Adverse Effect of Certain Technical and Formulated Pyrethroids on Some Blood Components of Treated Rats

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ABSTRACT

The effect of certain technical and formulated forms of pyrethroids on some blood parameters in rats given single oral dose or repetitive sub-lethal doses of these compounds were investigated. Results showed that cypermethrin in both forms caused significantly increase in glucose concentration in the blood of treated rats. On the other hand, deltamethrin , fenvalerate and cyhalothrin decreased its concentration. These increases or decreases were higher in case of technical pyrethroids than the formulated forms . Treatment of rats with cyhalothrin and cypermethrin increased the haemoglobin content (Hb) in their blood , while treatments with deltamethrin and fenvalerate caused fluctuated effect. Packed cell value (PCV) , haematocrit value, decreased in the blood of rats treated only with repeated doses of cypermethrin , deltamethrin and the formulated form of cyhalothrin . Most of the tested pyrethroids decreased the counts of red blood cells (RBC) and increased the counts of white blood cells (WBC) in the blood of treated rats .Mean cell volume (MCV) increased in the blood of pyrethroid- treated rats. The increase was more pronounced in the fenvalerate treatment. Both forms of tested pyrethroids increased mean cell haemoglobin (MCH) in the blood of treated rats. Furthermore, all of the tested pyrethroids increased mean cell haemoglobin concentration (MCHC) in the blood of treated rats except fenvalerate which decreased it .

INTRODUCTION

The pyrethroids are recognized as the fourth major class of synthetic organic insecticides. Since the commercial production of the first photostable pyrethroid in 1976, this group of compounds has achieved worldwide use with widespread agricultural and environmental health application (Elliot,1980) . These pesticides are usually applied in the formulated form where the active ingredient is mixed with organic solvent, emulsifying and wetting agents to increase their water miscibility and penetration. Pesticide formulation is, therefore, the process of transforming a pesticidal chemical into a product which can be applied by practical methods to permit its effective, safe and economical

use. However, it has been reported that formulation may cause synergism or antagonism to the toxicity of the active ingredients (EL-Sebae,1985 and Abdel-Rahim *et al.*,1994) . Also WHO (1991) has emphasized that the final toxic classification of any pesticide is intended to be by its formulation. Therefore, the aim of the present work was to study the adverse side effect of sub-lethal doses from certain technical and formulated pyrethroids on some haematological parameters in the blood of treated male albino rats.

MATERIALS AND METHODS

Tested insecticides : Cypermethrin (Technical , 91.6 % ; Formulated ,5%EC) , (RS)- α-cyano-3- phenoxybenzyl (1RS,3RS;1RS, 3SR)- 3- (2, 2-dichlorovinyl) –2,2-dimethyl cyclopropane carboxylate ; **Deltamethrin (Technical , 98 % ; Formulated** ,2.5%WP), (S)- α- cyano-3- phenoxybenzyl (1R, 3R) –3- (2,2- dibromovinyl) – 2,2- dimethyl cyclopropane carboxylate, **Fenvalerate (Technical , 92.9 % ; Formulated**,5%EC),(RS)- α- cyano-3-phenoxybenzyl (RS)-2-(4-chlorophenyl)-3- methyl butyrate and **Cyhalothrin (Technical , 95 % ; Formulated** ,2.5 % EC) (S) -α- cyano-3-phenoxybenzyl (Z)- (1R,3R)-3-(2-chloro-3, 3, 3-trifluoroprophenyl)- 2,2-dimethyl cyclopropane carboxylate .

Tested animals :

Three groups of laboratory acclimatized male albino rats, each of 80-90 gm weight, were used in this study as follows:

Rats of the first group were given orally a single dose , each equal to 0.01 LD_{50} from cypermethrin (2.5 a.i. mg/Kg) , deltamethrin (1.4 a.i. mg /Kg) and fenvalerate (4.5 a.i. mg/Kg) and cyhalothrin (0.8 a.i. mg /kg) , using corn oil as a solvent. Rats of the second group were given orally ten repetitive doses each equal to 0.01 LD_{50} of each pyrethroid in corn oil . The treatment was carried out every 48 hours . In the third group (check group) , rats were treated with 0.5 ml oil/kg body weight of corn oil and considered as check .

Collection of blood samples in each group was done after 48 hours from the last treatment.

Measurement of blood constituents :

Blood glucose was measured colourmetrically using the Glucose meter Accutrend alpha apparatus . Complete drop of blood was dropped on to the yellow test pad without touching the yellow mesh directly. The blue color was developed from the reaction between blood glucose and the reagent; Glucose oxidase (1.25 U) , Bis- (2-hydroxy-ethyl)- 4- hydromino-cyclohexa- 2.2 – dienylidiene, ammonium chloride (35.0 μg) ; 2.18-phosphomolybdic acid (191.4 μg) and non-reactive ingredient (8.1 mg) . The color was measured directly with the apparatus, and sugar concentration was read directly as mg/dl from the screen.

Haemoglobin measurment (Hb) was carried out according to Wintrobe method (Wintrobe *et al.*, 1981) . Haemoglobin is first oxidized by potassium ferricyanide into methaemeoglobin, which is converted into cyanomethaemoglobin.The absorbance of produced color was read (A_{sample}) at 450nm using Carlzeiss Jena spectrophotometer. Haemoglobin concentration was calculated as follow :

Haemoglobin concentration (gm/dl) = A_{sample} X 36.77

Where A = sample absorbance .

The haematocrit value (packed cell volume, PCV) was determined using microhaematocrit centrifuge MLW TH21. Haematocrit tubes were contained blood samples and stoppered at one of its end were centrifuged at 12000 r.p.m. for seven minutes . Haematocrit value was obtained by reading the packed cell volume on a special graduated haematocrit measurements. The obtained data were expressed as percentages of haematocrit value to the total blood volume .

Counting of red and white blood cells (RBCs and WBCs) :

Sod. chloride solution, 8.5 % (w/v) , haemocytometer, microscope Novex and red blood count cell micro pipette were used to achieve the counting of red blood cells (RBCs) .

Acetic acid solution , 1.5 % (w/v) , haemocytometer , microscope Novex and WBC count micro pipette were used to achieve the count of white blood cells (WBCs) . RBC and WBC counts were achieved according to the method of Britton (1963) and Seiverd (1964) .

The mean cell volume (MCV), mean cell haemoglobin (MCH) and the mean cell haemoglobin concentration (MCHC) were referred as absolute values. These values were calculated from the results of red blood cell count, haemoglobin concentration and haematocrit value, respectively . These values have been widely used in the classification of anemia .

$$MCV = \frac{\text{\% Haematocrit X 10}}{\text{Number of RBC}} \quad \text{micron}^3 \text{ / red blood cell) .}$$

$$MCH = \frac{\text{Haemoglobin concentration (g/dl) x 10}}{\text{Number of RBC}} \quad \mu g$$

$$MCHC = \frac{\text{Haemogloin concentration (g/dl)}}{\text{\% of haematocrit}} \text{ X 100 (\%)}$$

Statistical analysis for haematological and enzyme studies was carried out using computer program " Statistica " . Statistical design was a factorial CRD (Complete Randomized Design) .

RESULTS AND DISSCUSSION

This study was done to explore the side effect of ceasrtain pyrethroids on some of the haematological parameters in the blood of treated rats .

Blood glucose : Blood glucose may and/or not become elevated as a result of exposure to environmental strissors (Mazeaud *et al* , 1977) . Results in Table (1) show that both treatments with both forms of cypermethrin increased significantly glucose concentration in the blood of treated rats. The percentage of increase ranged from 41.6 to 69.6 % . In contrast , a significant decrease of glucose consentration was found in the blood of cyhalothrin – deltamethrin – and fenvalerate –treated rats. These increases or decreases were higher in case of technical pyrethroids than the formulated ones. Also , the effect of tested pyrethroids was more pronounced in the repetitive doses treatments than in the single oral dose treatments .

Haemoglobin (Hb) content : Data in Table (2) revealed that cyhalothrin and cypermethrin increased the haemoglobin content in the blood of treated rats up to 11.9 -19.6 % . Deltamethin and fenvalerate slightly increased or decreased the haemoglobin concentration .However, there are a significant increase of Hb content in the blood of rats given repetitive doses of formulated deltamethrin and significant decrease in rats given single oral dose of formulated fenvalerate .

Haematocrit value , Packed cell volume (PCV) : Haematocrit value (PCV) is a parameter for determination of the volume of red blood cell. Results in Table (3) show that the tested pyrethroids did not significantly affect the percentage of PCV, except the repetitive dose treatments with both forms of cypermethrin or deltamethrin and the formulated form of cyhalothrin which decreased it with percentages ranged from 10.9 to 25.2 %.

Red blood cells (RBCs) : Data in Table (4) show that treatment of rats with repeated doses of the technical form of cyhalothrin increased significantly the counts of RBCs. Both forms of cypermethrin slightly increase RBCs with a percentage of increase 5.7 and 7.5 % in the single oral dose treatment while treatment of rats with repeated doses from cypermethrin decreased significantly RBCs counts with percentages ranged from 31.5 to 37.1 %. On the other hand, deltamethrin and fenvalerate decreased the RBC counts in the blood of treated rats with a minimum percentage of 13.2 % in deltamethrin single treatment and maximum percentage of 35.9 % in fenvalerate single treatment . In general , treatments with repeated doses from cypermethrin , deltamethrin and fenvalerate were the most effective treatments in the reduction of RBC counts in the treated rats.

White blood cells (WBCs) : As shown in Table (5), counts of white blood cells (WBCs) did not significantly increased in the blood of rats given single oral dose from the tested pyrethroids. However, treatment of rats with repetitive doses from each pyrethroid increased the counts of WBCs up to 142.9 % of control . The increase was more pronounced in the treatments of rats with formulated forms .

Mean cell volume (MCV) : Data in Table (6) revealed that mean cell volume , MCV, increased in the pyrethroid-treated rats, except the repetitive dose treatment with cyhalothrin. The increased in MCV was more significant in the fenvalerate-treated rats.

Mean cell haemoglobin (MCH) : Results recorded in Table (7) show that both forms of tested pyrethroids increased mean cell haemoglobin (MCH) in the blood of treated rats . The significant increases were found in the rats given repetitive doses of both deltamethrin and cypermethrin .

Mean cell haemoglobin concentration (MCHC) : Both treatments of rats with both types of cyhalothrin and cypermethrin and the repetitive dose treatment with deltamethrin caused an increase in mean cell haemoglobin concentration (MCHC) as shown in Table (8) . The percentages of increase ranged from 9.4 to 59.7 %. On the other hand, fenvalerate decreased slightly the MCHC . The percentage of decrease was significant (19.9 %) in the rats given single oral dose treatment with the formulated form .

The previous effect of pyrethroids, decrease and/or increase in glucose concentration , haemoglobin content (Hb) , packed cell volume (PCV) , red blood cells counts (RBCs) , white blood cells counts (WBCs) , mean cell volume (MCV) mean cell haemoglobin (MCH) and mean cell haemoglobin concentration (MCHC) in the blood of pyrethroid-treated rats almost were in agreement in most cases with the results of several authors. Mohamed (1988) found that daily doses of fenvalerate and deltamethrin caused a significant fall in haemoglobin content and a reduction in the number of RBCs, increase in the circulating leukocytes and temporary increase in blood glucose of treated rats . Also , Kadyrova *et al* .(1990) and EL-Bakary (1993) observed increase in sugar content in blood of rats after deltamethrin treatment . Shakoori *et al* (1990) found decrease in erythrocytic, leukocytic counts, PCV, Hb content and an increase in mean cell haemoglobin and mean cell haemoglobin concentration in the blood of rabbits after bifenthrin treatment. Also , a decrease in erythrothyte counts , PCV, Hb concentration and an increase in WBCs , as a result of treatment of male albino rats with cyhalothrin were recorded by Essawy *et al.* (1994) . Saxena (1997) observed decrease in total erythrocyte count , haemoglobin content , haematocrit value , mean cell volume and an increase in MCHC in blood of albino rats after cypermethrin treatment .

No significant changes were recorded in haemoglobin content, haematocrit value and RBCs counts , but the count of WBCs was significantly increased in mice treated with repeated sublethal doses of cypermethrin (EL-Gendy *et al.*, 1999) .

It is clear from the previous results that almost of the different effects , increase or decrease, of tested pyrethroids on the blood components were greater or lesser in the rats given formulated pyrethroids than that given technical ones. These changes may be due to the adjuvants which are added to technical pesticides . These adjuvants may synergized or antagonized the effect of the technical pesticide and/or increase the degree of its absorption from the gastrointestinal tract after oral dosing. Also, the polarity of the formulation molecules has a great effect on pesticide absorption rate and alter the physical properities of the technical pesticides. Therefore, these results suggest that , the adverse side effect of pesticides on the blood components of mammals must be studied not only by using technical pesticides but also by using the formulated pesticides.

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Table 1. *In vivo* effect of tested pyrethroids on glucose concentration in the blood of male albino rats.

Tested Pyrethroids	Glucose concentrations (mg / dl)			
	Formulated	% of Control	Technical	% of Control
Single oral dose				
Check (untreated)	80.5 ± 6.8	100.0	80.5 ± 6.8	100.0
Cyhalothrin	74.3 ± 3.4	92.3	72.0 ± 2.0	89.4
Cypermethrin	114.0 ± 12.0	141.6	123.7 ± 15.0	153.7
Deltamethrin	70.4 ± 11.6	87.5	61.7 ± 9.1	76.6
Fenvalerate	74.5 ± 1.5	92.5	65.5 ± 1.5	81.4
Repetitive dose				
Check (untreated)	74.0 ± 15.0	100.0	74.0 ± 15.0	100.0
Cyhalothrin	20.8 ± 1.0	28.1	20.0 ± 1.2	27.0
Cypermethrin	120.5 ± 6.5	162.6	125.5 ± 5.5	169.6
Deltamethrin	35.0 ± 14.5	47.3	20.0 ± 0.0	27.0
Fenvalerate	37.0 ± 5.5	50.0	23.3 ± 5.8	31.5

Table 2. *In vivo* effect of tested pyrethroids on haemoglobin (Hb) concentration in the blood of male albino rats.

Tested Pyrethroids	Haemoglobin concentration (g / dl)			
	Formulated	% of Control	Technical	% of Control
Single oral dose				
Check (untreated)	16.8 ± 1.9	100.0	16.8 ± 1.9	100.0
Cyhalothrin	18.8 ± 0.4	111.9	20.1 ± 2.4	119.6
Cypermethrin	20.0 ± 0.4	119.1	19.0 ± 1.3	113.1
Deltamethrin	17.0 ± 1.7	101.2	15.8 ± 1.5	94.1
Fenvalerate	14.9 ± 0.3	88.7	16.3 ± 1.7	97.0
Repetitive dose				
Check (untreated)	13.9 ± 2.8	100.0	13.9 ± 2.8	100.0
Cyhalothrin	17.2 ± 2.7	123.7	18.4 ± 1.2	132.4
Cypermethrin	18.0 ± 2.2	129.5	16.6 ± 0.4	119.4
Deltamethrin	18.1 ± 1.7	130.2	13.4 ±1.1	96.4
Fenvalerate	14.8 ± 1.7	106.5	13.4 ± 3.9	96.4

Table 3. *In vivo* effect of tested pyrethroids on haematocrit value, packed cell volume (PCV%), in the blood of male albino rats.

Tested Pyrethroids	Haematocrit value (PCV %)			
	Formulated	% of Control	Technical	% of Control
Single oral dose				
Check (untreated)	33.7 ± 4.9	100.0	33.7 ± 4.9	100.0
Cyhalothrin	36.5 ± 1.3	108.3	35.2 ± 3.3	104.5
Cypermethrin	33.3 ± 3.3	98.8	34.8 ± 4.1	103.3
Deltamethrin	33.7 ± 2.1	100.0	33.8 ± 1.6	100.3
Fenvalerate	37.3 ±1.3	110.7	35.2 ± 2.8	104.5
Repetitive dose				
Check (untreated)	38.5 ± 3.3	100.0	38.5 ± 3.3	100.0
Cyhalothrin	32.3 ± 0.3	83.9	38.8 ± 3.3	100.8
Cypermethrin	34.3 ± 1.5	89.1	28.8 ± 2.0	74.8
Deltamethrin	31.7 ± 1.5	82.3	32.5 ± 2.5	84.4
Fenvalerate	41.0 ± 1.8	106.5	38.8 ± 3.2	100.8

Table 4. *In vivo* effect of tested pyrethroids on red blood cells (RBCs)counts in the blood of male albino rats.

Tested Pyrethroids	RBCs counts (X 10^6 / mm^3)			
	Formulated	% of Control	Technical	% of Control
Single oral dose				
Check (untreated)	5.3 ± 0.2	100.0	5.3 ± 0.2	100.0
Cyhalothrin	5.1 ± 0.4	96.2	5.6 ± 0.4	105.7
Cypermethrin	5.6 ± 0.5	105.7	5.7 ± 0.6	107.5
Deltamethrin	4.6 ± 0.4	86.8	5.6 ± 0.5	105.6
Fenvalerate	4.1 ± 0.8	77.4	3.4 ± 1.4	64.1
Repetitive dose				
Check (untreated)	5.4 ± 0.1	100.0	5.4 ± 0.1	100.0
Cyhalothrin	5.3 ± 0.4	98.1	6.0 ± 0.4	111.1
Cypermethrin	3.7 ± 0.2	68.5	3.4 ± 0.4	62.9
Deltamethrin	4.4 ± 0.11	81.5	4.3 ± 1.4	79.6
Fenvalerate	5.4 ± 0.5	100.0	4.2 ± 0.9	77.8

Table 5. *In vivo* effect of tested pyrethroids on white blood cells (WBCs) counts in the blood of male albino rats.

Tested Pyrethroids	WBCs counts ($X10^3$ / mm^3)			
	Formulated	% of Control	Technical	% of Control
Single oral dose				
Check (untreated)	13.9 ± 1.4	100.0	13.9 ± 1.4	100.0
Cyhalothrin	16.8 ± 0.8	120.9	15.9 ± 1.3	114.4
Cypermethrin	14.1 ± 1.6	101.4	14.0 ± 1.9	100.7
Deltamethrin	13.3 ± 3.0	95.7	14.9 ± 1.8	107.2
Fenvalerate	15.5 ± 2.6	111.5	12.3 ± 0.9	88.5
Repetitive dose				
Check (untreated)	12.6 ± 0.7	100.0	12.6 ± 0.7	100.0
Cyhalothrin	18.0 ± 0.2	142.9	15.3 ± 0.9	121.4
Cypermethrin	15.8 ± 1.1	125.4	13.4 ± 1.7	106.3
Deltamethrin	16.5 ± 1.3	130.9	16.6 ± 0.6	131.7
Fenvalerate	18.0 ± 1.4	142.8	17.2 ± 1.4	136.5

Table 6. *In vivo* effect of tested pyrethroids on mean cell volume (MCV) in the blood of male albino rats.

Tested Pyrethroids	MCV (μ^3 / red blood cell)			
	Formulated	% of Control	Technical	% of Control
Single oral dose				
Check (untreated)	63.6 ± 8.2	100.0	63.6 ± 8.2	100.0
Cyhalothrin	71.6 ± 2.7	112.5	62.9 ± 3.0	98.8
Cypermethrin	59.4 ± 1.0	93.4	61.1 ± 4.5	96.1
Deltamethrin	73.3 ± 5.1	115.2	60.4 ± 4.8	94.9
Fenvalerate	91.0 ± 3.9	143.0	103.5± 3.6	162.8
Repetitive dose				
Check (untreated)	71.3 ± 4.6	100.0	71.3 ± 4.6	100.0
Cyhalothrin	60.9 ± 4.2	85.4	64.7 ± 4.0	90.7
Cypermethrin	95.7 ± 8.6	130.0	84.7 ± 3.8	119.5
Deltamethrin	72.1 ± 1.7	101.1	75.6 ± 1.8	113.3
Fenvalerate	71.9 ± 2.0	100.8	97.6 ± 30.8	136.9

Table 7. *In vivo* effect of tested pyrethroids on mean cell haemoglobin (MCH) in the blood of male albino rats.

Tested Pyrethroids	MCH (µg)			
	Formulated	% of Control	Technical	% of Control
Single oral dose				
Check (untreated)	31.7 ± 4.8	100.0	31.7 ± 4.8	100.0
Cyhalothrin	36.9 ± 2.4	116.3	39.4 ± 3.1	124.3
Cypermethrin	35.7 ± 5.9	112.7	33.8 ± 5.7	105.1
Deltamethrin	37.0 ± 3.8	116.6	28.0 ± 2.2	89.0
Fenvalerate	36.3 ± 0.9	114.6	37.4 ± 1.0	151.2
Repetitive dose				
Check (untreated)	25.7 ± 4.7	100.0	25.7 ± 4.7	100.0
Cyhalothrin	32.5 ± 2.2	126.3	30.7 ± 2.3	119.3
Cypermethrin	48.6 ± 6.4	189.3	48.8 ± 5.8	190.0
Deltamethrin	41.1 ± 7.7	160.1	31.2 ± 7.6	121.4
Fenvalerate	24.8 ± 5.2	96.6	35.2 ± 4.6	137.1

Table 8. *In vivo* effect of tested pyrethroids on mean cell haemoglobin concentration(MCHC) in the blood of male albino rats.

Tested Pyrethroids	MCHC (%)			
	Formulated	% of Control	Technical	% of Control
Single oral dose				
Check (untreated)	49.9 ± 4.2	100.0	49.9 ± 4.2	100.0
Cyhalothrin	51.5 ± 2.3	103.2	57.1 ± 3.1	114.4
Cypermethrin	60.1 ± 1.1	120.4	55.0 ± 6.9	109.4
Deltamethrin	50.4 ± 1.9	101.1	46.6 ± 2.6	93.7
Fenvalerate	39.5 ± 0.5	80.1	46.4 ± 2.9	92.8
Repetitive dose				
Check (untreated)	36.1 ± 4.2	100.0	36.1 ± 4.2	100.0
Cyhalothrin	53.3 ± 1.4	147.5	47.4 ± 3.3	131.4
Cypermethrin	52.5 ± 5.0	145.4	57.6 ± 5.4	159.7
Deltamethrin	57.1 ± 3.0	158.2	41.2 ± 3.2	114.2
Fenvalerate	36.1 ± 5.6	100.0	35.0 ± 2.1	96.9

الملخص العربي

التأثيرات الضارة لبعض المبيدات البيروثرويدية النقية والمجهزة على بعض مكونات الدم في الفئران المعاملة

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تم دراسة التأثيرات الجانبية الضارة لجرعات تحت مميتة من المبيدات البيروثرويدية في صورتها النقية وصورتها المجهزة على بعض مكونات دم الفئران المعاملة بجرعة منفردة واحدة وبجرعات متكررة عن طريق الفم وأوضحت النتائج ما يلي :

١- أن المعاملة بالسيبرمثرين النقي أو المجهز تسببت في حدوث زيادة معنوية في تركيز جلوكوز الدم بينما تسببت المعاملة بالدلتامثرين ، الفينفاليرات و لامدا سيهالوثرين في حدوث خفض معنوي . وكانت الزيادة أو الانخفاض في التركيز أكثر في حالة استخدام المبيدات النقية عن المبيدات المجهزة .

٢- أن المعاملة بالـ لامدا سيهالوثرين والسيبرمثرين تسببت في حدوث زيادة في هيموجلوبين الدم بينما تسببت المعاملة بالدلتامثرين والفينفاليرات إلى حدوث تأثيرات طفيفة بالزيادة أو النقص في تركيز الهيموجلوبين .

٣- تسببت المعاملة المتكررة بالسيبرمثرين والدلتامثرين والصورة المجهزة من لامدا سيهالوثرين إلى حدوث انخفاض في حجم الدم المعبأ .

٤- أن المعاملة بمعظم المبيدات البيروثرويدية تسببت في حدوث انخفاض في عدد كرات الدم البيضاء .

٥- تسببت المعاملة بالبيروثرويدات إلى حدوث زيادة في حجم كرات الدم الحمراء وكان أكثر المبيدات تأثيرا هو مبيد الفينفاليرات .

٦- تسببت المعاملة بالبيروثرويدات في حدوث زيادة في متوسط هيموجلوبين الخليـــة وكذلـك تسببت في حدوث زيادة في النسبة المئوية لمتوسط تركيز هيموجلوبين الخلية في الفئران المعاملة بجميع صور البيروثرويدات ماعدا مبيد الفينفاليرات التي تسببت في خفضها .

وأوضحت نتائج البحث أن البيروثرويدات المختبرة بصورتها النقية والمجهزة تســبب فــي جــدوث تأثيرات بالزيادة أو النقص في مكونات الدم المختبرة وفي معظم المعاملات وجد أن التأثيرات كانت أكــثر معنوية في حالة المعاملة المتكررة بالجرعات التحت مميتة من هذه المبيدات عن المعاملة بالجرعة المنفردة منها كما وأن التأثيرات تكون أعلى أو أقل في حالة المعاملة بالمبيدات المجهزة عن المبيدات النقية ، لذا فإن من نتائج البحث ممكن القول بأنه لابد من اختبار التأثيرات الضارة للمبيدات المجهزة حتى تعطي صـــورة حقيقية عما تحدثه هذه المبيدات عند استعمالها في مكافحة الآفات .