increase or decrease were recorded. However, no significant differences was recorded between open field treated and untreated plants. Data of carbohydrate contents showed no significant differences among the insecticide treatments in greenhouse and open field plants and control ones, except for cypermethrin

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treatment in open field that showed significant reduction in carbohydrate contents. Moreover, data revealed that carbohydrate contents were higher in all open field than that of greenhouse treated plants. Furthermore, data showed slight reduction of P in greenhouse and significant increase in open field treated plants. In contrast, slight increase of N content was recorded in open field and dramatic effect was observed in greenhouse treated plants. In the case of trace elements, data showed an increase of Fe contents in both greenhouse and open field treated plants. However, dramatic effects were recorded in Mn, Zn and Cu contents in both experiments. In conclusion, the impact of insecticides on chemical composition of pepper plants might depend on growing conditions and locations, the form and availability of each element in soils, uptake and distribution within pepper plants, influence of environmental factors and the chemical structure of the applied insecticide.

INTRODUCTION

Recently, more chemicals were used in modern agriculture for controlling pests and consequently increasing crop yields to meet the demand of increasing population in the world mainly in the developing countries. Misuse and intensive application of these chemical causes many environmental problems. One of these problems is the persistent residue of pesticides that accumulate in soil or plant. Those residues could interfere or react with plant nutrients, affect transformation, availability of nutrient elements in soil which are essential for plant life, accordingly affect the productivity of crop plants (Album, 1952). Several studies showed the effects of lethal and sub lethal doses of pesticides on carbohydrate in some organisms and suggested that these insecticides affect carbohydrate metabolism. Consequently, they alter their metabolic functions to meet the required energy demands under the insecticides toxic stress condition (Um *et al.*, 1991; Parveen

et al., 1998; Rajamannar and Manohar, 1998; George and Ambrose, 1999). Likewise, Gabr *et al.*, 1989, studied the influence of metalochlor foliar spray on carbohydrate content and photosynthetic activity in transplanted tomato plants. Gaweesh and El-Bially (1991) studied the response of rapeseed to some herbicides, and they concluded that treatment with linuron resulted in greatest carbohydrate and they reported significant correlation between carbohydrates and ash content. Sundaraj and Tamiselvan (1991) investigated the influence of deltamethrin on some biochemical parameters in cotton leaves, and concluded that total sugar, leaf reducing sugar and total chlorophyll content increased with increasing frequency of deltamethrin application. Sanaa *et al.*, (1993) and Sonna, (1993) investigated the effect of some herbicides on yield and chemical composition of peanut seeds and maize plants, and concluded that all herbicides slightly increased carbohydrate content of seeds and maize grains. Also, Mahmoud *et al.*, (1996) studied the residual effect of soil application of some pesticides on soybean and reported that pesticides decreased the concentration of carbohydrates. In the meantime, Szynal and Sykut, (1993) and Sharma *et al.*, (2000) studied the influence of treated wheat with herbicides on the macro and microelements content of the grain and straw. They concluded that herbicides generally increased grain Ca and K contents and decreased Mn and Zn contents, and in many cases the changes were not significant. Potassium, Ca, Mg and Na concentrations of the treated straw were found to be different from the untreated. Likewise, Gupta *et al.*, (1989) studied the effect of herbicide treatments on N contents of wheat and lentil plants and concluded that all treatment reduced N contents in wheat and lentils plants. Further, Warman and Harvard (1997) studied the effect of pesticides on mineral contents of carrots and cabbage. They concluded that five elements in carrots roots (N, S, Mn,

Cu and B). Two elements in carrots leaves (S and Na), three elements in cabbages, (N, Mn and Zn) were affected by the treatment.

The objective of this research is to determine the impact of using pirimiphos-methyl, chlorpyrifos-ethyl, cypermethrin and fenvalerate on the chemical composition of greenhouse and open field pepper plants.

MATERIALS AND METHODS

Chemicals: Four insecticides were purchased locally and used for this experiment. Two of them belongs to organophosphates; Actellic (pirimiphos-methyl) O-(2-diethylamino-6-methyl-pyrimidin-4-yl) O,O-dimethyl phosphoro-thioate, 50% EC and Dursban (chlorpyrifos-ethyl) O,O-diethyl O-(3,5,6-trichloro-2-pyridinyl) phosphorothioate, 48% EC, was applied at rates of 2.0 ml/liter. The other two belongs to synthetic pyrethroids; Cypermethrin ($\pm$) α -cyano-3-phenoxybenzyl ($\pm$)-cis, trans -3-(2,2- dichlorovinyl)-2,2- dimethyl-cyclopropanecarboxylate, 10 % EC was applied at a rate of 0.5 ml/l and Sumicidin (fenvalerate) (RS)- α -Cyano-3-phenoxybenzyl (RS)-2-(4-Chlorophenyl)-3-methylbutyrate, 20% EC at rate of 0.75 ml/l.

Field Trials: The experiment was carried out at the King Fiasal Research Station at Al-Hassa, Saudi Arabia. The experiments was designed in randomize block design. Cultural practices were applied as recommended for commercial production of greenhouse and open field pepper. Insecticides applications were repeated three times at 15 days intervals. Three replicates were set up for each treatment. A hand operated Knapsack sprayer was used to apply the insecticides. The effect of the

four insecticides on the chemical composition of greenhouse and open field pepper was estimated. Samples of treated plants were taken twice after each spray treatment (one week each) to determine the following constituents; moisture content percent ash, carbohydrates, N, P, Fe, Cu, Mn and Zn contents.

Determination: The percent of moisture and ash contents were determined according to the AOAC method (1980). Carbohydrates were determined according to Pearson (1976). Total N and P were determined according to Cottenie (1980). While Fe, Cu, Mn and Zn were determined by the Atomic Absorption Spectrophotometry. Statistical analysis was carried out according to Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

Effect of insecticides on moisture, ash and carbohydrate contents of pepper plants:-

1- Greenhouse pepper plants: The effect of tested insecticides on the chemical composition of greenhouse pepper plants is listed in Table (1). The percent of moisture reached 8.9, 8.6, 8.4, 8.7 and 8.5 % in pirimiphos-methyl, chlorpyrifos-ethyl, cypermethrin, fenvalerate and control, respectively. Statistical analysis revealed significant increase of moisture content in pirimiphos-methyl and fenvalerate treated plants as compared with non-treated plants. However, no significant differences were observed between chlorpyrifos-ethyl or cypermethrin treatments and control. Ash contents revealed no significant differences between insecticide treatments as compared with control except for fenvalerate treatment that showed significant increase. In the case of carbohydrate contents data showed no

significant differences among the insecticide treated and non-treated plants.

2- Open field pepper plants: Data showed no significant differences of both moisture and ash contents between insecticide treatments and the control plants. The moisture content ranged between 8.8 % in fenvalerate and 8.1 % in chlorpyrifos-ethyl treated plants. While it was 8.5 % in the control plants. However, the ash content ranged between 16.0 % in pirimiphos-methyl and 15.6 % in cypermethrin treated

Table (1): Effect of some insecticides on moisture, ash and carbohydrate contents of greenhouse and open field pepper plants.

Insecticide	Plant constituent *					
	Moisture Content %		Ash %		Carbohydrates %	
	G.H. [†]	O.F. [#]	G.H.	O.F.	G.H.	O.F.
Pirimiphos-Methyl	8.9	8.5	15.6	16.0	12.7	14.9
Clorpyrifos-Ethyl	8.6	8.1	15.3	15.7	12.8	15.0
Cypermethin	8.4	8.2	14.7	15.6	11.8	14.5
Fenvalerate	8.7	8.8	15.9	15.9	12.3	15.0
Control	8.5	8.5	14.8	15.2	12.2	15.4
LSD _{0.05}	0.2	0.5	1.0	1.0	0.7	0.6

* Mean of 18 samples of six weeks of three insecticide sprays at 15 days intervals.

[†] G.H. = Green house plants

[#] O.F. = Open field plants

plants. While it was 15.2 % in the control plants. In the case of carbohydrate contents, the data showed no significant differences between insecticide treatments when compared with control except for cypermethrin treatments that showed significant reduction in the carbohydrate contents (Table 1). Moreover, the data revealed that carbohydrate contents were higher in all open field than that of greenhouse treated plants.

Effect of insecticides on nitrogen and phosphorus of pepper plants:-

1- Greenhouse pepper plants: The effect of tested insecticides on the major elements, N and P contents of greenhouse cucumber plants is listed in Table (2). Data showed significant reduction of N contents in pirimiphos-methyl and chlorpyrifos-ethyl treated as compared with non-treated plants. However, significant increase was recorded between fenvalerate and the control. In the meantime, no significant difference was recorded between cypermethrin and the control. In the case of P content data revealed significant reduction in all insecticide treatments except for pirimiphos methyl as compared with control.

2- Open field pepper plants: Data showed that N content ranged between 23.5, 26.0, 22.3 g/kg in chlorpyrifos-ethyl, cypermethrin treated plants, and non-treated plants, respectively. Statistical analysis revealed no significant differences of N content between chlorpyrifos-ethyl, fenvalerate treated and the non-treated plants. However, pirimiphos-methyl and cypermethrin treated plants showed significant increase in N content when compared with control (Table 2). Phosphorus contents reached 2.2, 2.1, 2.0 and 2.0 g/kg in pirimiphos-methyl, chlorpyrifos, cypermethrin and fenvalerate, respectively compared with 1.5 g/kg in the control. Data of P content revealed significant increase of phosphorus

Table (2): Effect of some insecticides on nitrogen and phosphorus content of greenhouse and open field pepper plants.

Insecticide	N _(g/kg)		P _(g/kg)	
	G.H. ⁺	O.F. [#]	G.H.	O.F.
Pirimiphos-Methyl	25.3	25.6	2.5	2.2
Clorpyrifos-Ethyl	27.6	23.5	1.7	2.1
Cypermethin	29.2	26.0	1.8	2.0
Fenvalerate	37.6	23.6	2.1	2.0
Control	30.1	22.3	2.5	1.5
LSD _{0.05}	1.0	1.6	0.2	0.1

* Mean of 18 samples of six weeks of three insecticide sprays at 15 days intervals.

+G.H.= Green house plants

O.F. = Open field plants

contents in all insecticide treatments when compared with the control (Table 2).

Effect of some insecticides on trace elements of pepper plants:-

1- Greenhouse pepper plants: The effect of tested insecticides on Fe, Mn, Zn and Cu contents of cucumber plants is shown in Table (3). Data showed significant increase of Fe content at all insecticide treatments except for cypermethrin as compared with control. The maximum amount of Fe content was 139.3 mg/kg pirimiphos-methyl

treated plants. The lowest amount of Fe was recorded in the control plants (92.1 mg/kg). In the case of Mn content, significant reduction was recorded in all insecticide treated plants except for cypermethrin treatment that showed non significant difference as compared with the untreated plants. Data of Zn content revealed significant reduction of Zn in chlorpyrifos-ethyl and cypermethrin treated compared with the non-treated plants. However, significant increase was recorded in fenvalerate treatment compared with control. Zinc content ranged between 58.7 and 86.1, and 71.3 mg/kg at cypermethrin, fenvalerate treated plants, and untreated plants, respectively. On the other hand, significant increases were observed in plant Cu contents in all insecticide treatments except for cypermethrin as compared with control. The Copper content reached, 14.7, 9.4, 9.2, 15.2 and 8.5 mg/kg in pirimiphos-methyl, chlorpyrifos-ethyl, cypermethrin, fenvalerate and control, respectively.

Table (3): Effect of some insecticides on trace elements contents of greenhouse and open field cucumber plants.

Insecticide	Trace elements* (mg/kg)							
	Fe		Mn		Zn		Cu	
	G.H. ⁺	O.F. [#]	G.H.	O.F.	G.H.	O.F.	G.H.	O.F.
Pirimiphos-Methyl	139.3	119.8	74.2	26.9	68.9	50.3	14.7	6.0
Chlorpyrifos-Ethyl	106.7	123.1	74.9	24.3	63.9	48.4	9.4	5.3
Cypermethrin	92.4	117.2	78.7	25.3	58.7	46.5	9.2	6.5
Fenvalerate	114.6	131.6	73.3	28.7	86.1	63.0	15.2	7.0
Control	92.1	116.6	84.2	23.0	71.3	46.8	8.5	6.1
LSD _{0.05}	6.5	2.5	6.7	1.6	5.4	3.4	0.8	0.7

* Mean of 18 samples of six weeks of three insecticide sprays at 15 days intervals.

+ G.H.= Green house plants

O.F. = Open field plants

2- Open field pepper plants: In open field treated pepper plants, data showed significant increase in Fe content at all insecticide treated as compared with untreated plants. The highest increase of Fe content was noticed with fenvalerate treatment that reached 131.6 mg/kg, followed by chlorpyrifos-ethyl (123.1 mg/kg), then cypermethrin (117.2 mg/kg), and the lowest was noticed with the control (116.6 mg/kg). Data also showed an increase in Mn contents in all insecticide treatments compared with control. Moreover, the increase was significant in all insecticide treatments except for chlorpyrifos-ethyl treatment. The highest increase of Mn was recorded in fenvalerate while the lowest at chlorpyrifos-ethyl treated plants. The data of Zn and Cu contents showed dramatic effect between all treatments. The amount of Zn reached 50.3, 48.4, 46.5 and 63.0 mg/kg in pirimiphos-methyl, chlorpyrifos-ethyl and cypermethrin treated plants, respectively, compared with 46.8 mg/kg in the control plants. The statistical analysis showed significant increase in Zn contents in pirimiphos-methyl and fenvalerate treated as compared with the untreated plants. However, no significant increase between chlorpyrifos-ethyl or cypermethrin and control. In the case of Cu content, significant differences were observed between chlorpyrifos-ethyl and / or fenvalerate and the control, while no significant differences were recorded between pirimiphos-methyl or cypermethrin treated and the untreated plants (Table 3). The data also showed that the levels of Mn, Zn and Cu were higher in the greenhouse compared with open field ones at all insecticide treatments.

The data of greenhouse pepper in line with the results of Gupta *et al.* (1989) and Mahmoud *et al.*, (1996), who found that herbicide treatments reduced carbohydrate contents of wheat, lentil and soybean. However, Gaweesh and El-Bially (1991) and El-Maziny and El-Sayed (1991) concluded that treatments

with herbicides increased carbohydrates and reported significant correlation between carbohydrates and ash content. Also, Sundaraj and Tamiselvan (1991) found that total sugar, leaf reducing sugar and total chlorophyll contents increased with increasing frequency of deltamethrin application. The data of moisture and ash contents showed different effects between treated and untreated greenhouse plants in which slight increase or decrease were recorded. However, no significant differences were recorded between open field treated and untreated plants. The result in greenhouse treated plants matched with the results of Sonna, (1993); Hasaneen *et al.*, (1994) and Saafan, (1999), who reported that pesticides has an effect on water content and carbohydrates in castor bean and maize plants. Considering the impact of pesticides on the major-elements, the data showed slight reduction of P content in greenhouse treated plants and significant increase in open field treated ones. Moreover, slight increase of N content was recorded in open field treated plants and dramatic effect was observed in greenhouse treated ones. In the case of trace elements data showed an increase of Fe contents in both green house and open field treated plants. However, various effects were recorded in Mn, Zn and Cu contents in both experiments. In the meantime, the results of Szydal and Sykut (1993) concluded that herbicides generally increased grain Ca and K contents and decreased Mn and Zn contents. Furthermore, Warman and Harvard (1997) found that yield of carrots and cabbages were not affected by pesticide treatments. Whereas, five elements in carrots roots (N, S, Mn, Cu and B) and two elements in carrots leaves (S and Na) were influenced by the treatment; in cabbages, N, Mn and Zn were affected.

From the previous data, it is apparent that insecticides had an effect on the moisture, ash, carbohydrates, N, P and the

determined trace elements in both greenhouse and open field plants. Generally, the impact of insecticides on chemical composition of pepper plants might depends on planting condition and locations, the form and availability of each element in soils, uptake and distribution within pepper plants, influence of environmental factors and the chemical structure of insecticide.

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الملخص العربي

تأثير مبيدات حشرية معينة على المكونات الكيميائية لنباتات الفلفل في الصوب والحقل المكشوف

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تم تقويم تأثير أربعة مبيدات حشرية هي البريميوفوس ميثايل ، الكلوربيريفوس إيثايل والسيبرمثرين والفينفايرت على المكونات الكيميائية لنباتات الفلفل في كل من الصوب والحقل المكشوف. وتم تطبيق المبيدات عند المعدلات الموصى بها لمكافحة الآفات الحشرية. أوضحت النتائج تأثيرات متفاوتة للمبيدات على كل من محتوى الرطوبة والرماد للنباتات المعاملة في الصوب حيث تم تسجيل انخفاض في بعض المعاملات وزيادة في البعض الآخر. كما أظهرت النتائج عدم وجود اختلافات معنوية بين نباتات الحقل المكشوف المعاملة والغير معاملة. كما أظهرت النتائج عدم وجود اختلافات معنوية في المحتوى من الكربوهيدرات بين جميع معاملات المبيدات والمقارنة في كل من نباتات الصوب و الحقل المفتوح ما عدا معاملة السيبرمثرين في الحقل المكشوف حيث أظهرت انخفاض معنوي في محتوى الكربوهيدرات. كما أظهرت النتائج ارتفاع في محتوى الكربوهيدرات في نباتات الحقل المكشوف عن نباتات الصوب، وانخفاض قليل في محتوى الفسفور في نباتات الصوب المعاملة وزيادة معنوية في نباتات الحقل المكشوف المعاملة. وعلى العكس كانت هناك زيادة قليلة في المحتوى من النيتروجين في نباتات الحقل المعاملة وكانت هناك تأثيرات متفاوتة في التأثير على نباتات الصوب. وفي حالة المعادن الصغرى أظهرت النتائج زيادة في محتوى الحديد في كل من نباتات الصوب والحقل المكشوف المعاملة بينما كانت هناك تأثيرات متفاوتة في التأثير على محتوى كل من المنجنيز الزنك والنحاس في كلا الموقعين وعموماً فإن تأثير المبيدات على المكونات الكيميائية لنباتات الفلفل ربما يعتمد على ظروف وموقع الزراعة وشكل ومدى توافر كل عنصر في التربة وكذلك تحركه وانتقاله وتوزيعه خلال النبات وتأثير العوامل البيئية وكذلك التركيب الكيميائي للمبيد.

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