THE INDUCTIVE EFFECTS OF SOME AGROCHEMICALS ON THE ACTIVITIES OF CERTAIN ENZYMES IN *TETRANYCHUS URTICAE*

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ABSTRACT

The activity of certain enzymes (under the same conditions previously used for evaluating the inductive effect a lag period of 48 hrs.) was determined in order to figures out the mechanism of such effects. The percent of increase or decrease of the enzymes activities were determined either when a single application of agrochemicals was conducted or when mites were pre-exposed to inducers. In case of single application of tested agrochemicals, the data reflected that, with few exceptions, a general trend of inductive was noticed but with different ratios. Moreover, this inductive effect seemed to be non specific. In other words, no single compound caused the same level of induction on all tested enzymes. In term of figures, The highest recorded percentage of increase were; 83.7 , 78.0, 89.4, 76.7, 80.0 and 350 corresponding to fenpyroximate, feric. boron, zinc, manganese and zinc on AChE, acid phosphatase, alkaline phosphatase, GOT, GPT and non specific esterase, respectively.

In case of testing the effect on enzymes prepared from mites pre-exposed to inducers the results showed a general positive and unique trend of tested micronutrients for elevating the activity of all the tested enzymes but varied in their magnitude. Moreover, the data reflected that all tested herbicides could be considered, in general, moderate inducers since they increased moderately the activity of all bioassay enzymes. The only exception was their effects on the activity of alkaline phosphatases, which fluctuated between inhibitors to activators. Data clearly indicated that there is no apparent correlation between the observed acaricidal activity and the recorded elevation of enzymes activities.

INTRODUCTION

It is well known that, there is large number of foreign compounds which have shown to increase the activities of some enzyme systems that catalyzed the metabolism of xenobiotics in various animal species including man. This process of increased activity of these enzyme systems on exposure to chemicals is referred to as enzyme induction.

Elevated levels of glutathione S-transferases (GSTs) play a major role as a mechanism of resistance to insecticides and acaricides in resistant pest insects and mites, respectively. Such compounds are either detoxicated directly via phase I metabolism or detoxicated by phase II metabolism of metabolites as formed by microsomal monooxygenases (**Nauen and Stumpf, 2002**). The effect of several acaricides on the enzyme activity of recombinant glutathione S-transferase (rGST) was studied. Some acaricides (ethion. amitraz. chlorpyrifos, DDT, cypermethrin, diazinon, ivermectin, deltamethrin and flumethrin) inhibited rGST. Contrarily, coumaphos had an activating effect. Although the accurate mechanisms of the *B. microplus* resistance to acaricides remain elusive, this work helps in understanding how acaricides can interact with GST (**Itabajara, *et al.* 2004 and Molin and Mattsson 2008**)

The number of compounds known to induce the activity of these enzymes is large including drugs, insecticides. polycyclic hydrocarbons and many others. It has also become apparent that, even though all inducers do not have the same effects, the effect tend to be nonspecific to the extent that any single inducer may induce more than one enzymatic activity (**Hodgson and Levi, 1997**).

The metabolism of toxicants and their overall toxicity can be modified by many factors functioning of the organism. It is entirely possible that many changes in the toxicity are due to changes in metabolism. However, among the many extrinsic factors are agrochemicals particularly herbicides and metallic fertilizers that, affect the metabolism of xonobiotics.

Therefore, the current study was carried out to throw a bean of light on the role of some agrochemical such as herbicides, acaricides and micronutrients, as inducers for acetylcholine esterase (AchE), acid and alkaline phosphatases, transaminases (i.e. GOT and GPT) as well as non specific estrases in the carmine spider mite. *Tetranychus uriticae* (Koch)

MATERIALS AND METHODS

1. Tested organisms (*Tetranychus urticae*):

A strain of the mite *T. urticae* (Koch) was collected from infested leaves of castor bean plants grown in the experimental farm of Sakha.

Agricultural Research, Kafr El-Sheikh. This strain was reared under optimum laboratory conditions according to **Dittrich *et al.*, (1981)**

2.Agrochemical used:

2.a. Acaricides:

- Propargite(68%) Bromite: 2-[4-(1,1-dimethylethyl) phenoxy] cyclohexyl 2-propynyl sulfite. A formulated sample (68% E.C.) was supplied by uniroyal for chemical Company U.S.A.
- Propargite(73%) Comite: 2-[4-(1,1-dimethylethyl) phenoxy] cyclohexyl 2-propynyl sulfite. A formulated sample (73% E.C.) was supplied by uniroyal for chemical Company U.S.A.
- Fenpyroximate: 1,1-dimethylethyl(*E*)-4-[(1.3-dimethyl-5-phenoxy-1*H*-pyrazol-4-yl) methyl-ene] amino]oxy]methyl] benzoate. A formulated was (5% suspension concentrate) supplied by Nihon Nohyaku Company Tokyo-Japan.
- Dicofol (Kelthane): 2,2,2- trichlor-1,1-bis (4-chloro-phenyl) ethanol. A formulated sample (18.5% E.C.) was supplied by Rohm and Haas Company.
- Bromopropylate (Noeron): Isopropyl 4,4- dibromo-benzilate. A formulated sample (50% E.C.) was supplied by Ciba-Gaigy AG-Egypt.

2.b. Inducers:

2.b.1. Herbicides:

- Flumeturon (Cotoran): *N,N*-dimethyl-*N'*-[3-(trifluoromethyl) phenyl]urea. A formulated sample (50% E.C.) was supplied by Ciba-Gaigy AG-Egypt.
- Fluazifop (Fusilade): (*RS*)-2-[4-(5-(trifluoromethyl)-2-pyridyloxy) phenoxy]propionic acid. A formulated sample (12.5% E.C.) was supplied from Manufacture Zeneca.
- Haloxyfop Gallant: (*RS*)-2-[4-(3-chloro-5-(trifluoromethyl)-2-pyridyloxy) phenoxy] propionic acid. A formulated sample (12.5% E.C.) was supplied from (DowElanco)
- Oxyfluorfen (Goal): 2-chloro-1-(3-ethoxy-4-nitrophenoxy)-4-(trifluoromethyl)benzene. A formulated sample (24 % E.C.) was supplied from Manufacturer Rohm and Haas.

- Pendimethalin (Stomp): *N*-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine. A formulated sample (24 % E.C.) was supplied from American Cyanamid Company.

2. b.2.Micronutrients chelates:

- Fe-chelate: contains 12% ferric in the form of EDTA (ethylene diamine tetra acetic acid). A sample was supplied from El-Naser Company for feltilizer and pesticides.
- Mn-chelate: contains 12% manganese in the form of EDTA (ethylene diamine tetra acetic acid). A sample was supplied from Ciba- Geigy.
- Zn-chelate: contains 14% zinc in the form of EDTA (ethylene diamine tetra acetic acid). A sample was supplied from Ciba-Geigy.
- Boron: NaB2O7 the rate of application is 200g/200 liter water/fed

3- Biochemical studies:

It is apparent from the extensive reviews that induction is a complex, non specific and relatively as slower process **(Hoagland, 1989).** However, our previous data indicated that the peak of inductive effect under laboratory conditions was noticed when a lag period of 48 hours was permitted. Thus, the activity of certain enzymes under the same conditions was determined in order to figures out the mechanism of such effect. In other words, the assays of certain enzymes were carried out in mite homogenate prepared from mites either being exposed to any of the tested acaricides or inducers (herbicides or micronutrients) alone or being exposed to the tested acaricides after being exposed to the inducer by 48 hours.

3.1. Evaluation of some agrochemicals as inducers:

Some herbicides. Flumeturon, Fluazifop, Haloxyfop, Oxyfluorfen and Pendimethalin) as well as some micronutrients currently used as fertilizers (ferric, manganese, zinc and boron) were chosen as inducers to evaluate their toxicity on *T urticae* under lab. Conditions at five concentrations levels. Data showed that all of them could be considered non-toxic to adult females of *T urticae*. So, the least level (1/16 of the recommended rate) of these inducers, was used on the following treatments.

For evaluating the inductive effect of any inducer, adult females of *T urticae* were exposed first to sublethal concentration (1/16) of each of the tested inducers then after certain intervals of time (24, 48 or 72 hours) they were re-exposed to the LC_{25} of the acaricide.

3.2. Quantitative determination of some enzymes activities:

To determination the activity of certain enzymes, the following procedures were used as follows: **Van Aspren (1962)** for non-specific esterases, **Ellman *et al.*, (1961)** for A cetylcholine esterase (AchE), **Moss (1984)** for acid phosphatase, **Kind and King (1954)** for alkaline phosphatase and **Reithman and Frankel (1957)** for Glutamic-oxalo acetic transaminase GOT (AST) and Glutamic-pyruvic transaminase GPT (ALT).

The specific activities was calculated according to the following equation:

$$\text{Specific activity} = \frac{\text{Absolute activity in a desird homogemate volume}}{\mu\text{g protein in the same homogenate volume}}$$

RESULTS AND DISCUSSION

Some ageochemicals (acaricides, herbiciudes and micronutrients) were bioassayed for their effects on the specific activity of some enzymes in order to figure out the mechanisms of induction responsible for increasing or decreasing the acaricidal activity against *T. urticas*. The assays were carried out in mite homogenate prepared from mites either being exposed to any of tested acaricides or inducers (herbicides or micronutrients) alone or being re-exposed to the tested acaricides after being exposed to the inducer by 48 hours.

I. Effect of some agrochemicals applied alone on certain enzyme activities of mites:

I.1. Effect on non-specific esterases:

The effect of different agrochemicals on the enzyme-activity was evaluated and the data are presented in Table (1). It is quite clear to notice that all tested agrochemicals had a general trend of induction but varied in their magnitude. However, the tested micronutrients proved to be the superiors in this respect. The obtained percentages of increase were 350, 214.3, 192.9 and 157.1 % for zinc, manganese, ferric, and boron, respectively.

Among the tested acaricides, dicofol had the most inductive effect with a percentage of increase equal to 111.8 followed by propargite(68%), bromopropylate and fenpyroximate with values of 100, 82.4 and 76.5 respectively.

Concerning the effect of herbicides on the activity of non-specific esterases, the results showed that Oxyfluorfen had the most inductive effect followed by Flumeturon with values of 189.5 and 157.9%, respectively. The other tested herbicides showed slight inductive effects ranged between 15.8-36.8 %.

Careful observation of all forementioned results, one can noticed that the tested micronutrients proved to induce the activity of all tested enzymes as compared with the other tested agrochemicals. However, the only exception was their mild effects on AChE. Moreover, tested herbicides could be considered, in general, moderate inducers as they increased-moderately the activity of all tested enzymes. The only exception was their effects on the activity of alkaline phosphatase which fluctuated between inhibitory and inductive effects. However, the inductive effects of the tested acaricides varied according to the tested enzyme. Moreover, they proved to induce apparent activity of both AChE and non-specific esterases. On the other hand, a general inhibitory effect (with few exceptions) was noticed in case of the other bioassayed enzymes.

I.1. Effect on acetyl choline esterase:

The specific activity as well as the percent of increase or decrease of acetyl choline esterase activity after 48 hours of application are presented in Table (1). It is quite clear that, apart of Haloxyfop, all tested agrochemicals increased acetyl choline esterase activity by different ratios.

Based on the percent increase in enzyme-activity, it was noticed that the most pronounced effect was obtained in case of the acaricide fenpyroximate with an percent of increase of 83.67%; while propargite (68%) had, the least inductive effect (10.2%).

It is of interest to mention that there is a significant difference between the inductive effect of propargite (68%) (10.2) and comite (34.7) in spite of having the same chemical structure. This might be due to the difference in their formulations including the additive materials, surfactants, solvents and others which might affect the enzyme activity.

Concerning the tested herbicides, it was quit clear that, with the exception of Haloxyfop (which gave an inhibitory effect), a general inductive effect was noticed. The most inductive effect was noticed in case of fusalide treatment (70%) while the least one was noticed in case of flumeturon treatment (25%).

As for the tested micronutrients, positive inductive effect were also found with all tested micronutrients. Zinc was the most effective (50% increase) while the other elements gave so close effects (38.3-40%). With respect to tested herbicides, the data showed that, a part of Haloxyfop, all tested agrochemicals increased the specific activity of AChE with different levels. This trend of results might be expected since most of tested herbicides are polycyclic hydrocarbons and are not specific for acting on AChE as a specific target as did most organophosphorus and carbamates compounds. This result agreed fully with the previous finding of El-Deeb (1989) who stated that all tested inducers (acaricides, herbicides and fertilizers containing metals; iron, manganese and zinc) caused an increase in the AChE activity accompanied by a decrease in its sensitivity to the inhibition by methomyl *in vivo*.

I.3. Effect on acid phosphatase:

Concerning the inductive effect of tested agrochemicals, it is quite clear that most of treatments caused inductive effects (Table 1). The most pronounced effect was noticed when mites were treated by the chelating form of ferric (+78%) while the least induction occurred in case of manganese chelate treatment (+7%). Concerning the effect of tested acaricides on the activity of acid phosphatase. the data revealed that both of propargite (68%) and propargite(73%) inspite of having the same chemical structure but they differed significantly in their inductive effects. Their recorded values were. 18.75 and +55%. respectively. This significant difference might be due to the difference in their formulations. On the other hand, the other tested acaricides gave a slight inhibition to the activity of the acid phosphatase. as their percentage of inhibition were: 8.25, 18 and 5 for fenpyroximate. dicofol and neoron, respectively.

As for the tested herbicides. it is quite clear that Haloxyfop was the only herbicide which gave a slight inhibitory effect with a percentage value of 5%. The other tested herbicides gave percentage of inhibition ranged between 35-50%.

In general, the highest inductive effects were noticed in case of tested micronutrients. Among them ferric-chelate treatment exhibited the highest value (78%) while the least on was obtained in case of manganese (7%).

I.4. Effect on alkaline phosphatase:

Apart of the micronutrients the data presented in Table (1) confirmed the fact that the phenomenon of enzyme induction is not specific since most of the compounds which showed significant inductive effects on acid phosphatase caused an inhibitory effect against alkaline phosphatase.

It is of great interest to mention that among tested agrochemicals, micronutrients could be considered as specific ligands for enzyme induction since they induced the activity of broad spectrum enzymes; Acetyl choline esterase, acid phosphatase, alkaline phosphatase, GOT, GPT and non specific esterases. The data also revealed that, among micronutrients treatments, alkaline phosphatase was induced more apparently by boron (89.38%) than by other tested micronutrients. However, the inductive effects of the different micronutrients could be arranged in the following descending order: Boron > Ferric > Manganese > zinc.

Concerning the tested acaricides, propargite(73%) was the only compound that gave a pronounced inductive effect with a percentage of 61.73. On the other hand, propargite(68%) (which has the same chemical structure of propargite(73%)) inhibited effect of alkaline phosphatase activity. However, the difference in their formulations, which included the additive materials, solvents, surfactants..., etc., might be behind the contradiction of their effects on alkaline phosphatase activity. Moreover, this result reemphasized the previous finding that the induction of enzyme activity is a complex and nonspecific process. However, such difference might explain the significant difference between the acaricidal toxicity of propargite(73%) and propargite(68%) to mites as mentioned before.

As for dicofol and bromopropylate, the results showed that both acaricides caused significant inhibition to alkaline phosphatase. Their recorded values were: 65 and 45%, respectively.

Reviewing the data of the tested herbicides (Table 1), it could be fairly concluded that Flumeturon was the only compound that increased alkaline phosphatase activity with a percentage of 84 9%. On the other hand Haloxyfop caused a drastic inhibition to the same enzyme (-58.49%). However, the other tested herbicides had no significant effect in this respect.

I.5. Effect on GOT (AST):

Data in Table (1) showed that with the exception of Dicofol and Bromopropylate, all tested agrochemicals increased the activity of GOT enzyme. The most inductive effect (76.65) was noticed when mites were exposed to 1/16 of the recommended concentration of the micronutrient, zinc. On the other hand, the least inductive effect was recorded in case of manganese-chelate (4.06%).

Comparing the obtained percentages of increase that are recorded for the tested acaricides, one can noticed that Feripyroximate was the only compound that had an apparent inductive effect with a percentage of increase equal to 65.3%. On the other hand, the two acaricides; Dicofol and Bromopropylate gave an inhibitory effects on the transaminase GOT. Their corresponding percentages of inhibition were -34.3 and -25%, respectively.

Concerning the effect of tested herbicides as inducers, the data clearly indicated that all tested herbicides proved to induce GOT but at different ratios. The most inductive effect was exhibited by Flumeturon (70.1%), while the least inductive effect was recorded with Pendimethalin which had an increase value of 18.1 % compared with the untreated mites.

As for the micronutrients, the results revealed that with the exception of manganese-chelate, all tested elements caused significant induction to GOT-activity and there corresponding percentages of increase were 76.65, 58 and 57.5% for Zn, boron and Fe-chelate, respectively.

I.6. Effect on GPT (ALT):

Table (1) summarized the specific activity of the transaminase enzyme; GPT as well as the calculated percent of increase or decrease in the enzyme-activity as being affected by a single application of any compound of the tested agrochemicals. In general, it could be concluded that the tested micronutrients had the most pronounced inductive effects on the activity of GPT. The obtained percentages of increase were 80, 70, 60.2 and 42 for manganese, ferric, zinc and boron, respectively.

As for the tested herbicides, a slight or a moderate inductive effect was noticed with all tested compounds except flumeturon which increased the activity of GPT by 60%. The tested acaricides differed significantly in their effects on GPT. Their effects varied completely between inhibitory and inductive effect. dicofol, propargite(68%) and

Propargite(73%) inhibited GPT with values of 50.3, 32 and 11.76%, respectively. On the other hand, both of Feripyroximate and Bromopropylate induced GPT by 40.1 and 15.7%, respectively.

II. Effect of tested acaricides on the specific activity of certain enzymes prepared from mites pre-exposed to inducers:

The enzymatic activities were bioassayed in mites homogenate prepared from individuals being exposed first to 1/16 of the recommended concentration of the inducer (herbicide or micronutrient) followed by a subsequent exposure to LC25 of any tested acaricide after 48 hrs.-interval in between. The enzymatic preparations were carried out 48-hrs. after the last treatment according to the results of previous bioassay done under laboratory conditions. The results are presented in Tables (2, 3 and 4).

II.1. Effect on non-specific esterases:

The specific activity as well as the expected and observed percent increase or decrease of non-specific esterases activity after 48 hrs of application are listed in Table (2). Careful reviewing of these results, it could fairly concluded that, all micronutrients as inducers potentiate significantly the activity of non-specific esterase. Within herbicides Pendimethalin showed antagonistic effects with all tested acaricides against the activitv of non specific esterases. On the other hand, Fluazifop was the only herbicide that potentiate significantly the activity of the aforementioned enzyme when being used before all tested acaricides.

There is significant differences between the observed and the expected activity of most treatments. In term of figures, the expected activity of Flumeturon + Dicofol treatment is, 269.7% while the observed value is 7.14%. In many cases particularly in case of the interactions of Pendimethalin with all tested acaricides, the expected values are positive while the observed values are negative. These findings re-emphasized that the phenomenon of induction is not a simple process but it is a rather complex one.

Table (1): The Specific activity and % increase or decrease of tested enzymes in *T. urticae* after treatments

Treatments	Application rate (ppm)	Specific activity and % increase or decrease of tested enzymes											
		AchE		Acid phos*		Alk. Phos**		GOT (AST)		GPT (ALT)		Non specific esterase	
		S.A.	%I.	S.A.	%I.	S.A.	%I.	S.A.	%I.	S.A.	%I.	S.A.	%I.
1- Acaricides	LC_{25}												
Propargite(68%)		0.54	+10.2	0.38	+18.8	0.08	-67.4	2.03	+18	0.23	-32	0.34	+100
Propargite(73%)		0.66	+34.7	0.50	+55	0.39	+61.7	1.94	+13	0.30	-11.8	0.23	+35.3
Fenpyroximate		0.90	+83.7	0.29	-8.3	0.26	+8	2.84	+65.3	0.48	+40.1	0.30	+76.5
Dicofol		0.73	+48.5	0.26	-18	0.08	-65	1.13	-34.3	0.17	-50.3	0.36	+111.8
Bromopropylate		0.67	+36.1	0.30	-5	0.13	-45	1.29	-25.1	0.39	+15.7	0.31	+82.4
Control		0.49	-	0.32	-	0.24	-	1.72	-	0.34	-	0.17	-
2- Herbicides	1/16F												
Flumeturon		1.49	+25.5	0.66	+35	0.98	+84.9	2.93	+70.1	0.67	+60	0.49	+157.9
Fluazifop		0.20	+70	0.71	+45.5	0.49	-7.5	2.60	+51.2	0.48	+15.1	0.23	+21.1
Haloxyfop		0.71	-40	0.47	-5	0.22	-58.5	2.33	+35.3	0.51	+21.3	0.22	+15.8
Oxyfluorfen		1.61	+40.3	0.66	+35.2	0.51	-4.5	2.50	+45.2	0.46	+10.3	0.55	+189.5
Pendimethalin		1.96	+65.0	0.74	+50	0.54	+1.9	2.03	+18.1	0.53	+27	0.26	+36.8
Control		1.19	-	0.49	-	0.53	-	1.72	-	0.42	-	0.19	-
3- micronutrients	1/16F												
Fe-chelate		1.13	+38.3	0.57	+78.0	2.7	+68.6	2.71	+57.5	0.6	+70	0.41	+192.9
Mn-chelate		1.14	+39.1	0.34	+7.0	1.97	+23.1	1.79	+4.1	0.38	+80	0.44	+214.3
Zn-chelate		1.23	+50	0.53	+63.6	1.66	+3.8	3.04	+76.7	0.56	+60.2	0.63	+350.0
Boron		1.14	+40	0.51	+59.0	3.03	+89.4	2.72	+58.0	0.50	+42	0.36	+157.1
Control		0.82	-	0.32	-	1.60	-	1.72	-	0.35	-	0.14	-

F = Field application rate, S.A. = Specific activity, %I. = % increase or decrease, Acid phos* = Acid phosphatase, Alk. Phos** = Alkaline phosphatase, % Increase or decrease in the activity of tested enzyme=((S.A of enzyme in treatment – S.A in control) / S.A in control)*100.

II.2. Effect of tested acaricides on the specific activity of acetyl choline esterase:

The specific activity as well as the expected and observed percent increase or decrease of acetyl choline esterase activity after 48 hours of application are presented in Table (2). Careful observation of the obtained results indicated that although all treatments caused significant elevation of AChE activity but the interaction between the different inducers and tested acaricides differed considerably from one treatment to another.

In other words, some of these interactions i.e. (Flumeturon + Propargite(68%)), (Flumeturon + Bromopropylate), (Fluazifop + Propargite(68%)), (Fluazifop + Propargite(73%)), (Fluazifop + Fenpyroximate) and (Fluazifop + Dicofol) resulted in additive effect. Other interactions i.e. (Fluazifop + Bromopropylate), (Oxyfluorfen + Dicofol) in addition to all Haloxyfop + acarides interactions resulted in pronounced potentiation to the AChE activity. On the other hand, other treatments i.e. (Flumeturon + Feripyroximate), (Flumeturon + Dicofol), (Pendimethalin + Feripyroximate) and (all Zn-chelated + acaricides) interactions caused significant decrease to AChE activity.

II.3. Effect of tested acaricides on the specific activity of acid phosphatase:

Based on the inductive effects of tested compounds, one can noticed that all treatments caused pronounced inductive effects and increased the activity of acid phosphatase (Table 3). Again the observed inductive effects re-emphasized that the interactions between the inducers and the tested acaricides differed from antagonistic effect (i.e. Haloxyfop + Propargite(68%). Boron + Propargite(68%). Boron + Propargite(73%) and Fe-chelated + Propargite(73%)) to additive effect (i.e. Flumeturon + Fenpyroximate. Haloxyfop + Feripyroximate, Haloxyfop + Bromopropylate. and Fe-chelated + Bromopropylate), and in most cases the interaction resulted in very pronounced activation (i.e. Flumeturon + Propargite(68%). Flumeturon + Bromopropylate, Fluazifop + Dicofol and Pendimethalin + Dicofol).

It is of great interest to mention that neither the inducers nor the acaricides had a specific trend of interaction. In other words, Boron for instance increased the activity of acid phosphatase when being used before Feripyroximate and Dicofol while it caused antagonistic effects when being applied before Propargite(68%), Propargite(73%) and Neoron.

II.4. Effect on alkaline phosphatase:

Data presented in Table (3) revealed that Flumeturon, Pendimethalin, Boron and Fe-chelate potentiate the activity of alkaline phosphatase when being interacted with all tested acaricides. Moreover, the magnitude of activation was more than 1 folds in case of Fe-chelated + Bromopropylate treatment. The data also showed that both Propargite(68%) and Propargite(73%) caused significant antagonistic effect to the activity of alkaline phosphatase when being used after Fluazifop, Haloxyfop, Oxyfluorfen, Mn-chelated and Zn-chelated. On the other hand, the other tested acaricides showed significant activation to alkaline phosphatase activity when being used after the previously mentioned inducers.

It is of great interest to mention that inspite of the single application of each of Bromopropylate, Fluazifop, Haloxyfop and Oxyfluorfen exhibited antagonistic effects to alkaline phosphatase activity when being used separately (Table 1) but the interaction of each of Fluazifop. Haloxyfop and Oxyfluorfen with Bromopropylate resulted-in significant activation of alkaline phosphatase activity (Table 3). This result confirmed the fact that the phenomenon of enzymeinduction is a complex process and the inducer have a biphasic effect.

II.5. Effect on GOT (AST):

The specific activity as well as the percent increase or decrease of GOT prepared from mites exposed first to some inducers then re-exposed to the tested acaricides were determined and the data are presented in Table (4). It is quite clear that all treatments resulted in increasing the activity of GOT with respect to the untreated control. Comparing between the expected and observed activity, it could be fairly concluded that the magnitude of activation is almost more than additive effect in most treatments. However, in few cases the observed activity was less than the expected ones, i.e. (Flumeturon + Feripyroximate), (Fusalide + Propargite(68%) or Propargite(73%)), (Haloxyfop + Fenpyroximate) and (Oxyfluorfen + Fenproximate). The results also revealed that inspite of the single application of both Dicofol and Bromopropylate decreased the activity of GOT (Table 1) but their interaction with all tested inducers resulted in pronounced activation of GOT enzyme (Table 4).

II.6. Effect on GPT (ALT):

The specific activity of GPT as well as the calculated percent activity are summarized in Table (4). It is quite clear that apart of the interaction treatments of Pendimethalin and Feripyroximate or Bromopropylate, all treatments resulted in significant increase in the activity of the transaminase enzyme; GPT. The data also revealed that Flumeturon could be considered the most effective inducer when being used before all tested acaricides. In addition the interaction of Flumeturon with Propargite(68%) or Propargite(73%) caused, in general, the highest inductive effects with percentages of increase amounted to 439.21 and 331.37%, respectively.

The activity of enzyme systems in various animal species including man can be markedly increased by exposure to a large number of drugs, pesticides, and indstrial chemicals. This process, is referred to as enzyme induction. There is no consistent structural relationship between the compounds capable of bringing about induction. The major features these compounds have in common is that they are lipid soluble and generally have a relatively long half-life in the animal species in which they act as an inducer **(Hodgson and Levi, 1997)**. However, the current results showed a general positive and unique trend of tested micronutrients for elevating the activity of all tested enzymes but varied in their magnitude. It is of great interest to mention that all evaluated enzymes in this study are not metalo-depending enzymes. Therefore, the induction of these enzymes should be occurred indirect. This might be done either through regulating the pH of the enzyrne-media. initiation of vital process and or being essential for the incorporation of some vital components. However. our results agreed with the previous finding of many investigators. **Yusof et al., (1992)** showed that the induction of ornithine decarboxylase was induced by metal ions in mammals organs. **Morre *et al.* (1984)** stated that gel electrophoresis showed that there- was increased incorporation of label gamma "P-ATP into protein bonds following auxin-treatment. Stimulation of incorporation was given by diglyceride with Ca which increased protein kinase activity in other systems. Moreover. **Petrie *et al.* (1996)** investigated the loss of creatine kinase induction in Zn-deficient cultures of myoblasts resulted from direct effect on enzyme induction or was a consequence of an inability of the cells to enter the differentiation pathway in the absence of Zn. Selenium was a key cellular anti-oxidant and it was known that the requirement for this element increased the induction of the cytochrome

P450 systems (**Braganza *et al.*, 1988**). Moreover, **El-Deeb (1989)** reported that the elemental composition of the tested fertilizers especially iron, manganese and zinc were of critical concern in the biological activity of Spodoptera littoralis enzymes. The addition of metal ions to peptidases, amidases and phosphatases greatly increased the catalytic activity of these enzymes **(Lehninger, 1950).**

The current data also revealed that all tested herbicides could be considered, in general, moderate inducers since they increased the activity of all bioassayed enzymes moderately. The only exception was their effects on the activity of alkaline phosphatase which fluctuated between decreasing to increasing effect. This trend of results agreed with the previous finding of **Joshi and Tewari (1980)** who showed that male adult albino mice when being injected intera peritoneally with 5 mg/kg of simazine, level of glutamate oxaloacetate transaminase (GOT) decreased, but levels of glutamate pyruvate transaminase (GPT) increased in liver. Levels of GOT increased in kidney, while alkaline phosphatase levels were significantly decreased in both brain and liver. Albino rats fed P and a.-BHC (Lindane) for 2 weeks increased the activities of alkaline phosphatase and SGPT and decreased in serum acid phosphatase activity in serum **(Srinivasan and Radhakrishnamurty, 1980).** On the other hand, **El-Deeb (1989)** showed that all tested inducers caused sever inhibition to both acid and alkaline phosphatases.

Concerning the effect of the different herbicides (as inducers) on the activity of tested acaricides to adult females of *T urticae* the data revealed that Fluazifop and Pendimethalin were almost the most potent inducers. This result confirmed the previous findings of El-Deeb (1989) who stated that all tested herbicides had almost a potentiating effect on all tested insecticides but to a great extent in case of Pendimethalin.

Although the phenomenon of enzyme induction had been reported by many investigators, but the question raised in mind is to what extent the elevation of enzyme activity correlated with the acaricidal efficiency.

Table (2): The specific activity and the expected and observed percent of increase or decrease on non-specific esterase and AchE in *T. urticae* (Koch.) after different treatments

Treatments		Non-specific esterase			Acetyl choline esterase		
Conc. (1/16 F)	Conc. (LC_{25})	S.A.	%increase or decrease		S.A.	%increase or decrease	
			Observed	Expected*		Observed	Expected*
Flumeturon	Pro.	0.16	+14.30	+257.9	0.32	+39.13	+35.7
	Propa.	0.17	+21.43	+193.2	0.29	+25.96	+60.2
	Fen.	0.16	+14.29	+234.4	0.32	+37.43	+109.2
	Dicofol	0.15	+7.14	+269.7	0.34	+46.52	+74.0
	Brom.	0.11	-21.43	+240.3	0.35	+52.17	+61.6
Fluazifop	Pro.	0.40	+185.71	+121.1	0.42	+83.87	+80.2
	Propa.	0.36	+157.14	+56.4	0.44	+92.13	+104.7
	Fen.	0.58	+314.29	+97.6	0.62	+169.57	+153.7
	Dicofol	0.38	+171.43	+132.9	0.50	+117.39	+118.5
	Brom.	0.50	+257.14	+103.5	0.64	+177.34	+106.1
Haloxyfop	Pro.	0.02	-85.71	+115.8	0.35	+50.04	-29.8
	Propa.	0.06	-57.14	+51.1	0.30	+29.73	-5.3
	Fen.	0.36	+157.14	+92.3	0.61	+162.48	+43.7
	Dicofol	0.34	+142.86	+127.6	0.34	+48.09	+8.5
	Brom.	0.20	+42.86	+98.2	0.39	+69.74	-3.9
Oxyfluorfen	Pro.	0.45	+221.43	+289.5	0.30	+31.04	+50.5
	Propa.	0.51	+264.29	+224.8	0.29	+27.78	+75.00
	Fen.	0.15	+7.14	+266.0	0.47	+104.30	+124.0
	Dicofol	0.08	-42.86	+301.3	0.55	+138.69	+88.8
	Brom.	0.77	+464.29	+271.9	0.46	+98.88	+76.4
Pendimethalin	Pro.	0.10	-26.43	+136.8	0.63	+172.26	+75.2
	Propa.	0.11	-21.43	+72.1	0.56	+143.65	+99.7
	Fen.	0.09	-35.71	+113.3	0.42	+84.39	+148.7
	Dicofol	0.08	-42.86	+148.6	0.61	+163.04	+113.5
	Brom.	0.10	-26.43	+119.2	0.55	+138.65	+101.1
Boron	Pro.	0.52	+271.40	+257.1	0.41	+78.65	+50.2
	Propa.	0.42	+200.0	+192.4	0.32	+37.39	+74.7
	Fen.	0.19	+35.71	+233.6	0.49	+1113.04	+123.7
	Dicofol	0.32	+128.57	+268.9	0.31	+33.48	+88.5
	Brom.	0.16	+14.29	+239.5	0.44	+90.82	+76.1
Fe-chelate	Pro.	0.24	+71.43	+292.9	0.38	+67.17	+48.5
	Propa.	0.33	+135.71	+228.2	0.44	+92.22	-73.0

Table (2): Continues.

Treatments		Non-specific esterase			Acetyl choline esterase		
Conc. (1/16 F)	Conc. (LC_{25})	S.A.	%increase or decrease		S.A.	%increase or decrease	
			Observed	Expected*		Observed	Expected*
Fe-chelate	Fen.	0.63	+350.00	+269.4	0.46	+102.13	+122.0
	Dicofol	0.30	+114.30	+204.7	0.49	+113.04	+86.8
	Brom.	0.43	+207.14	+275.3	0.42	+83.91	+74.4
Mn-chelate	Pro.	0.23	+64.28	+314.3	0.52	+126.90	+49.3
	Propa.	0.19	+35.71	+249.6	0.59	+158.00	+73.8
	Fen.	0.29	+107.14	+290.8	0.50	+177.39	+122.8
	Dicofol	0.22	+57.14	+326.1	0.47	+105.52	+87.6
	Brom.	0.70	+400.00	+296.7	0.57	+150.00	+75.2
Zn-chelate	Pro.	0.17	+21.43	+450.0	0.33	+42.04	+60.2
	Propa.	0.20	+42.86	+385.3	0.27	+18.78	+84.7
	Fen.	0.28	+100.00	+426.5	0.42	+83.82	+133.7
	Dicofol	0.16	+14.29	+461.8	0.30	+30.20	+98.5
	Brom.	0.20	+42.86	+432.4	0.38	+66.74	+86.1
Control		0.14			0.23		

Pro. = Propargite(68%), Propa. = Propargite(73%), Brom. = Bromopropylate, Fen. = Fenpyroximate, F = Field application rate, S.A. = Specific activity O.D/mg proten. *The expected percent of enzyme activity is the algebral some of the percent increase or decrease value obtained from the effect of each of the inducer and the acaricide (in each treatment) when being applied alone

Table (3): The specific activity and the expected and observed percent of increase or decrease of acid phospatase and alkaline phosphatase in *T. urticae* (Koch.) after different treatments

Treatments		Acid Phosphatase			Alkaline Phosphatase		
Conc.(1/16 F)	Conc. (LC_{25})	S.A.	%increase or decrease		S.A.	%increase or decrease	
			Observed	Expected*		Observed	Expected*
Flumeturon	Pro.	0.71	+217.23	+53.8	0.39	+121.48	+17.5
	Propa.	0.58	+159.73	+90.0	0.40	+128.38	+146.6
	Fen.	0.30	+34.45	+26.7	0.44	+148.44	+92.9
	Dicofol	0.41	+82.46	+27.0	0.18	+1.70	+19.9
	Brom.	0.49	+117.58	+30.0	0.23	+28.32	+39.9
Fluazifop	Pro.	0.45	+101.38	+64.3	0.11	-37.53	-74.9
	Propa.	0.60	+168.32	+100.5	0.11	-40.70	+54.2
	Fen.	0.43	+92.48	+37.2	0.27	+50.36	+0.5
	Dicofol	0.62	+173.64	+27.5	0.33	+84.00	-72.5
	Brom.	0.54	+142.28	+40.5	0.28	+59.13	-52.5

Table (3): Continues

Treatments		Acid Phosphatase			Alkaline Phosphatase		
Conc.(1/16 F)	Conc. (LC_{25})	S.A.	%increase or decrease		S.A.	%increase or decrease	
			Observed	Expected*		Observed	Expected*
Haloxyfop	Pro.	0.23	+2.15	+13.8	0.10	-41.04	-125.9
	Propa.	0.23	+3.45	+50.0	0.11	-38.38	+3.2
	Fen.	0.35	+58.47	+53.5	0.40	+126.11	-50.5
	Dicofol	0.53	+135.17	+130.2	0.13	-24.48	-123.5
	Brom.	0.26	+17.36	+12.4	0.30	+68.40	-103.5
Oxyfluorfen	Pro.	0.33	+48.81	+54.0	0.06	-67.21	-71.9
	Propa.	0.40	+77.63	+90.2	0.5	-70.66	+57.2
	Fen.	0.39	+74.63	+26.9	0.24	+34.59	+3.5
	Dicofol	0.41	+81.21	+17.2	0.28	+57.26	-69.5
	Brom.	0.42	+87.47	+30.2	0.25	+40.30	-49.5
Pendimethalin	Pro.	0.69	+210.56	+68.8	0.35	+98.69	-65.5
	Propa.	0.61	+170.0	+105.0	0.33	+83.72	+63.6
	Fen.	0.24	+5.95	+41.7	0.38	+113.28	+9.9
	Dicofol	0.48	+115.26	+32.0	0.18	+3.79	-63.1
	Brom.	0.97	+333.60	+45.0	0.19	+7.85	-43.1
Boron	Pro.	0.25	+11.32	+67.8	0.49	+178.68	+22.0
	Propa.	0.24	+7.29	+114.0	0.46	+161.39	+151.1
	Fen.	0.73	+227.96	+50.7	0.30	+68.29	-97.4
	Dicofol	0.42	+87.47	+41.0	0.38	+112.89	+24.4
	Brom.	0.23	+4.78	+54.0	0.27	+52.29	-44.4
Fe-chelate	Pro.	0.25	+13.15	+96.8	0.44	+150.19	+1.4
	Propa.	0.26	+15.66	+133.0	0.31	+76.37	-130.5
	Fen.	0.45	+102.42	+69.7	0.38	+115.49	-76.8
	Dicofol	0.38	+71.63	+60.0	0.41	+131.38	+3.8
	Brom.	0.36	+61.35	+73.0	0.63	+254.44	+23.8
Mn-chelate	Pro.	0.47	+110.16	+25.3	0.12	-30.41	-44.3
	Propa.	0.41	+87.06	+62.0	0.17	-6.27	-84.8
	Fen.	0.61	+175.12	-1.3	0.39	+119.39	-31.1
	Dicofol	0.41	+85.59	-11.0	0.40	+127.13	-41.9
	Brom.	0.51	+126.35	+2.0	0.51	+186.99	-21.9

Table (3): Continues

Treatments		Acid Phosphatase			Alkaline Phosphatase		
Conc.(1/16 F)	Conc. (LC_{25})	S.A.	%increase or decrease		S.A.	%increase or decrease	
			Observed	Expected*		Observed	Expected*
Zn-chelate	Pro.	0.36	+59.37	+82.4	0.17	-1.13	-63.6
	Propa.	0.36	+62.19	+118.6	0.12	-13.76	+65.5
	Fen.	0.74	+232.70	+55.3	0.38	+115.97	+11.8
	Dicofol	0.62	+180.58	+45.6	0.51	+187.28	-61.2
	Brom.	0.29	+30.25	+58.6	0.17	-2.43	-41.2
Control	0.224			0.177			

Pro. = Propargite(68%), Propa. = Propargite(73%). Brom. = Bromopropylate, Fen. = Fenpyroximate, F = Field application rate. S.A. = Specific activity O.D/mg proten. *The expected percent of enzyme activity is the algebral some of the percent increase or decrease value obtained from the effect of each of the inducer and the acaricide (in each treatment) when being applied alone

Table (4): The specific activity and the expected and observed percent of increase or decrease of GPT and GOT *T. urticae* (Koch.) after different treatments

Treatments		GPT			GOT		
Conc.(1/16 F)	Conc. (LC_{25})	S.A.	%increase or decrease		S.A.	%increase or decrease	
			Observed	Expected*		Observed	Expected*
Flumeturon	Pro.	2.75	+439.21	+28.0	1.74	+118.68	88.1
	Propa.	2.20	+331.37	+47.3	1.70	+106.81	83.1
	Fen.	0.95	+86.27	+100.1	1.11	+35.04	135.4
	Dicofol	1.22	+139.22	+9.7	1.42	+72.75	35.8
	Brom.	0.95	+86.27	+75.7	1.26	+53.28	45.0
Fluazifop	Pro.	0.95	+86.27	-16.9	0.94	+14.36	69.2
	Propa.	0.90	+76.47	-2.4	1.00	+21.65	64.2
	Fen.	1.75	+243.14	+55.2	2.1	+155.47	116.5
	Dicofol	0.86	+68.62	-35.2	1.53	+86.13	16.9
	Brom.	1.77	+247.06	+30.8	1.18	+43.55	26.1
Haloxyfop	Pro.	0.60	+17.64	-10.7	1.20	+45.99	53.3
	Propa.	0.63	+23.53	+8.6	1.10	+33.82	48.3
	Fen.	0.78	+52.94	+61.4	1.17	+42.35	101.6
	Dicofol	0.65	+27.45	-29.0	1.50	+82.48	1.0
	Brom.	0.71	+39.22	+37.0	2.00	+143.31	10.2
Oxyfluorfen	Pro.	1.90	+272.50	-21.7	1.15	+39.90	63.2
	Propa.	1.51	+194.12	-2.4	2.10	138.60	58.2
	Fen.	0.67	+31.38	+50.4	1.01	+22.87	110.5

Table (4): Continues

Treatments		GPT			GOT		
Conc.(1/16 F)	Conc. (LC_{25})	S.A.	%increase or decrease		S.A.	%increase or decrease	
			Observed	Expected*		Observed	Expected*
Oxyfluorfen	Dicofol	0.66	+29.41	-40.0	1.87	127.49	10.9
	Brom.	1.25	+145.09	+26.0	1.82	121.41	20.1
Pendimethalin	Pro.	1.11	+117.65	-5.0	1.50	+82.48	36.1
	Propa.	1.38	+170.59	+14.3	1.00	+21.65	31.1
	Fen.	0.22	-56.86	+67.1	1.34	+55.72	83.4
	Dicofol	0.52	+1.96	-23.3	1.31	+59.37	-16.2
	Brom.	0.39	-23.53	+42.7	1.41	+70.32	-7.0
Boron	Pro.	1.51	+198.00	+10.0	1.57	+78.0	+76.0
	Propa.	1.05	+105.88	+30.24	1.62	+83.67	+71.0
	Fen.	0.92	+80.39	+82.1	1.66	+88.21	+123.3
	Dicofol	0.76	+49.02	-8.3	1.61	+82.54	+23.7
	Brom.	0.87	+70.59	+57.7	1.57	+77.80	+32.9
Fe-chelate	Pro.	1.41	+176.47	+38.0	1.67	+89.34	+75.5
	Propa.	1.4	+280.39	+82.7	1.96	+122.2	+70.5
	Fen.	0.92	+80.39	+110.1	1.25	+41.72	+122.8
	Dicofol	1.62	+217.64	+19.7	1.33	+50.79	+23.2
	Brom.	0.97	+90.20	+85.7	1.33	+50.79	+32.4
Mn-chelate	Pro.	1.65	+223.53	+48.0	2.97	+216.33	+22.1
	Propa.	1.99	+290.19	+67.3	2.87	+225.39	+17.1
	Fen.	1.35	+164.71	+120.1	2.04	+131.29	+69.4
	Dicofol	1.36	+166.67	+29.7	1.84	+108.61	-30.2
	Brom.	1.91	+274.50	+95.7	1.84	+108.61	-21.0
Zn-chelate	Pro.	1.65	+223.53	+28.2	1.48	+68.18	+94.7
	Propa.	1.90	+272.55	+47.5	1.42	+60.99	+89.7
	Fen.	1.35	+164.71	+100.3	1.91	+116.55	+142.0
	Dicofol	1.36	+166.67	+9.9	0.89	+1.14	+42.4
	Brom.	1.91	+274.51	+75.9	0.93	+5.44	+51.6
Control		0.51			6.88		

Pro. = Propargite(68%), Propa. = Propargite(73%), Brom. = Bromopropylate. Fen. = Fenpyroximate, F = Field application rate, S.A. = Specific activity O.D/mg proten. *The expected percent of enzyme activity is the algebral some of the percent increase or decrease value obtained from the effect of each of the inducer and the acaricide (in each treatment) when being applied alone

To answer this question, the acaricidal potency (as percentage mortality) of all tested compounds as well as percent elevation or inhibition of the bioassayed enzymes is recorded in Tables (5 and 6). Precise investigation of these data, one can noticed that there is no apparent correlation between the observed mortality and the percent increase or decrease of the activity of all bioassayed enzymes. In other words, comparing between Propargite(68%) and Fenpyroximate (Table, 5), it is quite clear that both acaricides showed an equal toxic effect against *T urticae* but their levels of AChE-induction, for instance, varied significant (more than 8 times). Moreover. both acaricides contradicted in their effects on the activity of GPT as Propargite(68%) showed an inhibitory effect while Feripyroximate gave an inductive effect. However, this trend of contradiction between the observed mortality and the level of induction or inhibition of the bioassayed enzymes, was quite pronounced with most tested agrochemicals either applied alone (Table, 5) or in pairs in which the inducer was applied first followed by the acaricide after 48-hrs. interval in between (Table 6). These results re-emphasize that the level of increase in the specific activity of all evaluated enzymes was not proportional in all cases with the acaricidal potency indicating that other factor(s) could be responsible for the acaricidal efficiency and/or the bioassayed enzymes are not the targets or behind the metabolizing processes of such compounds. EI-Deeb (1989) stated that the level of decrease in the specific activity of AChE was not proportional in all cases with methomyl potentiation suggesting other factors than AChE are responsible for methomyl resistance in *Spodoptera littoralis* larvae. No differences were found in AChE activity in susceptible and resistant larvae of *Heliothis virescens* (F.), although there were substantially higher levels of non-specific esterase activity in resistant insect (**Whitten and Bull, 1970**). Moreover, **Kansouh *et al.* (1981)** investigated the activity of alkaline phosphatase in larvae of susceptible, Metacil-resistant and fenitorothion-resistant strains of S. littoralis. They found that the alkaline phosphatase in susceptible strain was only slightly higher than in the resistant strains, leading to the conclusion that this enzyme was not a major defence mechanism in the resistant strains of *S. littoralis*.

The data also revealed that all tested inducers do not have the same effects, the effects tend to be non-specific to the extent that any single inducer could induced more than one enzymatic activity and in some cases. the inducer have biphasic effects (inhibition and induction). In term of figures. Fenpyroximate showed pronounced induction and elevated the activities of AChE. GOT. and non-specific esterases with activity values of 83.7, 65.3 and 76.5%, respectively (Table 4). At the same time, it caused an inhibitory effect on acid phosphatase (Table 5). The same trend of results were also observed with most tested herbicides as inducers (Tables 5 and 6). The foregoing results agreed fully with the finding of many investigators **(Perry et al., 1971; Davison and Sell, 1972; Fawade and Galdhar, 1980; Joshi and Tewari, 1980; El-Deeb, 1989 and Archana and Nath 1995)**. However, from the practical point of view, one should be careful on selecting the proper inducer, since the effect differed according to the specific compound, the target enzyme and time of application.

Table (5) Toxicity of sublethal concentrations* of different agrochemicals to adult females of *T. urticae* as well as their effects on the activity of bioassayed enzymes

Agrochemicals	% M (48 hrs)	Increase or decrease in the activity of bioassayed enzyme-system					
		AChE	Acid Phosph.	Alkaline Phosph.	GOT	GPT	non-specific esterases
Pro.	22.0	+10.2	+18.8	-67.4	+18.0	-32.0	+100
Propa.	19.0	+34.7	+55.0	+61.7	+13.0	-12.7	+53.3
Fen.	22.0	+83.7	-8.3	+8.0	+65.3	+40.1	+76.5
Dicofol	20.0	+48.5	-18.0	-65.0	-34.3	-50.3	+111.8
Brom.	23.0	+36.1	-5.0	-45.0	-25.1	+15.7	+82.4
Flumeturon	4.4	+25.5	+35.0	+84.9	+70.1	+60.0	+157.9
Fluazifop	2.5	+70.0	+45.5	-7.5	+51.2	+15.1	+21.1
Haloxyfop	2.1	-40.0	-5.0	-58.5	+35.3	+21.3	+15.8
Oxyfluorfen	6.0	+40.3	+35.2	-4.5	+45.2	+10.3	+189.5
Pendimethalin	6.7	+65.0	+50.0	+1.9	+18.1	+27.0	+36.8
Boron	4.2	+40.0	+59.0	+89.4	+58.0	+42.0	+157.1
Fe-chelate	4.0	+38.3	+78.0	+68.8	+57.5	+70.0	+192.9
Mn-chelate	4.7	+39.1	+7.0	+23.1	+4.1	+80.0	+214.3
Zn-chelate	5.1	+50.1	+63.6	+3.8	+76.7	+60.2	+350.0

Pro. = Propargite(68%), Propa. = Propargite(73%), Brom. = Bromopropylate, Fen. = Fenpyroximate *sublethal concentration = LC_{25} in case of tested acaricides and 1/16 of the recommended field rate in case of both tested herbicides and micronutrients.

The current data also showed that it has been particularly difficult to ascribe mechanism to these interactions or to discern structure - function relationship among the tested agrochemicals. In other words, Fluazifop and Pendimethalin were almost the most potent inducers inspite of the chemical structure of Fluazifop is bicyclic molecule while Pendimethalin is mono cyclic. On the other hand, Oxyfluorfen was the least effective inducer inspite of being a polycyclic herbicide. This result confirmed the previous finding of **Neal et al., (1986)** who stated that, there is no consistent structural relationship between the compounds capable of bringing about induction. However, **El Deeb (1989)** mentioned that polycyclic aromatic hydrocarbons induced specific alterations in enzyme activity with simultaneous qualitative change in the spectral characteristics of cytochrome P450.

It is of interest to mention that the phenomenon of induction was not only contributed to chlorinated hydrocarbon compounds, since Pendimethalin which is a free-chlorine hydrocarbon herbicide gave higher effect than Oxyfluorfen which is polycyclic hydrocarbon having one chlorine atom in its structure. Moreover, Boron which is a non-organic and free-chlorine inducer elevated the activity of all bioassayed enzymes and considered the superior one for activating the activity of alkaline phosphatase.

Exposure of animals and arthropods to sublethal doses of organic .compounds including drugs, insecticides, herbicides and agrochemicals was found to exert enzyme- induction for many enzyme-systems e.g. transaminases (**Joshi and Tewari, 1980; Anadon *et al.*, 1988**), acid and alkaline phosphatases (**Fawada and Galdhar, 1980; Joshi and Tewari, 1980; Srinivasan and Radhakrishnamurty, 1980; and El-Deeb, 1989**), non specific esterases (**Whitten and Bull, 1970; Georghious *et al*, 1975; Salem *et al.*, 1979; Munir *et al.*, 1983 and ElDeeb, 1989**), and glutathion-S-transferases (**Ottea and Plapp, 1984; Cohen, 1986; Wedleigh and Yu, 1987; Carrillo *et al.*, 1990; and Synder *et al.*, 1995**).

Table (6) Inductive effect of the sublethal concentrations* of inducers on the efficiency of tested acaricides and the activity of bioassayed enzymes

Agrochemicals	% M (48 hrs)	Increase or decrease in the activity of bioassayed enzyme-system					
		AChE	Acid Phosph.	Alkaline Phosph.	GOT	GPT	NSE
Flumeturon+Propargite(68%)	60.0	+39.13	+217.23	+121.48	+111.68	+439.21	+14.30
Flumeturon+Propargite(73%)	69.6	+25.96	+159.73	+128.38	+106.81	+331.37	+21.43
Flumeturon + Fenpyroximate	90.4	+37.43	+34.45	+148.44	+35.04	+86.27	+14.29
Flumeturon + Dicofol	82.3	+46.52	+82.46	+1.69	+72.75	+139.22	+7.14
Flumeturon+Bromopropylate	81.6	+52.17	+117.58	+28.32	+53.28	+86.27	-21.43
Fluazifop + Propargite(68%)	70.7	+83.87	+101.38	-37.53	+14.36	+86.27	+185.71
Fluazifop + Propargite(73%)	91.9	+92.13	+168.32	-40.70	+21.65	76.47	+157.14
Fluazifop + Fenpyroximate	82.2	+169.57	+92.48	+50.36	+155.47	+243.14	+314.29
Fluazifop + Dicofol	79.4	+117.39	+173.64	+84.00	+86.13	+68.62	+171.43
Fluazifop + Bromopropylate	90.9	+177.34	+142.28	+59.13	+43.55	+247.06	+257.14
Haloxyfop+ Propargite(68%)	64.8	+50.04	+2.15	-41.04	+45.99	+17.64	-85.71
Haloxyfop+ Propargite(73%)	80.0	+29.73	+3.45	-38.38	+33.82	+23.53	-57.14
Haloxyfop+ Fenpyroximate	89.0	+162.48	+58.47	+126.11	+42.35	+52.94	+157.14
Haloxyfop + Dicofol	75.0	+48.09	+135.17	-24.48	+82.48	+27.45	+142.86
Haloxyfop + Bromopropylate	80.6	+69.74	+17.36	+68.40	+143.31	+39.22	+42.86
Oxyfluorfen+Propargite(68%)	59.3	+31.04	+48.81	-67.21	+39.90	+272.5	+221.43
Oxyfluorfen+Propargite(73%)	59.0	+27.78	+77.63	-70.66	+138.6	+194.12	+264.29
Oxyfluorfen + Fenpyroximate	67.9	+104.30	+74.63	+34.59	+22.87	+31.38	+7.14
Oxyfluorfen + Dicofol	56.7	+138.69	+81.21	+57.26	+127.49	+29.41	-42.86
Oxyfluorfen+Bromopropylate	60.0	+98.88	+87.47	+40.30	+121.41	+145.09	+464.29
Pendimethalin+Propargite(68%)	68.6	+172.26	+210.56	+98.69	+82.48	+117.65	-26.43
Pendimethalin+Propargite(73%)	91.2	+143.65	+170.00	+83.72	+21.65	+170.59	-21.43
Pendimethalin + Fenpyroximate	79.3	+84.39	+5.95	+113.28	+55.72	-56.86	-35.71

Table (6) Continues

Agrochemicals	% M (48 hrs)	Increase or decrease in the activity of bioassayed enzyme-system					
		AChE	Acid Phosph.	Alkaline Phosph.	GOT	GPT	NSE
Pendimethalin + Dicofol	80.6	+63.04	+115.26	+3.79	+59.37	+1.96	-42.86
Pendimethalin+Bromopropylate	91.2	+138.65	+333.60	+7.85	+70.32	-23.53	-26.43
Boron + Propargite(68%)	77.18	+78.65	+11.31	+178.68	+78.0	+198.0	+271.4
Boron + Propargite(73%)	65.57	+37.39	+7.29	+161.39	83.67	+105.88	+200.0
Boron + Fenpyroximate	84.24	+113.04	+227.9	+68.29	+88.21	+80.39	+35.71
Boron + Dicofol	70.21	+33.48	+87.9	+112.89	+82.54	+49.02	+128.57
Boron + Bromopropylate	88.46	+90.82	+4.78	+52.29	+77.80	+70.59	+14.29
Fe-chelated+Propargite(68%)	44.37	+67.17	+13.15	+150.19	+89.34	+176.47	+71.43
Fe-chelated+Propargite(73%)	62.09	+92.22	+15.66	+76.37	+122.22	+280.39	+135.74
Fe-chelated+Fenpyroximate	67.83	+102.13	+102.42	+115.49	+41.72	+80.39	+350.0
Fe-chelated+Dicofol	70.00	+113.04	+71.63	+131.38	+50.79	+217.64	+114.30
Fe-chelated+Bromopropylate	69.23	+83.91	+61.65	+254.44	50.79	+90.20	+207.14
Mn-chelated+Propargite(68%)	72.65	+126.9	+110.16	-30.41	+216.33	+223.53	+64.28
Mn-chelated+Propargite(73%)	85.31	+158.0	+87.1	-6.77	+225.39	+290.19	+35.71
Mn-chelated+Fenpyroximate	58.43	+117.39	+175.12	+119.39	+131.29	+164.71	+107.14
Mn-chelated+Dicofol	65.31	+105.52	+85.59	+127.13	+108.61	+166.67	+57.14
Mn-chelated+Bromopropylate	71.55	+150.0	+126.35	+186.99	+108.61	+274.50	+400.0
Zn-chelated+Propargite(68%)	60.33	+42.04	+59.37	-1.13	+68.18	+223.53	+21.43
Zn-chelated+Propargite(73%)	67.90	+18.78	+62.19	-13.76	+60.99	+272.55	42.86
Zn-chelated+Fenpyroximate	80.00	+83.82	+232.7	+115.97	+116.55	+164.71	+100.0
Zn-chelated+Dicofol	67.35	+30.2	+180.58	+187.28	+1.13	+166.67	+14.29
Zn-chelated+Bromopropylate	67.18	66.74	+30.25	-2.43	+5.44	++274.51	+42.86

NSE: Non specific esterases *sublethal concentration = 1/16 of the recommended field rate in case of both tested herbicides and micronutrients.

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الملخص العربي

تقيم بعض الكيماويات الزراعية (مبيدات الحشائش والخصبات المحتوية على عناصر معدنية) على نشاط بعض الانزيمات فى العنكبوت الاحمر

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اجريت الدراسة بغرض القاء الضوء على دور بعض المركبات الزراعية كمبيدات الحشائش والمخصبات المحتوية على عناصر معدنية كمحفزات لبعض الانزيمات وعلاقة ذلك بالفعل السام لبعض المبيدات الاكاروسية المستخدمة فى مكافحة العنكبوت الاحمر. وقد اسفرت النتائج عن الاتى:-

أ- تاثير المعملات المنفردة:

اوضحت النتائج انه باستثناء بعض الحالات البسيطة فانه يمكن القول ان هناك اتجاه عام لوجود فعل تحفيزى للمركبات المختبرة على جميع الانزيمات تحت الدراسة ولكن بنسب مختلفة. أظهرت جميع المخصبات المختبرة تحفيز نشاط الانزيمات المختبرة برغم ان جميع هذه الانزيمات لا تحتوى فى تركيبها على اى عنصر مما يدل على ان التاثير التحفيزى لنشاط الانزيمات يتم بطريقة غير مباشرة. أظهرت جميع مبيدات الحشائش تاثير تحفيزى معتدل لنشاط الانزيمات. يختلف التاثير التحفيزى حسب نوع الانزيمات والمادة المحفزة فمثلا مبيد الفينبيروكسيمات اعطى نسبة لتحفيز نشاط انزيم الاسيتايل كولين استراز (+٨٣,٧) بينما الحديد اعطى اعلى نسبة تحفيز لنشاط انزيم الفوسفاتيز الحامضى (+٧٨) اما عنصر الزنك فقد احدث اعلى تحفيز لكل من الـ GOT ، الاستريز غير المتخصص بقيم ٧٦,٧ ، ٣٥٠ على الترتيب. ومن الجدير بالذكر ان عنصر المنجنيز الذى اظهر تاثير تحفيزى ضعيف لنشاط جميع الانزيمات الا انه كان اكثر العناصر تحفيزا لانزيم الـ GPT بقيمة قدرها (+٨٠).

ب – تاثير المعاملات المزدوجة (الناتجة من التعرض للمحفز اولا ثم المبيد).

أوضحت النتائج حدوث زيادة فى نشاط الانزيمات المحفزة نتيجة استخدام المواد المحفزة ولكن بنسب متفاوته وكانت المخصبات المعدنية بصفة خاصة اكثر تاثيرا من مبيدات الحشائش. أوضحت النتائج عدم وجود علاقة بين التاثير التحفيزى للانزيمات تحت الدراسة وزيادة السمية مما يدل على ان زيادة السمية قد ترجع الى بعض الانزيمات الاخرى او الى اسباب اخرى غير مباشرة. برغم ان مبيدات الحشائش المستخدمة اظهرت تاثير تحفيزى متوسط لنشاط الانزيمات الا ان استخدام كل من الفيوزاليد او الجول (مبيدات حشائش) ، المنجنيز او الزنك (مخصبات) قبل استخدام مبيد البروميت او الكوميت ادى الى حدوث تثبيط لنشاط انزيم الفوسفاتيز القاعدى.