EVALUATION OF SOME AGROCHEMICALS AS INDUCERS AFFECTING THE EFFICIENCY OF SOME ACAROIDS AGAINST *T. URTICAE* UNDER LABORATORY AND FIELD CONDITIONS

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ABSTRACT

The current study was carried out to evaluate the role of some agrochemicals (herbicides and micronutrients chelates) as inducers affecting the efficiency of certain acaricides against *T. urticae* under lab and field conditions. The data showed that Fenpyroximate under lab conditions was superior in its effect with LC_{50} of 3.75 ppm, while Bromidte and Kelthane had the lowest effect with LC_{50} values of 13.5 and 11 ppm, respectively. Evaluation of the same acaricides under field conditions (using the recommended rate) revealed that all acaricides were more effective in reducing the population density of *T. urtica* moreover, Fenpyroximate, Bromite and Comite were proved to be superior in their effect for controlling *T. urticae* while, Kelthane was the least effective compound.

It was noticed that all herbicides and micronutrients induced the toxic effect of the tested acaricides and this effect had its peak when the period between the application of the inducer and the acaricide was 48 hrs. the main difference between the action of herbicides and micronutrients was that herbicides can considered as inducer at all the tested intervals, while, with the micronutrients there was not any affect when the interval was 24 hrs. In general it was found that goal was the least effectively inducer with all tested acaricides, while Fusilade and Stomp were the most superior in this respect. As for the efficiency of micronutrients as inducers, the data revealed that based on the calculated inductive indexes values, boron could be considered the most effective inducer will all the tested acaricides except Comite whereas, iron was the least nutrient in this respect. The indexes are 95-37, 87.48, 84.92 and 77.75 for boron,manganese, zinc and ferric respectively.

Concerning the evaluation of tested inducers under field conditions, the obtained results showed that all inducers potentiated the tested acaricides particularly at 24 and 48 hrs. intervals one should be

careful on selecting the proper inducer, since the effect differed according to the specific compound and time of application. From the practical point of view, the obtained percent of reduction are quite enough to be used particularly when acaricides are used in an integrated pest management programme.

INTRODUCTION

It is well known that there is a large number of foreign compounds have been 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. A symposium in 1965 and a landmark review by Conney in 1967 established the importance of induction in xenobiotic interactions. Since then, it has become clear that this phenomenon is widespread and nonspecific.

It has also become apparent that, even though not all inducers have the same effects, the effects tend to be nonspecific to the extent that any single inducer may induce more than one enzymatic activity (**Hodgson and Levi 1997**). In addition, some inducers, such as Phenobarbital, were found to have a general effect, while others, such as the polycyclic hydrocarbons, induced a much narrow range of enzyme activities (**Hodgson and Tate 1971**).

The metabolism of toxicants and their overall toxicity can be modified by many factors both extrinsic and intrinsic to the normal functioning of the organism. However, among the many extrinsic factors are agrochemicals particularly herbicides and metallic-fertilizers, that affect the metabolism of xenobiotics, but the information is scattered and often appear contradictory. Therefore, the current study was carried out to throw a beam of light on the role of some compounds, such as herbicides, acaricides, and micronutrients, as inducers and their relationship with the acaricidal toxicity of some acaricides commonly used for controlling mites. In addition, to establish the proper time-interval between using the inducers and the toxicants.

MATERIALS AND METHODS

1. *Tetranychus urticae* (Boisduval):

A strain of the mite *T. urticae* (Boisduval) was collected from infested leaves of castor bean oil grown in the experimental farm of Sakha, Agricultural Research, Kafr El-Sheikh. This strain was reared under optimum laboratory condtions away from any pesticidal contamination for 6 successive generations before being used in the bioassay test according to the method advised by **El-Dokash (2001).**

2.Agrochemical used:

2.a. Acaricides:

- 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.
- 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.
- 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.
- 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:

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

- 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

3,1.Evaluation the effect of inducers on the acaricidal toxicity to *T.urticae* under Lab conditions:

The toxic effects of tested chemicals to the adult female mites, *T. urticae* by the leaf disc dip technique according to (Siegler, 1947). Mortality counts were made 24 hours after treatment. Correction for the control mortality was made by using Abbott's formula (1925).

3.2.Procodures for testing the inductive effects of tested inducers under Lab and field conditions.

These were done according to the methods adopted by El-dokash (2001).Mortality counts were recorded after 24 hours and the percent reduction was calculated according to the equation of Handerson and Tilton (1955)

RESULTS AND DISCUSSION

Evaluation of some agrochemicals as inducers:

I.Evaluation of acaricidal toxicity to *Tetranychus urticae*:

I.1.Toxicity of tested acaricides to adult female spider mites *T.urticae* in the laboratory:

The contact toxicity of some acaricides on the adult stage of the two spotted spider mite *Tetranychus urticae* was evaluated using the leaf disc technique (**Siegler, 1947**). Mortality counts was recorded 24 hours after treatment and the data were statistically analyzed by **Litchifield and Wilcoxon method (1949).**

Based on the obtained LC_{50} values (Table 1), it could be noticed that Fenpyroximate was superior in its effect on the adult stage with LC_{50} value of 3.75 ppm. while Bromite and Kelthane were almost equal and had the lowest effect as their corresponding LC_{50} values were 13.5 and 11 p.p.m., respectively. The LC_{50} value of Kelthane was included within the confidence limits of Bromite as indicated in Table (1). This result in expected since Kelthane was considered the oldest acaricide used in Egypt so it is expected that the mite population might develop resistance towards it.

It is of interest to notice that, although both Bromite and Comite ' :d the same chemical structure, but their toxic effects to the tested mite are quietly different. This might be due to the differences in their formulations, which might have different additives. These additives might affect the actual acaricidal potential of comite against the tested mite. Concerning the obtained slope values, the data represented in table (1), showed that the highest degree of populations homogeneity was obtained towards Kelthane which had the highest slope value (2.56). Since Kelthane was the least toxic compound (Table 1), accordingly the relatively degree of homogeneity might be towards resistance not to susceptibility. The logic interpretation for this might be due to the back history and the long term of using this compound in large scale for controlling mites. It is of great interest to mention that although Fenpyroximate had the 2nd highest slope value following Kelthane, but based on its LC_{50} value, it is quite fair to say that the tested population might be relatively homogenous towards Susceptibility not towards resistance.

Table (1) Toxicity of different acaricides to adult female spider mites (*T. urticae*) under laboratory condition

Acaricides	LC_{50} ppm	LC_{50} confidence limited	Slop
Bromite	13.50	900 – 20.25	1.10
Comite	7.00	5.00 – 9.80	1.27
Fenpyroximate	3.75	3.05 – 4.61	2.22
Kelthane	11.00	9.17 – 13.2	2.56
Noeron	5.85	4.50 – 7.40	1.72

On the other hand, the most flattest LC-P line was obtained in case of Bromite (1.1) reflecting a relatively high degree of heterogeneity towards this compound. The data also revealed that both Bromite and Comitte had so close slope values of 1.1 and 1.27, respectively. This result means that the response of the tested population towards both acaricides is the same.

The obtained results are in good harmony with those of Sameeh and El-Abdin (1985) who recorded that Kelthane was the least effective acaricide on *T. turkestani* in Iraq and against *T. urticae* (El-Magouze, 1997). Moreover, our results revealed that Comite was superior against *T. urticae* this result agreed fully with many investigators (Park et al., 1986; Gough and qayyum, 1987; Fornazier *et al.*, 1989, Estrade *et al.*, 1990 and Derballa, 1999).

I.2. Toxicity of tested acaricides to *T. urticae* under field conditions:

The data presented in Table (2) showed that *T.urticae* mites were quite abundant before conducting the field experiments during 1994 and 1995 seasons. Based on the percent reductions (Table 3), it could be fairly concluded that the population density of *T. urticae* mites was, in general, very low in all acaricidal treatments with respect to the untreated control.

The data also revealed that although no significant difference was found among all acaricidal treatments, but Fenpyroximate, Bromite and Comite were more effective in reducing the population density of *T. urticae* even two weeks after application. However, the average percent reduction during 1994 ranged between 94-99, 87-94, 75-88 and 29-70% one, two, three and four weeks after application, respectively. The same trend of results was observed in 1995 season with slight differences.

The data presented in Table (2) showed that the total average percent reduction of *T. urticae* in different treatments are 87.5, 86.5, 87.63, 78.13 and 84.1% for Bromite, Comite, Fenpyroximate, Kelthane and Noeron, respectively. Egual effect was observed between Bromite, Comite and Fenpyroximate during two seasons. On the other hand, Kelthane was the least effective one on *T.urticae*.

Table (2): The average number of *T. urticae* mites/10 soybean leaves as well as their percent reduction during two seasons, 1994 and 1995.

Treatment	No. of mites and %R	No. of mites before application		The average number of *T. urticae* as well as their percent reduction during two seasons, 1994 and 1995										
				First week		Second week		Third week		Fourth week		mean		Total average
		1994	1995	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995	
Bromite	No.	1952	1179	98	39	70	68	326	84	188	84	170	69	119.7
	%R	-	-	94	96	94	96	80	87	70	83	85	91	87.5
Comite	No.	1425	1425	104	35	96	65	239	80	186	99	156	70	113.1
	%R	-	-	99	97	89	94	80	90	60	83	82	91	86.5
Fenpyroximate	No.	1787	1235	58	41	74	74	186	99	181	95	125	77	101.0
	%R	-	-	95	96	93	92	88	86	69	82	87	89	87.6
Kelthane	No.	1387	1913	58	129	63	196	203	227	317	249	160	200	180.3
	%R	-	-	94	93	92	87	82	79	29	69	74	82	78.1
Noeron	No.	1922	1917	67	61	142	133	397	163	206	188	203	136	169.6
	%R	-	-	95	96	87	91	75	85	67	77	81	87	84.1
Control	No.	1628	1563	1139	1404	933	1203	1314	884	528	643	978	1033	1006
	%R	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

No. = number of mite. %R= % reduction

Reviewing the previous results, it is quite evident that Fenpyroximate, Bromite and Comite were superior in their effect for controlling *T. urticae* while Kelthane was the least effective compound in this respect. These results confirmed and coincided with the previous results of the efficiency of these compounds under laboratory conditions (Table 1). However, the back history and long term of using Kelthane might be behind the ineffectiveness of Kelthane under field conditions. The concurrent results agreed fully with previous finding of **Lal and Pillai (1984)** who reported that Dicofol (Kelthane) at 0.03% was ineffective both initially and residually against *Tetranychus neocalodonicus* and *T. cinnabarinus*. Moreover, the same trend of results was reported by many investigators who assayed Kelthane on different species of Tetranychus mites (**Sameeh *et al.*, 1985; Pokharkar *et al.*, 1986 and Dzolkhifli and Khoo, 1989**). The data also showed that Comite was found to be effective against Tetranychid mites. However, this compound was found to be superior by many investigators (**Park *et al.*, 1986; Gough and qayyum, 1987; Fornazier *et al.*, 1989, and Botha *et al.*, 1994**).

Evaluation of some agrochemicals as inducers:

Many agrochemicals such as micronutrients and herbicides are used in a large scale along the agricultural season either directly to the desired crop in order to improve the yield. Accordingly, residues of such chemicals are progressively accumulated in the micro agroecosystem. These residues might affect the efficiency of the applied pesticides either by induction or inhibition of xenobiotic-metabolizing enzymes in the target organism.

II.1. Toxicity of herbicides alone to adult females of *T.urticae*:

Five herbicides namely Cotoran, Fusilade, Gallent, Goal and Stomp were tested under laboratory conditions for their toxicities to adult females of *Tetranychus urticae* using the leaf disc dip echnique according to **Siegler (1947)**. These compounds were tested at five different concentration levels, the recommended one, 1/2, 1/4, 1/8 and 1/16 of the recommended concentration. Mortality counts were recorded 24 hours later, and the resultsare presented in table (3). Data revealed that all tested herbicides could be fairly considered non toxic to adult females of *T.urticae*. in term of figures, the highest concentrations of all tested compounds (the recommended conc.) which ranged between 312.5 to 3000 p.p.m. resulted only in slight mortality which ranged between 10.2 to 32.8% (Table 3). Comparing these results with those obtained in case of tested acaricides (Table 1), it could be fairly concluded that all tested herbicides have poor acaricidal action against *T.urticae*. however, this result was expected since herbicides, in general, act on plant targets which are completely different from those of arthropods. However, both Stomp and Cotoran had relatively the highest toxic effect among the tested herbicides. On the other hand, Gallent had the lowest toxic effect. However, as the concentration level decreased, the efficiency of tested herbicides decreased gradually till the effect become negligible at a level of 1/16 of the recommended concentration. Thus, this level of concentration was chosen for the following experiments.

Table (3): Acaricidal activity of different concentrations of tested herbicides after 24 hours of treatment on adult females of *T. uriticae*.

Herbicides	Recommended concentration R.C. (ppm)	% mortality of mites treated with:				
		*R.C.	1/2 R.C.	1/4 R.C.	1/8 R.C.	1/16 R.C.
Cotoran	3000	30.0	20.3	15.5	9.4	4.4
Fusilade	625	17.5	14.2	10.0	7.0	2.5
Gallent	312.5	10.2	8.6	6.4	4.1	2.1
Goal	900	15.3	13.9	10.5	8.5	6.0
Stomp	2500	32.8	24.1	21.0	10.0	6.7

*R.C. = Recommended concentration

II.2. effect of herbicides (inducers) on the toxicity of tested acaricides to adult females of *T.urticae*:

Adult females of *T.urticae* were exposed first to a sublethal concentration (1/16 of the recommended concentration) of each of the tested inducers. The mites which pre-exposed to each inducer were divided into three groups according to the interval between the exposure to the tested inducer and the subsequent exposure to the LC_{25} of the acaricide (deduced from the LC-P line for each acaricide). These intervals are 24, 48 and 72 hours for the 1st, 2nd and 3rd group, respectively. In all groups, mortality counts were recorded 24 hours after the re-exposure to the last treatment (exposure to the LC_{25} of the tested acaricides).

Data presented in table (4) clearly indicate that in spite of the differences in the chemical structure of all tested herbicides, but all of them increased the toxic effects of tested acaricides. However, the most effective treatments were noticed when mites were pre-exposed to

Fusilade (inducer) followed by Bromite or Comite or Noeron with an interval of 48 hours. This means that the inductive effect of any tested inducer needs a lag period to reflect the effect more pronounced. This result agreed fully with the previous finding of **Hodgson and Levi (1997)** who reported that the induction is a slwer process. Moreover, **Suzuki and Lee (1981)** reported that epoxide hydroxylae was induced at varying time but the maximum induction occurred at 48 hours.

The inductive effect might be due to one or more of the following suggesting mechanisms: (1) Induction of certain enzyme(s) responsible for activation or modification of xenobiotic metabolism to more toxic form (2). Inhibition of certain enzyme(s) that detoxificate the acaricides to a less toxic metabolite and so the actual concentration reached the site of action might increased, (3). Alteration of mite-target in a situation that it become more sensitive to the action of the tested compound.

It is of interest to re-emphasize that although both Bromite and Comite have the same active ingredient, but their response to the inductive effect of the different herbicides was quite different (Table 4). This result could be interpreted by the finding of **Hongson and Levi (1997)** who stated that all inducers do not have tha same effect, the effect tend to be nonspecific to the extent that any inducer induced more than one enzymatic activity.

Comparing the percent mortality of tested acaricides after 24 hours interval, one can notice that, a part from Cotoran, the inductive toxic effect is always higher in case of Bromite than Comite (Table 4). The case was reversed when the adopted interval was 48 hours. This result agreed fully with the finding of **Hodgson (1997)** who stated that some compounds had biphasic effects as they acted as inducers and inhibitors, however, inhibition of microsomal monooxygenase activity is fairly rapid (24 hours) and involved a direct interaction with cytochrome, whereas induction is a slower process.

As for the effects of tested inducers on the toxicity of Noeron and Kelthane to adult females of *T.urticae*, the data presented in Table (4) revealed that the whole features previously found in Bromite and Comite were repeated again. However, the most pronounced increase in the toxic action was noticed in the treatments where Fusilade and Stomp were used as inducers before the application of Noeron and Kelthane by 48 hours. The recorded mortalities in case of Noeron are 90.9 and 91%, respectively. On the other hand, an antagonistic effect was recorded when the mite population were exposed first to Cotoran then re-exposed to Noeron or Kelthane after 72-hours-interval (Table 4).

Table (4): Effect of tested herbicides on the toxicity of tested acaricides to adult females of *T. urticae* at different intervals.

Treatment	% mortality at intervals of:		
	24 hours	48 hours	72 hours
Bromite (LC_{25})	22.00	-	-
Cotoran (1/16)*+ Bromite (LC_{25})	29.63	60.00	12.98
Fusilade (1/16) + Bromite (LC_{25})	44.12	70.65	18.95
Gallent (1/16) + Bromite (LC_{25})	40.91	64.76	21.95
Goal (1/16) + Bromite (LC_{25})	46.00	59.30	21.43
Stomp (1/16) + Bromite (LC_{25})	51.52	68.59	17.50
Comite (LC_{25})	19.00	-	-
Cotoran (1/16)*+ Comite (LC_{25})	38.03	69.57	17.14
Fusilade (1/16) + Comite (LC_{25})	31.10	91.67	14.29
Gallent (1/16) + Comite (LC_{25})	36.11	80.00	13.04
Goal (1/16) + Comite (LC_{25})	30.30	59.00	16.28
Stomp (1/16) + Comite (LC_{25})	20.00	91.17	8.45
Noeron (LC_{25})	23.00	-	-
Cotoran (1/16)*+ Noeron (LC_{25})	20.93	81.55	7.69
Fusilade (1/16) + Noeron (LC_{25})	33.30	90.90	18.13
Gallent (1/16) + Noeron (LC_{25})	58.54	80.55	18.18
Goal (1/16) + Noeron (LC_{25})	32.73	60.00	23.08
Stomp (1/16) + Noeron (LC_{25})	38.24	91.17	20.80
Kelthane (LC_{25})	20.00	-	-
Cotoran (1/16)*+ Kelthane (LC_{25})	20.55	82.28	10.87
Fusilade (1/16) + Kelthane (LC_{25})	50.00	79.35	22.47
Gallent (1/16) + Kelthane (LC_{25})	48.15	75.00	15.52
Goal (1/16) + Kelthane (LC_{25})	30.55	56.67	14.29
Stomp (1/16) + Kelthane (LC_{25})	30.23	80.56	18.36
Fenpyroximate (LC_{25})	22.00	-	-
Cotoran (1/16)*+ Fenpyroximate (LC_{25})	21.05	90.38	19.67
Fusilade (1/16) + Fenpyroximate (LC_{25})	62.00	82.18	21.15
Gallent (1/16) + Fenpyroximate (LC_{25})	51.42	88.95	27.27
Goal (1/16) + Fenpyroximate (LC_{25})	36.20	67.86	23.80
Stomp (1/16) + Fenpyroximate (LC_{25})	37.50	79.31	27.18

(1/16)* = 1/16 of the recommended concentration

The data also revealed that in case of Kelthane, the level of induction could be considered moderate as the highest percent mortality was 82.28 in treatment in which Cotoran was used as inducer with an interval of 48 hours. The long term of using Kelthane for controlling mites in Egypt resulted in developing resistant strain(Table 1) which might be behind the moderate level of its induction.

Reviewing the current results of Fenpyroximate, one can observe some differences than the forementioned results: (1) For the first time, Cotoran and Gallent were superior in their inductive effects with the tested acaricides. (2) Fusilade and Gallent showed the most pronounced potentiation at 24 hours-intrval. (3) No case of antagonism was observed at 72 hours-interval. Moreover, the recorded percent mortality, at this period, did not decreased to the level of using the LC_{25} concentration of the tested acaricides alone.

II.3. Evaluation of the inductive effect of tested inducers on the toxicity of acaricides to *T.urticae*:

To evaluate the inductive effect of tested inducers on the toxicity of all tested acaricides to adult females of *T.urticae*, a grade of 100 was given to the inducer which caused the highest percent mortality, then the inductive index was calculated according to the following equation:

$$\text{Inductive index} = \frac{\%\ \text{mortality of the tested inducer}}{\%\ \text{mortality of the most effective inducer}} \text{X100}$$

Comparing the obtained results presented in Table (5), one can observe the following general remarks: (1) With the exception of Fenpyroximate-treatment, Goal was, in general, the least effective inducer with all tested herbicides while Fusilade and Stomp were the most superior in this respect. In term of figures, the average inductive indexes could be arranged descendingly in the following order: 97.41, 96.44, 91.37, 90.05 and 71.61 for Fusilade, Stomp, Gallent, Cotoran and Goal, respectively. This results agreed fully with previous finding of El-Deeb (1989) who stated that pre-treatment of S. littoralis larvae with all tested herbicides had almost a potentiating effect on all tested insecticides but to a great extent in case of stomp.

With few exception, it could be concluded that the same order of toxicity previously found when the tested acaricides were used alone was coincided the same order of potentiation. In other words, Bromite which proved to be the least toxic acaricides to mites under laboratory conditions, was also the least potentiated one with all tested inducers at

48-hours-interval. However, the descending order of toxicity of the tested acaricides was: Fenpyroximate > Noeron> Comite> Kelthane = Bromite. This order was nearly almost the same order of potentiation.

Table (5) Inductive effect of herbicides (inducers) on the toxicity of tested acaricides to adult females of *T. urticae* at 48-hours-interval

Inducers	Acaricides										Average Inductive index
	Bromite		Comite		Noeron		Kelthane		Fenpy.		
	% M	Ind. Ind.	% M	Ind. Ind.	% M	Ind. Ind.	% M	Ind. Ind.	% M	Ind. Ind.	
Cotoran	60.0	84.93	69.57	75.89	81.55	89.45	82.28	100	90.38	100.0	90.05
Fusilade	70.65	100	91.67	100	90.90	99.70	79.35	96.44	82.18	90.93	97.41
Gallent	64.76	91.66	80.0	87.27	80.55	88.35	75.0	91.15	88.95	98.43	91.37
Goal	59.30	83.93	59.0	64.36	60.00	65.81	56.67	68.87	67.86	75.08	71.61
Stomp	68.59	97.08	91.17	99.45	91.17	100.0	80.56	97.91	79.31	87.75	96.44

%M= % Mortality, Ind. Ind.= Inductive index, Fenpy.= Fenpyroximate

The data revealed that there is no link between the chemical structure of the inducer (herbicide) and the inductive effect to the acaricidal toxicity. Since both Fusilade and Gallent had almost the same chemical structure, but Gallent had an additional chlorine atom which markedly affected its potential effect especially at 48 hours-interval. Moreover, the chemical structure of the herbicide either monocyclic or polycyclic did not contribute any importance in its effect, since Fusilade and Stomp were almost the most potent inducers inspite of the chemical structure of Fusilade is polycyclic molecule while stomp is monocyclic. On the other hand, goal was the least effective inducer inspite of being a polycyclic herbicide.

It is of interest to mention that the phenomenon of induction was not only contributed to chlorinated hydrocarbon gave the higher effect than Goal which is polycyclic hydrocarbon having one chlorine atom in its structure (Table 5). However, **Neal *et al.* (1986)** stated that there is no consistent structural relationship between the compounds capable of bringing about induction. Moreover, several hundred compounds of diverse chemical structure have been shown to induce many enzymes. These compounds include drugs, insecticides, polycyclic hydrocarbons, and many other; the only obvious common denominator is that they are organic and Lipophilic **(Hodgson, and Levi 1997)**. In addition, **El-Deeb**

(1989) found that pretreatment of Spodoptera littoralis with sublethal concentrations of some agrochemicals (Kelthane, some herbicides and some foliar fertilizers) had a potentiation effect with all tested insecticides.

II.4. Toxicity of micronutrients alone to adult females of *Tetranychus urticae*:

Some micronutrients currently used as fertilizers to improve the quality of agricultural production were evaluated under laboratory conditions for their acaricidal activity to adult females of *T.urticae*. these micronutrients are ferric, manganese ,zinc and boron. All of them are in the chelated form except boron which was used as sodium borate salt. They were tested at different concentration levels; recommended concentration (R.C.), 1/2, 1/4, 1/8 and 1/16 R.C. The same procedures which were used in case of herbicides were adopted here. Mortality counts were recorded 24 hours after treatment and the obtained results are presented in Table (6). Data showed that all tested micronutrients could be considered not toxic to the tested mites at all tested concentrations and this was expected since these elements are not acaricides. Thus, 1/16 of the recommended concentration was chosen for the following experiments.

Table (6): Acaricidal activity of different concentrations of tested micronutrients after 24 hours of treatment on adult female of two spotted spider mite *T. urticae*

Micronutrients	R.C. (ppm)	% mortality of mites treated with:				
		*R.C.	1/2 R.C.	1/4 R.C.	1/8 R.C.	1/16 R.C.
Fe-chelate	120	17.6	15.2	12.0	7.9	4.0
Mn-chelate	120	14.3	14.3	10.3	7.6	4.7
Zn-chelate	105	18.0	18.0	11.6	8.2	5.1
Boron (NaB_2O_7)	29.8	16.0	16.0	9.3	6.1	4.2

*R.C. = Recommended concentration

II.5. Effect of micronutrients (inducers) on the toxicity of tested acaricides to adult female of *T.urticae*:

The procedures previously mentioned for testing the inductive effects of herbicides on the acaricidal potency were re-applied with the tested micronutrients with all specifications.

Data presented in table (7) clearly indicate that the action of all tested micronutrients required a lag period more than 24 hours to be pronounced.this was a main difference between the action of herbicides and micronutrients as inducers. However, the most potentiation effect was noticed with boron while the least effective one was Fe-chelate with corresponding mortalities in case of Bromite for instance are: 77.18 and 44.37%, respectively. The data also re-emphasized that increasing the interval to 72 hours, the potentiation effect was almost unsignificant or some-times turned to be antagonistic effect. Any how, this potentiation might be due to induction of certain enzyme(s) either metalo or not or certain coenzyme(s) (which needs these elements for their natural roles) that are necessary for acaricidal activation. Moreover, these elements might inhibit certain eenzyme(s) or coenzyme(s) required fo acaricidal degradation by means of complex formation between the metals and the enzyme. This complex might be stable within certain limits of time (48 hours) then it become reversible to get the enzyme free to act naturally and degrade the acaricide to less toxic metabolites.

Comparing the data presented in Table (7), one can concluded that the main features were almost noticed in both Bromite and Comite. However, the only differences was that the level of potentiation with Comite was relatively higher than that obtained with Bromite at 48 hours-interval. In term of figures, the percent mortalities in case of Comite were 62.09, 85.31, 67.9 and 65.57 for ferric, manganese, zinc and boron, respectively while these figures in case of Bromite were 44.37, 72.65, 60.33 and 77.78.

The data also revealed that the inductive effect in both Comite and Bromite needs a certain time interval of 48 hours as no case of potentiation was observed either at 24 or 72-hours intervals. However, this was expected since both acaricides have the same active ingredient. Also, the data revealed that Ferric was the least effective element with both acaricides.

Concerning the effect of inducers on the toxicity of Noeron to *T.urticae*, the data presented in Table (7) indicated that the most clear case of potentiation was noticed in the treatment in which female-mites were first exposed to boron followed by Noeron within 48-hours interval in between, as the recorded percent mortality accounted 88.46. moreover, as the interval prolonged to 72-hours, a general slight antagonistic effect was noticed particularly in the treatment where Fe-chelate was used as inducer. This might be, as discussed before, due to the induction at this period had occurred to degredative enzyme(s). It is of great interest to mention that the highest level of induction had occurred in the treatment where boron (Sodium salt) was used as inducer with Noeron inspite of being hydrophilic which contradict with the common properties of inducers as they are organic and lipophilic.

Table (7): effect of tested micronutrient on the toxicity of tested acaricides to adult females of *T. urticae* at different intervals.

Treatment	% mortality at intervals of:		
	24 hours	48 hours	72 hours
Bromite (LC_{25})	22.00	-	-
Fe-chelate (1/16)* + Bromite (LC_{25})	26.09	44.37	21.43
Mn-chelate(1/16) + Bromite (LC_{25})	28.07	72.65	21.05
Zn-chelate (1/16) + Bromite (LC_{25})	26.19	60.33	15.78
Boron (1/16) + Bromite (LC_{25})	38.09	77.18	24.19
Comite (LC_{25})	19.00	-	-
Fe-chelate (1/16)* + Comite (LC_{25})	27.50	62.09	23.53
Mn-chelate(1/16) + Comite (LC_{25})	21.15	85.31	20.00
Zn-chelate (1/16) + Comite (LC_{25})	18.87	67.90	16.67
Boron (1/16) + Comite (LC_{25})	33.33	65.57	22.22
Noeron (LC_{25})	23.00	-	-
Fe-chelate (1/16)* + Noeron (LC_{25})	31.00	69.23	15.38
Mn-chelate(1/16) + Noeron (LC_{25})	22.06	71.55	20.69
Zn-chelate (1/16) + Noeron (LC_{25})	21.74	67.18	19.35
Boron (1/16) + Noeron (LC_{25})	26.32	88.46	17.50
Kelthane (LC_{25})	20.00	-	-
Fe-chelate (1/16)* + Kelthane (LC_{25})	22.91	70.00	18.31
Mn-chelate(1/16) + Kelthane (LC_{25})	24.30	65.31	10.34
Zn-chelate (1/16) + Kelthane (LC_{25})	20.63	67.35	8.82
Boron (1/16) + Kelthane (LC_{25})	47.82	70.21	24.00

(1/16)* = 1/16 of the recommended concentration

With respect to the effect of inducers on the toxicity of Kelthane to adult females of *T.urticae* the trend of results presented in Table (7) was quite cincided with those obtained with both Bromite and Comite. With the exception of boron-treatment, there wasn't any case of potentiation occurred when Kelthane was pre-cede by all tested micronutrients by 24-hours-interval. However, the most pronounced potentiation occurred after 48-hours-intervals and the level of induction in all treatments was almost 70, 65.31, 67.35 and 70.21 for ferric, manganese ,zinc and boron, respectively. On the other hand, the most noticeable antagonistic effect was exhibited when Kelthane was preceded by zinc at 72-hours interval as the corresponding percent mortality was 8.82 (Table 7).

In case of Fenpyroximate, the result in Table (7) indicated that although, the general trend of results was quite similar to those obtained with Comite and Bromite, but few differences could be noticed, i.e. slight increase in the toxicity was exhibited even when the adopted period between the two exposures was 24 hours interval, and boron was the least effective metal in this respect. Manganese was the least effective element at 48 hours-interval while boron was the most effective one. A general slight antagonistic effect was noticed when Fenpyroximate was precede by all tested elements at 72-hours-interval. However, the most antagonistic effect was exihibited in case of zinc-treatment and the corresponding percent mortality accounted 14.28.

To evaluate the inductive effect of any macronutrient (inducer) on the toxicity of all tested acaricides to adult females of *T.urticae*, the inductive index was calculated (as previously mentioned) and the results presented in Table (8) revealed that based on the inductive indexes values, boron could be considered the most effective inducer with all tested acaricides except Comite, whereas, quite expectedly, iron caused moderate increase in the inductive effect. However, the average inductive indexes could be arranged descendingly in the following order: 95.37, 87.48, 84.92 and 77.75 for boron, manganese, zinc and ferric, respectively.

Changes in mineral nutrition have also been observed to affect monoxygenase activity. Moreover, an excess of dietary cobalt, cadmium, manganese and lead caused an increase in the hepatic glutathion levels and a decrease in P-450 content **(Hodgson and Levi 1997)**.

The fluctuation of the inductive effects of all tested elements (Table 8) confirmed the previous finding of **Hodgson and Levi (1997)** that all inducers do not have the same effects; the effect tend to be non specific to the extent that any single inducer induced more than an enzymatic activity. The data also revealed that there was no link between the electrochemical series of the tested metals (inducers) and the inductive effect to the acaricidal toxicity. Moreover, enzyme affinities to the various metals are, however, quite dissimilar. However, it is of great interest to mention that the greatest inductive effects occurred with boron (Table 8) which is, strictly speaking, a nonmetal, it is in the group IIIA metals and is of some toxicologic concern **(Hammoud and Beliles, 1980)**.

Table (5) Inductive effect of herbicides (inducers) on the toxicity of tested acaricides to adult females of *T. urticae* at 48-hours-interval

Inducers	Acaricides										Average Inductive index
	Bromite		Comite		Noeron		Kelthane		Fenpy.		
	%M	Ind. Ind.	%M	Ind. Ind.	%M	Ind. Ind.	%M	Ind. Ind.	%M	Ind. Ind.	
Fe-chelate	44.37	57.49	62.09	72.78	69.23	78.26	70.0	99.70	67.83	80.59	77.75
Mn-chelate	72.65	94.13	85.31	100	71.55	80.88	65.31	93.02	58.43	69.36	87.48
Z -chelate	60.33	78.17	67.90	79.59	67.18	75.94	67.35	95.93	80.00	94.97	84.92
Boron	77.18	100	65.57	76.86	88.46	100	70.21	100.00	84.24	100.0	95.37

%M= % Mortality, Ind. Ind.= Inductive index, Fenpy.=Fenpyroximate

III. Effect of some inducers on the efficiency of certain acaricides against *T.urticae* under field conditions:

The field experiments were carried out in the farm at Faculty of Kafr El-Shiekh during two successive season 1996 and 1997 , respectively. Certain acaricides namely Bromite, Kelthane and Noeron were chosen for this study. Each acaricide was used at LC_{25}- concentration. Also, certain inducers were selected, Cotoran and Fusilade (as herbicides) and Fe-chelate (as micronutrient). However, each inducer was used at 1/16 of its recommended concentration. All data are recorded and analyzed according to the method of Duncan's multiple range test (**Duncan, 1955**).

Data presented in Table (9) indicated that the population density of *Tetranychus urticae* (Boisd.) was quite high before spraying chemicals. However, although all chemicals-treatments decreased the mite population but, in general, all tested acaricides were the most effective while Cotoran was the least effective one in this respect. Moreover, the decrease in mite population after chemical-treatments by the inducers was time-dependent. In other words, the highest decrease occurred after 72 hours of treatment. This might be due to the relatively long-term of mite exposure to the tested inducers.

The percent of reductions of mites were recorded in Table (9). The results showed that Bromite had the highest percent reduction of *T.urticae* at the three periods while Cotoran had the least value. In term of Figures, the percent reductions after 24 hours are 37.4, 18.9, 13.8, 9.4, 9.6 and 12% for Bromite, Noeron, Kelthane, Cotoran, Fusilalade and Fe-chelate, respectively.

Table (9): Number of mites/10 leaves of soybean before and 24, 48 and 72 hours after chemical treatment during 1996 and 1997 seasons

Treatment	No. Of mites / 10 leaves					
	Before spraying			24 hours		
	1996	1997	Average	1996	1997	Average
Bromite	172	150	161	41abc	70b	55.5
Noeron	162	152	157	50bc	60b	55
Kelthane	250	338	294	82ef	150bc	116
Cotoran	290	198	244	100efg	110fg	105
Fusilade	230	218	224	80fg	120fg	100
Fe-chelate	254	343	298.5	86gh	180bc	133
Control	593	597	595	199i	350i	274.5

Table (9): Continued

Treatment	No. Of mites / 10 leaves					
	48 hours			72 hours		
	1996	1997	Average	1996	1997	Average
Bromite	41ab	60ab	50.5	35a	57ab	46
Noeron	40ab	50a	45	35a	47a	41
Kelthane	70e	130cd	100	60ab	125cd	92.5
Cotoran	75e	85d	80	65ab	80d	72.5
Fusilade	58be	95d	76.5	50b	90d	70
Fe-chelate	65de	150cd	107.5	55b	140cd	97.5
Control	150f	274f	212	130c	250h	190

Means followed by a common letter are not significant difference at 5% level by DMRT, A =Average

Data presented in Tables (10 and 11) indicated that pre-exposure of *Tetranychus urticae* (Boisd.) to sublethal concentration of Cotoran potentiate the toxicity of Noeron, Bromite and Kelthane when being used at LC_{25}- concentration. It is of interest to mention that with the exception of Kelthane, the most effective potentiation occurred 48 hours after spraying the inducer. However, the potentiation of Kelthane was time-dependent. In term of Figures, the percent of reductions were 30.62, 34.21 and 55.9% after the intervals of 24, 48 and 72 hours, respectively (Table 11) . this result confirmed the previous finding of **Hodgson and Levi (1997)** who stated that the action of the inducer is not specific and varied from one compound to another.

As for the effect of Fusilade on the efficiency of certain acaricides against *T.urticae*, the data presented in Tables (10 and 11) revealed that Fusilade increased the toxicity of Bromite, Noeron and Kelthane at all intervals, but the greatest potentiation occurred with both Bromite and Kelthane at 24 hours-interval with average percent reductions of 77.5 and 66.2%, respectively. While this potentiation occurred at 48-hours interval in case of Noeron.

Table (10): Average acaricidal activity of some chemicals against *T. Urticae* at different invervals the two successive seasons (1996-1997)

Treatment	24 hours			48 hours			72 hours		
	1996	1997	Average	1996	1997	Average	1996	1997	Average
Bromite	37.4	20.4	28.9	16.9	12.9	14.9	18.2	9.3	13.7
Kelthane	13.8	24.4	19.1	2.4	16.2	9.3	3.4	11.7	7.6
Noeron	18.9	32.7	25.8	13.9	28.3	21.1	13.1	26.2	19.6
Cotoran	9.40	5.2	7.3	9.8	6.5	8.1	9.8	3.5	69.7
Fusilade	9.60	6.1	7.9	12.1	5.1	8.6	12.5	1.4	7.0
Fe-chelate	12.0	10.5	11.3	10.8	4.7	7.8	12.9	2.5	7.7

Table (11): Average effect of some inducers on the toxicity of certacaricidal activity of some chemicals against *T. Urticae* at different invervals the two successive seasons (1996-1997)

Treatment	24 hours			48 hours			72 hours		
	1996	1997	A.	1996	1997	A.	1996	1997	A.e
Cotoran + Bromite	30.4	27.2.	28.8	78.9	49.9	64.6	31.4	21.5	26.5
Cotoran + Kelthane	30.6	37.2	33.9	34.2	19.1	26.7	55.9	20.8	38.4
Cotoran + Noeron	42.7	57.1	49.9	65.1	62.2	63.7	21.5	2.90	12.2
Fusilade + Bromite	75.5	79.5	77.5	51.9	56.4	54.2	39.5	50.1	44.8
Fusilade + Kelthane	68.5	63.9	66.2	51.2	42.3	46.8	40.9	42.7	41.8
Fusilade + Noeron	68.5	49.6	41.6	57.8	41.6	49.7	19.5	33.5	26.5
Fe-chelate + Bromite	69.6	65.5	67.6	19.5	64.6	42.1	49.6	53.1	51.4
Fe-chelate + Kelthane	28.9	36.4	32.7	50.2	23.7	37.0	22.9	17.3	20.1
Fe-chelate + Noeron	38.5	40.3	39.4	42.1	60.2	51.2	33.3	16.8	25.1

A. = Average

It is of great interest to mention that the potentiation of Kelthane with Cotoran was time-dependant but the reverse occurred in case of Kelthane which had been potentiated with Fusilade. From the practical point of view, one should be careful for selecting the proper inducer since the effect differed according to the specific compound and time of application. However, Fusilade should be used within 24-48 hours before using the proper acaricide as its potentiation effect decreased significantly after 72-hours.

With respect to the effect of Fe-chelate on the efficiency of tested acaricides against *T.urticae*, the data recorded in Tables (8 and 9) revealed that Fe-chelated increased the toxicity of Bromite at 24 and 72 hours but in case of Kelthane, the most inductive effect occurred at 48 hours. This effect might be attributed to an inductive effect of some activating enzymes such as oxidases and/or to the inhibition of certain metabolizing enzyme(s) which act on the tested acaricides by means of irreversible comlex formation between these enzymes and the elements.

In conclusion, based on the current results, it could be fairly concluded the following points:

1. all inducers potentiated the tested acaricides particularly at 24 and 48 hours-intervals.
2. one should be careful on selecting the proper inducer, since the effect differed according to the specific compound and time of application.
3. from the practical point of view, the obtained percent of reductions are quite enough to be used particularly when acaricides are used in an integrated pest management programs since the applied concentration is LC_{25} and this sublethal concentration quite low and has mostly no side effects on the natural predators and parasites.
4. minimizing the acaricidal concentration to a low level of LC_{25} will save money, decrease the rate of developing resistant strains and avoid environmental pollution.

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الملخص العربي

تقيم بعض الكيماويات الزراعية على الفعل السام لبعض المبيدات الاكاروسية وذلك تحت الظروف الحقلية والمعملية

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يهدف هذا البحث الي تقييم بعض مبيدات الحشائش (كوتوران- فيوزاليد- جالنت- ستومب) وبعض المخصبات الزراعية (بورون- الحديد المخلبي- المنجنيز المخلبي- الزنك المخلبي) علي الفعل السام لبعض المبيدات الاكاروسية (بروميت- كوميت- فينبيروكسيمات- كلثان- نيرون) وذلك تحت الظروف المعملية والحقلية وتتخلص اهم النتائج المتحصل عليها فيما يلي:

وجد أن مركب الفينبيروكسيمات كان اكثر المركبات في فعله السام بقيمة LC_{50} تقابل ٣,٧٥ جزء في المليون في حين كان مركب البروميت والكلثان لهما أقل تأثير بقيم ١٣,٥ ، ١١ جزء في المليون علي الترتيب. أظهر التقييم الحقلي أن جميع المبيدات الأكاروسية المستخدمة كانت فعالة في خفض أعداد الأكاروس وقد تراوحت نسب إنخفاض الأعداد ٩٣,٥ -٩٨ ، ٨٩-٩٥ ، ٨٠-٨٧، ٤٩ -٧٦,٥ بعد أسبوع، اثنين، ثلاثة وأربعة أسابيع من المعاملة. كما أوضحت النتائج أن مبيدات الفينبيروكسيمات و البروميت و الكوميت كانت ذات فعالية عالية في مكافحة الأكاروس في حين كان مبيد الكلثان أقلها في هذا الشأن.

لوحظ أن جميع مبيدات الحشائش وكذا المخصبات قد حفزت الفعل السام للمبيدات الأكاروسية المستخدمة في جميع الفترات المختبرة ولكن اكثر تأثير كان واضحا بعد ٤٨ ساعة. ان الفرق الأساسي بين فعل المبيدات الحشائش والمخصبات يتمثل في أن المخصبات لا تظهر فعلها التحفيزي بعد ٢٤ ساعة بينما أدت مبيدات الحشائش إلي زيادة الفعل السام للمبيدات الأكاروسية علي جميع الفترات المختبرة. كذلك لوحظ في بعض الحالات ان زيادة الفترة الزمنية (بين المعاملة بالمحفز و المبيد الأكاروسي) إلي ٧٢ ساعة فان ذلك يؤدي إلي حدوث تأثير تضادي أي تقليل الفعل السام للمبيد الأكاروسي. يمكن ترتيب التأثير التحفيزي لمبيدات الحشائش علي سمية المبيدات الأكاروسية كالاتي :- فيوزاليد> ستومب> جالنت> كوتوران> جول. أظهرت النتائج أن البورون كان أكثر المخصبات المستخدمة في زيادة الفعل السام للمبيدات الأكاروسية فيما عدا مع المبيد الأكاروسي الكوميت. في حين وعلي غير المتوقع كان المخصب المحتوي علي عنصر الحديد أقلها تأثيرا.

أدت جميع المحفزات المستخدمة الي زيادة الفعل السام وبصفة خاصة عندما كانت الفترة بين المعاملتين ٢٤ أو ٤٨ ساعة. يجب مراعاة الدقة في اختيار المحفزات المستخدمة حقليا حيث أن التأثير يتوقف علي نوع المحفز المستخدم و كذا علي الوقت بينه وبين المعاملة بمبيد الأكاروس. ومن وجهة النظر التطبيقية يمكن الاعتماد علي الجرعات المستخدمة من المبيدات الأكاروسية رغم أنها منخفضة جدا إذا ما تم إدراجها في برنامج مكافحة متكاملة حفاظا علي البيئة و مساهمة في تأخير ظهور صفة المقاومة ضد المبيدات الأكاروسية.