PERSISTENCE AND BEHAVIOR OF CERTAIN INSECTICIDE RESIDUES ON TOMATO FRUITS IN RELATION TO PROCESSING AND BIOCHEMICAL CONSTITUENTS OF FRUITS

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Abstract

This investigation was carried out to investigate the behavior and persistence of chlorpyrifos-methyl, diazinon and phenthoate insecticide residues on and in tomato fruits under normal field conditions. The residues half life values (RL_{50}) were determined, also the efficiency of some processes i.e. washing and blanching to remove the insecticide residues from treated fruits were also conducted. The effect of tested insecticides on chemical constituents of tomato plant fruits at harvest i.e. (carbohydrate fractions content, soluble protein contents and activity of peroxidase and polyphenol oxidase) was also studied. Results indicated that the initial residues of chlorpyrifos-methyl, diazinon and phenthoate were 1.88, 1.49 and 1.77 ppm on tomato fruits after one hour from application, respectively. The corresponding residues half-life values (RL_{50}) were 3.06, 1.25 and 7.20 days, respectively. Data also indicated that washing with tap water removed 10.38, 31.54 and 28.24% of chlorpyrifos-methyl, diazinon and phenthoate residues in tomato fruits after one hour from application, respectively. Blanching process were removed 40.45, 47.65 and 40.67% of chlorpyrifos-methyl, diazinon and phenthoate residues in tomato fruits after one hour from application, respectively. Results indicated that all tested insecticides treatment did not show any significant effect on total carbohydrates content, total soluble sugars, reducing sugars and non-reducing sugars content, total soluble protein contents and peroxidase activity and polyphenol oxidase activity in tomato fruits but phenthoate treatment had a significant decreased in total carbohydrates content in tomato fruits.

INTRODUCTION

Organophosphorus insecticides are widely used on vegetables and fruits to control insect pests because of their fast action and reasonable prolonged protection. These chemicals are generally less persistence and do not accumulate in the animal tissues and environment. The rapid development of agriculture in Egypt in last few years required increase in uses of agriculture chemicals and pesticides. Heavy use of pesticides has played an indirect significant role in increasing agriculture protection.

Pesticide residues after application on crops should be followed and the pre-harvest interval (PHI) should be also determined to be sure that the residues are below maximum residue limits (MRL'S) before marketing. Tomato (*Lycopersicon esculentum)* is important crop and widely used on many economic industries in Egypt.

Organophosphours insecticides namely chloryrifos-methyl, diazinon and phenthoate are widely used in Egypt to control the economic pests i.e. aphids (*Aphids gossypii)*, white fly (*Bemisia tabaci)*, and cotton leaf worm (*Spodopetra littorals)*.

This work aimed to study the behavior and the persistence of three insecticide residues on and in tomato fruits under normal field conditions. As well as the efficiency of washing and blanching in removing the insecticide residues from the treated vegetable crops by cited insecticides.

Moreover study the effect of the insecticide residues on the chemical constituents of tomato fruits at harvest i.e. moisture content, carbohydrate fractions content, soluble protein contents, and the activity of some enzymes (peroxidase and poly phenol oxidase).

MATERIALS AND METHODS

1. Residues of tested insecticides on tomato fruits:

1.1. Insecticides used:

1.Chlorpyrifos-methyl (Reldan E.C. 50%):

O, O dimethyl O- (3, 5, 6- tri chloro-2 pyridyl) phosphorothioate.

2. Diazinon (Basudin E.C. 60%):

O,OdiethylO-2 isopropyl-6- methyl pyrimidin-4-yl phosphorthioat.

3. Phenthoate (Cidial E.C.50%):

5- α. ethoxy carbonyl benzyl O, O- dimethyl phosphorodithoate.

1.2. Experimental and insecticides treatments:

Tomato was planted in El-Rohbaan village, El-Khankha center, Kaluobia Governorate, Egypt on April 10th 2000 under normal field conditions. The soil in this experiment was silty clay loam.

The experimental area was divided according to the complete randomized block design including three replicates. The plot area was 1/100 feddan. The northern plots were left as control. Tomato was sprayed on June 3rd 2000 with each of the three tested insecticides above mentioned. The insecticides formulation were diluted with water and then sprayed by using a knapsack sprayer equipped with one nozzle. The insecticides were applied at the recommended rates candidate 1L/fed.

Tomato fruit samples were taken at random from each experimental plot. Sub sampling was done at the laboratory, four replicates were taken 100gm for each one.

The samples intervals were one hour after application (zero time), 1, 3,7,10 and 15 days after application. Polyethylene bags were used for the collected samples and stored at - 20°C in a deep freezer until analysis.

1.3. Analytical procedures:

1.3.1. Extraction: Tomato fruits were extracted as mentioned by Mollhof (1975) which adapted to use methanol instead of acetone as a solvent for the extraction of the three tested insecticides. Samples were cut into small pieces in a warring blender (100g), a constant amount of distilled methanol (200ml) was used for extraction. The sample was blended for three minutes at high speed and filtered through a dry pad of cotton into a graduated cylinder. A known volume of filtrate (100 ml) was taken and partitioned successively with 100, 50 and 50 ml of dichloromethane for water separation from methanol extract in a 500ml separatory funnel after adding 30 ml of sodium chloride saturated solution. The combined dichloromethane phase was dried by filtration through a pad of cotton and anhydrous sodium sulfate, and then evaporated to dryness on a rotary evaporator at 40°C.

1.3.2. Clean up procedure: The florisil column clean up procedure of Mills et al. (1972) was used. A18mm (i.d.) x 40 cm glass column chromatography was filled with 6 gm of activated florisil (60-100 mesh) and topped with anhydrous sodium sulfate and compact thoroughly. The column was pre washed using 50 ml n- hexane. The sample extract was dissolved in 10 ml of the same solvent and transferred to the column and then eluted with 200 ml eluant (50 % dichloromethane: 48.5 % n-hexane: 1.5% acetonitrile) at rate of 5 ml /min. The eluant was evaporated to dryness by rotary evaporator at 40°C and the residues were ready for chromatographic determination.

1.3.3. Gas liquid chromatography determination:

HP 6890 gas chromatograph equipped with flame photometric detector operated in the phosphorus mode (526 nm) filter was used for determination of chlorpyrifos – methyl, diazinon and phenthoate. The column was PAS-1701 (25m x 0.32 mm x 0.52 mμ). Injector temperature was - 250°C, Detector temperature was250°C Column temperature were 230, 210 and 230°C for chlorpyrifos-methyl, diazinon and phenthoate, respectively.

Gases flow rates were 60, 30 and 30 ml/min. for nitrogen, hydrogen and air, respectively.

Retention times for chlorpyrifos –methyl, diazinon and phenthoate under these conditions were 1.99 and 3.14, respectively.

Rates of recoveries of the insecticides on tomato fruits were determined at the level of 1 ppm for the three insecticides under study. The average rate of recovery for the three insecticides were 90, 90 and 95% respectively.

2. Effect of some processes to remove the insecticide residues from treated vegetable crops:

Several home and industrial processing which are usually used were evaluated for their efficiencies in removing Chlorpyrifos-methyl, diazinon and phenthoate residues from tomato fruits which were treated with recommended rates. Samples were collected after one hour and one day from application and prepared as follow:

2.1. Washing with tap water: tomato samples were rinsed for three minutes with running tap water. Then drained on a clean paper for 30 minutes at room temperature until drying. Samples were kept in polyethylene bags under deep freezing until analysis.

2.2 Blanching of tomato fruits: Samples were placed in a jar filled with boiling water for 2 – 3 minutes then drained on a clean paper and left until reached to room temperature. Then samples were kept in polyethylene bags under deep freezing until analysis.

3. Chemical composition of plants determination:

Effect of insecticide residues on chemical constituents of tomato fruits.

3.1. Determination of carbohydrates fraction contents:

Acid hydrolysis of the plant material was carried out by using 5 g of the samples and 20 ml of hydrochloric acid 2N in a tube was sealed and kept in electrical oven over night at 90°C, after then samples were left to reach to room temperature and filtered on filter paper. The filtrate made to a known volume by distilled water. The total hydrosable carbohydrates were determined with phenol-sulfuric acid method as described by Hegazy et al. (2004).

Total Soluble sugars were extracted from the samples (2 g) in 80 % ethanol (20ml) over night. A known volume was evaporated and dissolved in a known volume of distilled water. Soluble sugars were determined by phenol sulfuric acid as described above according to Hegazy et al. (2004).

Reducing sugars were determined by picric acid methods mentioned by Hegazy et al. (2004).

The non- reducing sugars contents were calculated by the following equation:

Non-reducing sugar = total soluble sugars - reducing sugar

3.2. Protein analysis:

Extraction of enzyme fractions:

Samples were extracted with sodium phosphate buffer (0.2 M, PH 7.9) at $4^{\circ}C$ for one hour at ratio of 1:10 (w/v) as described by **Hegazy et al. (**2004). The homogenate was filtered through a triplicate layer of chess cloth, and then the supernatant was used for enzyme assay.

Soluble protein fraction was estimated by using the comassie brilliant blue G-250 according to Bradford (1976) with bovine serum albumin as standard.

Peroxides were assayed by photochemical method as Hegazy *et al.* (2004) that adapted to be suitable for determination.

The increasing in absorbance at 430 nm was recorded against blank (with phosphate buffer instead of enzyme extract). One unit of enzyme activity was defined as the amount of enzyme, which cause change in the optical density at 430 nm per minute at $25^{\circ}C$ under standard assay condition. Specific activity was expressed in units by dividing it on mg protein. The value of Σ at 430 nm for the reaction product of pyrogallol is 2.47 m M^{-1} CM^{-1}.

$$\text{Specific activity} = \frac{\Delta Abx1000xv}{mg\ (Protein)x\Sigma x0.1}$$

Where **ΔAb:** the change in absorbance at 430 nm.

V: extract volume

Σ: Constant equal 2.47 mM-1CM-1

polyphenol oxides was assayed by using photochemical method as described by Hegazy et al. (2004). The increasing in absorption at 420nm was measured by using Pye Unicam SP 1800 spectrophotometer. One unit of enzyme activity is defined as the amount of the enzyme that causes increase of 0.001 absorbance unit per minute at $25^{\circ}C$.

3.9.Statistical analysis:

Data were analyzed statistically using the complete randomized block design mentioned by Sendecor and Chachran (1967).

RESLUTS AND DISCUSSION

1. Persistence of tested insecticides on and in tomato fruits:

Data in Table (1) indicate the residues of chlorpyrifos-methyl, diazinon and phenthoate on and in tomato fruits at different intervals from insecticide application. The initial deposits were1.88, 1.49 and 1.77 ppm, respectively. These amounts were decreased to 1.77, 1.08 and 1.50 ppm after one day from application. These residues were dissipated to different degrees with the time elapsed after 3, 7, 10 and 15 days after insecticides application to reach 0.93, 0.16, 0.10 and 0.005 ppm for chlorpyrifos-methyl, 0.32,0.12, 0.10 and 0.01 ppm for diazinon and 1.21, 0.92, 0.51 and 0.15 ppm for phenthoate, respectively. The data indicate that the disappearance of the residues was found to be slowly, where the percent loss rate amounted to 3.27, 49.18, 91.25, 94.53 and 99.72 % for chlorpyrifos-methyl, 27.52, 78.52, 91.95, 93.28 and 99.32% for diazinon and 15.25, 31.63, 48.02, 71.18 and 91.52 % for phenthoate after 1, 3, 7, 10 and 15 days after insecticides application, respectively. Therefore, the residues half-life values were 3.06, 1.25 and 7.20 days for the three insecticides on and in tomato fruits, respectively. These results are in agreement with AL-Khalaf et al. (1992) who reported that the half-life periods for most organophosphours insecticides were less than 3 days on tomato fruits. El-Bakary et al. (1999) found that the RL_{50} of diazinon and pirimiphos-methyl were 1.33 and 0.75 days. Thabit (2002) reported that the RL_{50} of malathion and fenitrothion on tomato fruits were 16.6 and 43.4 hours.

Table 1. Residues of chlorpyrifos-methyl, diazinon and phenthoate in and on tomato fruits.

Time after application (days)	Chlorpyrifos-methyl		Diazinon		Phenthoate	
	ppm	Loss%	ppm	Loss%	ppm	Loss%
Initial#	1.88	0.00	1.49	0.00	1.77	0.00
1	1.77	3.27	1.08	27.52	1.50	15.25
3	0.93	49.18	0.32	78.52	1.21	31.63
7	0.16	91.25	0.12	91.95	0.92	48.02
10	0.10	94.53	0.10	93.28	0.51	71.18
15	0.005	99.72	0.01	99.32	0.15	91.52
RL_{50} days	3.06		1.25		7.20	

: One hour after application. Each value is the average of three replicates.

The initial deposits of chlorpyrifos-methyl, diazinon and phenthoate on tomato fruits were 1.88, 1.49 and 1.77 ppm, respectively. The percent of loss after one day of application was 3.27, 27.52 and 15.25% for chlorpyrifos-methyl, diazinon and phenthoate, respectively. The levels of insecticide residues were affected by many factors i. e. applied dosage, meteorological factors and biological factors, which depend on the kind and properties of the plants surface and kind of insecticide formulations.

On the other hand, the initial deposits are influenced by different factors, such as evaporation of the surface residue, which is depend on temperature condition, biological dilution which is depend on the increase in size of fruits or enlargement of surface leaves and chemical or biochemical decomposition, metabolism and photolysis.

Data of pesticide residues in treated crops are required for premarket registration of pesticides and for setting maximum residue limits (toxicologically acceptable level) to protect the consumer against the possible health hazards of exposure to pesticides Bates (1979).

According to (C.A.C.) Codex Alimentarius Commission (1997) the maximum residues levels (MRL'S) were 0.5 ppm for chlorpyrifos-methyl and diazinon on tomato fruits. The pre-harvest intervals (Safety period for consumption) were 5 and 2 days for chlorpyrifos-methyl and diazinon on tomato fruits. The safe period of harvesting vegetables treated with the organophosphorus insecticides was ranged between 1 day and 12 days post treatment, which depending on the chemistry of tested insecticide and kind of crops (Shokr 1997 and Shady et al. 2000).

2. Removal of tested insecticide residues from treated tomato fruits by some processes:

The efficiency of washing with tap water and blanching process were evaluated for removing chorpyrifos-methyl, diazinon and phenthoate residues from tomato fruits after one hour and one day of insecticides application.

2.1. Washing with tap water process:

The results in Table (2) show the levels in ppm and the percent of removal of each tested insecticide after treatment by the different processes after one hour and one day of insecticides application.

The results in Table (2) show that chlorpyrifos-methyl, diazinon and phenthoate residues on and in tomato fruits were 1.88, 1.49 and 1.77 ppm after one hour of insecticides application, respectively. These amounts were reduced to 1.64, 1.02, and 1.27 ppm after washing with tap water, respectively. With corresponding percent of removal were 10.38, 31.54 and 28.24 % respectively. While the residues were 1.77, 1.08 and 1.50 ppm after one day of application, these amounts were reduced to 1.22, 0.89 and 1.12 ppm after washing process. With corresponding percent of removal were 31.07, 18.05 and 25.33 % respectively. Ismail et al. (1993) found that washing the tomato fruits removed 15.30 % from profenofos residues. Thabit (2002) reported that washing removed 73, 40 % from malathion and fenitrothion residues on tomato fruits.

2.2. Blanching process:

The results in Table (2) show that the residues of chlorpyrifos-methyl, diazinon and phenthoate on and in tomato fruits were 1.88, 1.49 and 1.77 ppm respectively after one hour of insecticides application. The blanching process reduced these residues to 1.09, 0.78 and 1.05 ppm respectively, with corresponding percent of removal were 40.43, 47.65 and 40.67% after one hour from insecticide application, respectively. While the residue were 1.77, 1.08 and 1.50 ppm for chlorpyrifos-methyl, diazinon and phenthoate respectively. Which reduced to 1.53, 0.54 and 1.17 ppm by blanching process after one day from insecticide application, with corresponding percent of removal were 13.55, 50.00 and 22 % respectively. Ismail et al. (1993) reported that more residues (89%) were removed as the treated tomatoes were processed into tomato juice. Haggag (1994) found that blanching process removed 99, 100 % from hostathion residues from moloukhia leaves and okra fruits, respectively. Abdel-Baki et al. (2000) reported that blanching process removed 30.64 % from pirimiphos-methyl residues on green bean pods.

Table 2. Effect of some different process on certain insecticide esidues in and on tomato fruits, after one hour and one day of spraying.

Time after application	Process	Chlorpyrifos - methyl		Diazinon		Phenthoate	
		Residues		Residues		Residues	
		ppm	%Loss	ppm	%Loss	ppm	%Loss
Tomato fruits after one hour	Unprocessed	1.88	0.00	1.49	0.00	1.77	0.00
	Washed	1.64	10.38	1.02	31.54	1.27	28.24
	Blanched	1.09	40.43	0.78	47.65	1.05	40.67
Tomato fruits after one day	Unprocessed	1.77	0.00	1.08	0.00	1.50	0.00
	Washed	1.22	31.07	0.89	18.05	1.12	25.33
	Blanched	1.53	13.55	0.54	50.00	1.17	22.00

3. Effect of insecticides on the chemical composition of tomato fruits:

3.1. Effect on total carbohydrate contents in tomato fruits:

The results of chlorpyrifos-methyl, diazinon and phenthoate effect on total carbohydrate contents in tomato fruits are show in Table (3). The obtained results show that the amount of carbohydrate contents in tomato fruits in control, chlorpyrifos-methyl, diazinon and phenthoate treatments were 41.52, 44.58, 43.13, 37.76 mg/g fresh weight, respectively. Thabit (2002) found that the tomato fruits contain 3.4, 5 and 3.57 % total carbohydrates. The results referred to no significant effect of chlorpyrifos-methyl and diazinon on total carbohydrate content in tomato fruits compared with control. On the other hand the phenthoate had a significant decreased on total carbohydrate content at all intervals of study Aioub (1997) and Thabit (2002).

Table 3. Effect of tested insecticides on total carbohydrate contents mg/g fresh weight on tomato fruits.

Time after application(days)	Control	Chlorpyrifos-methyl	Diazinon	Phenthoate
Initial#	40.48	45.09	42.94	32.90
1	40.63	65.41	43.06	34.29
3	42.58	40.11	44.22	39.76
7	43.87	40.99	38.42	40.80
10	40.99	39.11	44.97	38.83
15	40.66	36.82	45.17	40.03
Means±SD	41.52±1.38	44.58±10.55	43.13±2.48	37.76±3.32
T Value (calculated)0.05		-0.67	-1.08	3.46*

One hour after application.

Each value is the average of three replicates.

(-Value): significant increased

3.2. Effect on total soluble, reducing and non reducing sugars:

Data in Table (4) show the effect of chlorpyrifos-methyl, diazinon and phenthoate treatment on soluble sugars content. The data indicate that the chlorpyrifos-methyl, diazinon and phenthoate did not show any significant effect on soluble sugars content in tomato fruits. The amounts of soluble sugars were 16.92, 16.07, 15.07 and 18.35 mg/g fresh weight for control, chlorpyrifos-methyl, diazinon and phenthoate, respectively. Data in Table (4) show the chlorpyrifos-methyl and phenthoate have no significant increase on reducing sugars content in tomato fruits. On the other hand, the diazinon had no significant decrease on reducing sugars content. The results in agreement with Thabit (2002). The values of reducing sugars were 5.57, 6.38, 4.46 and 6.40 mg/g for control, chlorpyrifos-methyl, diazinon and phenthoate, respectively. Data in Table (4) show that the three insecticides have no effect on non-reducing sugars content in tomato fruits. The values were 11.36, 9.66, 10.62 and 11.96 mg/g for control, chlorpyrifos-methyl, diazinon and phenthoate, respectively.

3.3. Effect on peroxidase, polyphenol oxidase activities and soluble protein contents:

Data in Table (5) indicate that chlorpyrifos –methyl, phenthoate and diazinon had no significant increase on peroxidase and polyphenol oxidase activities on tomato fruits, also have any significant decreases on soluble protein contents. The results are in agreement with Ismail et al. (1993) and Thabit (2002). The activities of peroxidase were 390.57, 1041.22, 657.41 and 461.25 for control, chlorpyrifos-methyl, diazinon and phenthoate treatment, respectively. Polyphenol oxidase activities were 101.96, 171.40, 260.58 and 211.91 for control, chlorpyrifos-methyl, diazinon and phenthoate treatment, respectively. The soluble protein contents were 9.04, 8.46, 8.49 and 8.73 mg/g fresh weight for control, chlorpyrifos-methyl, diazinon and phenthoate treatment, respectively.

Table 4. Effect of tested insecticides on total soluble sugars, reducing sugars and non-reducing sugars content on tomato fruits (mg/g fresh weight).

Time after application (days)	Control			Chlorpyrifos-methyl			Diazinon			Phenthoate		
	Total soluble	Reducing	Non-reducing	Total soluble	Reducing	Non-reducing	Total soluble	Reducing	Non-reducing	Total soluble	Reducing	Non-reducing
Initial#	21.65	8.12	13.53	19.81	7.79	11.84	15.08	4.93	10.15	17.94	5.17	12.77
1	13.70	4.06	9.64	11.67	3.92	7.75	17.49	4.49	13.00	21.44	7.27	14.17
3	19.42	5.93	13.49	8.48	4.02	4.46	13.66	4.89	8.77	14.21	5.84	8.37
7	17.25	6.36	10.89	19.44	7.36	12.08	11.19	2.98	8.21	19.11	7.54	11.57
10	12.43	4.44	7.99	18.62	7.78	10.84	19.08	5.71	13.37	19.61	6.43	13.18
15	17.11	4.49	12.62	18.39	7.42	10.97	13.93	3.73	10.20	17.81	6.13	11.68
Means±SD	16.92±3.44	5.57±1.54	11.3±2.25	16.06±4.77	6.38±1.87	9.66±2.98	15.0±2.8	4.46±0.96	10.6±2.13	18.35±2.42	6.40±0.88	11.6±2.00
T Value (calculated)0.05				0.36	- 0.98	1.02	0.80	1.44	0.44	- 0.65	-0.94	- 0.48

One hour after application.
Each value is the average of three replicates.
(-Value): significant increased

Table 5. Effect of tested insecticides on specific activity of peroxidase and polyphenol oxidase and soluble protein content (mg/g fresh weight) on tomato Fruits.

Time after application(days)	Control			Chlorpyrifos-methyl			Diazinon			Phenthoate		
	Peroxidase activity	Poly phenol oxidase	Soluble protein	Peroxidase activity	Poly phenol oxidase	Soluble protein	Peroxidase activity	Poly phenol oxidase	Soluble protein	Peroxidase activity	Poly phenol oxidase	Soluble protein
Initial	553.90	124.37	8.04	704.97	155.47	8.04	643.41	244.49	8.18	408.49	117.33	7.93
1	559.72	172.82	8.68	732.46	120.63	8.29	1341.53	297.32	8.45	805.92	644.03	8.54
3	251.46	103.52	9.66	238.95	84.31	11.86	487.78	240.96	8.30	524.65	161.98	9.26
7	371.43	57.34	8.72	3037.46	90.62	10.93	926.16	87.72	8.55	653.74	173.01	8.67
10	299.04	56.81	8.80	974.87	141.64	7.06	506.07	113.64	8.80	121.69	50.09	9.98
15	313.85	96.90	10.32	558.63	433.73	4.59	539.50	579.37	8.63	253.03	124.99	8.00
Mean±SD	391.57± 133.56	101.96± 43.22	9.04± 0.81	1041.22± 1007.22	171.40± 131.63	8.46± 2.63	740.74± 335.46	260.58± 176.12	8.49± 0.22	461.25± 253.49	211.91± 216.06	8.73± 0.78
T Value (calculated)0.05				- 1.56	- 1.21	0.47	-3.25	- 2.37	1.75	- 0.77	- 1.47	0.66

[#] One hour after application.
Each value is the average of three replicates.
(-Value): significant increased

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بقاء متبقيات بعض المبيدات على محصول الطماطم وعلاقتها بعمليات التصنيع والكيمياء الحيوية فى ثمارها

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١- قسم بحوث متبقيات المبيدات وتلوث البيئة- المعمل المركزى للمبيدات

٢- قسم الكيمياء الحيوية-كلية الزراعة - جامعة القاهرة

أجريت هذة الدراسة بهدف دراسة بقاء متبقيات ثلاثة مبيدات فسفورية وهي الكلوربيرفوس- ميثيل و الديازينون و الفينثيويت على محصول الطماطم و ذلك تحت الظروف الحقلية و تم اخذ العينات بعد ساعة من المعاملة،١ ،٣ ،٧ ،١٠ ،١٥ يوم من المعاملة

و يمكن تلخيص النتائج المتحصل عليها كالأتي :-

١- ثبات متبقيات كل من الكلوربيرفوس ميثيل و الديازينون و الفينثيويت على ثمار الطماطم . أوضحت النتائج إن الكمية المتبقية من الكلوربيرفوس ميثيل و الديازينون و الفينثيويت بعد ساعة من المعاملة كانت ١,٨٨، ١,٤٩ ، ١,٧٧ جزء في المليون على التوالي. و كانت فترة نصف العمر لهذه المبيدات ٣,٠٦ ، ١,٢٥، ٠,٢٧ يوم على التوالي. و كانت فترة الأمان للمستهلك١٠ ، ٢ يوم بعد الرش لكل من الكلوربيرفوس مثيل و الديازينون

٢- أوضحت الدراسة أن عملية الغسيل بماء الصنبور لأوراق الملوخية أدت إلى لإزالة ٥٤,٢٢ ، ٦٨,٩٨، ٧١,٨٩ ٪ من متبقيات الكلوزبيرفوس مثيل و الديازينون و الفينثيويت بعد ساعة من المعاملة على التوالي و إزالة. ٧٨,٥٧ ، ٥٤,٥٢ ، ٥٨,٩٨ ٪ من متبقيات هذه المبيدات بعد يوم واحد من المعاملة على التوالي . كما أدت عملية السلق لأوراق الملوخية إلى إزالة ٧٩,٧٤ ، ٧٨,٧١ ، ٩٨,٣ ٪ من متبقيات الكلوربيرفوس مثيل و الديازينون و الفينثيويت بعد ساعة من المعاملة على التوالي. ٨٧,٦٩ ، ٩٩,٩١ ، ٧٣,٧٠ ٪ من هذه المتبقيات بعد يوم واحد من المعاملة على التوالي.

٣- أوضحت النتائج إن كل من المبيدات المستخدمة ليست ذات تأثيرات معنوية على محتوى أوراق الملوخية من الكربوهيدرات الكلية و السكرات الكلية الذاتية و المختزلة و السكرات الغير المختزلة.وكلوروفيل أ و ب و الكلى و لوحظ ان استخدام مبيد الديازينون أدى لحدوث زيادة معنوية فى محتوى أوراق الملوخية من الكلوروفيل أ و ب و الكلى بينما مبيد الفينثيويث أدى الى حدوث نقص معنوى فى محتوى الأوراق من الكلوروفيل الكلى. وأوضحت النتائج إن كل من المبيدات المستخدمة ليست ذات تأثيرات معنوية على محتوى أوراق الملوخية من البروتين الكلى الذائب باستثناء المعاملة بمبيد الكلوربيرفوس مثيل أدت الى حدوث نقص فى محتوى أوراق الملوخية. لم يكن لهذه المبيدات أي تأثيرات على نشاط إنزيم البروكسيديز.