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CHLOROPHYLL AND CAROTENOID CONTENTS IN TOMATO AND CUCUMBER PLANTS IN RELATION TO DIMETHOATE AND PROFENOFOS APLLICATION

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ABSTRACT

The insecticides, dimethoate and profenofos were sprayed on tomato and cucumber plants at the fruiting stage. Effect of these insecticides by different concentrations (half, one, and twice recommended rates) on chlorophyll "a","b", total and carotenoid contents were determined after different days of spraying. Dimethoate was more effective against chlorophyll "a" of tomato and chlorophyll "b" of cucumber leaves and highly reduced total chlorophyll of both plant leaves. Chlorophyll "b" of tomato and "a" of cucumber was more sensitive to profenofos and total chlorophyll was highly reduced in both plants leaves. Profenofos and dimethoate were more active to reduce carotenoid contents of tomato than cucumber leaves.

INTRODUCTION

Chemical pest control proved to be an effective mean in protecting crops. However, the utilization of chemical in pest control depends on several factors including phytotoxicity of these chemicals. Some chemicals caused chlorosis that results from a reduction in chlorophyll synthesis or from distribution of existing chlorophyll. Although most pesticides are widely applied as foliage treatments for the control of some pests in numerous cultivated crops, their phytotoxicities are not well defined.

The content of chlorophyll "a" and "b" of cotton leaves was highly decreased by profenofos 72 % EC. (El-Shahaat, 1993). Also, total chlorophyll and carotenoid contnets of *Vigna mungo* were decreased by phosphamidon insecticide (Mathur and Mathur, 1989). In general, Mohapata *et al*, 1997 found that phostosynthesis was significantly affected by organophosphrous insecticides at concentration $\geq 50\ \mu M$.

The examination of M-2 seedlings of barley following pesticides treatment revealed a broad spectrum of chlorophyll deficient mutants and the tentative order of potency of the pesticides was fenitrothion > methyl parathion > Ekatin > Phorate (Grover and Malhi, 1989). Other groups of pesticides like imidazolinones herbicides were studied. Along, 2000 found that, pre and post-emergence application of Imazaquin showed strong tendency to reduce the concentrations of chlorophyll a and total of soybean leaves at 3 and 5 week after application, respectively, and disappeared its effect, 9 week after application.

The aim of this research is to study the effect of dimethoate and profenofos on chlorophyll and carotenoid contents in tomato and cucumber plant leaves.

MATERIALS AND METHODS

Insecticides used:-

Dimethoate O,O-Dimethyl-S-(N-methyl carbamoyl methyl) phosphorodithioate. It was supplied by BASF wgandotte crop. Agricultural Chemical Div., Fedral Republic of Germany. 40 % EC.

Profenofos : O-(4-bromo-2-chlorophenyl)-O-ethyl-S-propyl phosphorothioate. It was supplied by Ciba Geigy Ltd. (Switzerland), 72 % EC.

Determination of chlorophyll and carotenoid contents:-

Twelve plots were planted with tomato (*Lycopersicon eseulentum* Mill.) Var.Alfa-Hidra (Holland) and other twelve plots were cultivated with cucumber (*Cucumis safivus* L.) Var. California (U.S.A.) at Rasheed, El-Behera Governorate, Egypt (the area of each plot is 80 m^2) at 12 May 1993 and the plots were treated with dimethoate or profenofos at the fruiting stage. The applied doses of dimethoate were 150, 300, and 600 ml / fed, while the rates of profenofos were 375, 750, and 1500 ml / fed. The recommended dose on vegetables for dimethoate and profenofos were 300 and 750 ml / fed., respectively. Randomized block design was used for the experiments. Each treatment was replicated three times. All agricultural practices were made as usually done in commercial production of tomato and cucumber plants.

Tomato and cucumber leaves were collected from each plot at 0, 1, 3, 5, 7, and 9 days after spraying. Leaves samples were picked (20 leaves from each plot), then washed by tap water followed by distilled water and dried in air. The leaves were cut into small pieces and appropriate weights (0.25 gm each) were subjected to the extraction and determination of both chlorophyll "a" and "b", total and carotenoid according to the method of Arnon (1949) and Villanueva *et al*. (1985).

The contents of chlorophyll "a" and "b", and carotenoid were determined using Spectrophotometer at wavelengths 644, 662, 470 nm., respectively and the concentration of each component expressed as mg / gm leaf-tissues were calculated by the following equation (Villanueva *et al*., 1985).

$$\text{Chlorophyll "a"} = (10.1 \times A_{662} - 1.01 \times A_{644}) \times 0.2 \text{ mg / gm}$$

$$\text{Chlorophyll "b"} = (16.4 \times A_{644} - 2.57 \times A_{662}) \times 0.2 \text{ mg / gm}$$

$$\text{Total chlorophyll} = \text{Ch. "a"} + \text{Ch. "b"} \quad \text{mg / gm}$$

$$\text{Carotenoid} = \frac{(A_{470} - 1.28 \times \text{Ch. "a"}) + (56.7 \times \text{Ch. "b"})}{256 \times 0.906}$$

The obtained data were statistically analyzed according to Snedecor and Cochran, (1967)

RESULTS AND DISCUSSION

1-Effect of dimethoate and profenofos on chlorophyll content of tomato leaves:-

Chlorophyll "a" content: The effect of dimethoate and profenofos on chlorophyll "a" content are recorded in Table (1) The results indicated that chlorophyll "a" content in control treatment was decreased with increasing time of growth. Dimethoate at the tested concentrations decreased the content of chlorophyll "a" of tomato leaves. Comparing to control, it was found that the chlorophyll "a" content was significantly decreased by the tested concentrations in the following order: half of field rate > filed rate > double of field rate.

Concerning profenofos, it could be said that, the half of field rate proved to be more effective than the other two tested rates, since it was highly significantly decreased the chlorophyll "a" content of tomato leaves. These results indicated that the lowest tested rate (half of field rate) of both insecticides were the more effective to reduce the chlorophyll "a" content of tomato leaves.

Chlorophyll "b" content: The chlorophyll "b" content was reduced with increasing the age of leaves for control. Dimethoate with the three tested rates reduced the content of chlorophyll "b" of tomato leaves at different time of spraying, but the field rate slightly significant reduced it. Profenofos also affected the chlorophyll "b" content of tomato leaves with time and exhibited high significant reduction at half rate followed by the field and double field rates, respectively.

Total chlorophyll content: The content of total chlorophyll of tomato leaves was reduced with increasing the age of control plant, the effect of half field rate of dimethoate on it was correlated with the time of spraying, since it significantly decreased during the time of experiment. Profenofos caused reduction in the total chlorophyll content at its lowest rate (half rate) followed by field and double field rates with less extent.

2-Effect of dimethoate and profenofos on chlorophyll content of cucumber leaves:

Chlorophyll "a" content: The effect of dimethoate and profenofos on the chlorophyll content of cucumber leaves are recorded in Table (2). There was obvious reversible correlation between the content of chlorophyll "a" and the age of cucumber leaves. No obvious correlation was observed between the reducing effect of dimethoate at all tested rates with the time of spraying on chlorophyll "a" of cucumber leaves, it was found that a significant reduction by all tested rates of dimethoate on it. Profenofos reduced the chlorophyll "a" of cucumber leaves at all tested rates.

Table(1): Effect of dimethoate and profenofos on chlorophyll content (mg/gm) of tomato leaves.

Insectiside	Type of chlorophyll	Concentration cm^3/fed.	Days after spraying zero	1	3	5	7	9	Mean
Dimethoate	Ch."a"	Control	1.332	1.250	1.253	0.985	0.930	0.864	1.102^{a}
		Half.F.	1.007	1.048	0.836	0.934	0.814	0.792	0.917^{c}
		One.F.	0.886	0.963	0.972	0.954	0.941	0.925	0.940^{c}
		Two F.	0.973	0.986	0.777	1.125	0.773	1.405	1.006^{b}
	Ch."b"	Control	0.793	0.744	0.777	0.711	0.663	0.502	0.698^{a}
		Half F.	0.937	0.716	0.562	0.606	0.566	0.466	0.642^{a}
		One F.	0.568	0.635	0.637	0.626	0.468	0.550	0.611^{b}
		Two F.	0.637	0.665	0.522	0.747	0.541	0.863	0.662^{a}
	Total	Control	2.125	1.960	2.000	1.695	1.594	1.366	1.790^{a}
		Half F.	2.014	1.764	1.398	1.450	1.380	1.258	1.559^{c}
		One F.	1.455	1.599	1.609	1.580	1.589	1.475	1.551^{c}
		Two F.	1.610	1.651	1.299	1.896	1.313	2.268	1.673^{b}
Profenofos	Ch "a"	Control	1.332	1.250	1.253	0.985	0.930	0.864	1.102^{a}
		Half F.	1.098	0.947	0.863	0.757	0.718	1.048	0.905^{c}
		One F.	1.060	0.910	0.902	0.860	0.861	1.082	0.946^{bc}
		Two F.	0.900	0.837	0.836	1.139	1.050	1.135	0.983^{b}
	Ch "b"	Control	0.793	0.744	0.777	0.711	0.663	0.502	0.698^{c}
		Half F.	0.723	0.642	0.572	0.473	0.484	0.649	0.591^{d}
		One F.	0.704	0.585	0.606	0.578	0.554	0.698	0.621^{c}
		Two F.	0.610	0.549	0.536	0.768	0.711	0.745	0.653^{b}
	Total	Control	2.125	1.960	2.000	1.695	1.594	1.366	1.790^{a}
		Half F.	1.821	1.588	1.436	1.252	1.203	1.697	1.500^{c}
		One F.	1.764	1.495	1.511	1.437	1.414	1.780	1.567^{bc}
		Two F.	1.510	1.386	1.370	1.907	1.761	1.880	1.636^{b}

F = Recommended field rate

Means followed by the same letter are not significantly different at $_{0.05}$ level according to L.S.D test.

Table(2): Effect of dimethoate and profenofos on chlorophyll content (mg/gm) of cucumber leaves.

Insectiside	Type of chlorophyll	Concentration cm^3/fed.	Days after spraying						Mean
			zero	1	3	5	7	9	
Dimethoate	Ch."a"	Cntrol	1.242	1.059	0.607	0.621	0.593	0.569	0.782^{a}
		Half.F.	0.603	0.540	0.657	0.742	0.586	0.693	0.637^{b}
		One.F.	0.597	0.660	0.597	0.638	0.556	0.729	0.630^{b}
		Two F.	0.805	0.714	0.631	0.658	0.533	0.710	0.675^{b}
	Ch."b"	Control	0.743	0.704	0.402	0.375	0.344	0.414	0.497^{a}
		Half F.	0.428	0.438	0.442	0.329	0.475	0.475	0.431^{b}
		One F.	0.354	0.503	0.441	0.362	0.464	0.513	0.439^{b}
		Two F.	0.597	0.459	0.489	0.493	0.431	0.460	0.487$^{\sim}$
	Tntal	Control	1.979	1.732	1.009	1.002	0.937	0.983	1.274^{a}
		Half F.	1.030	0.978	1.099	1.071	1.061	1.168	1.068^{bc}
		One F.	0.851	1.163	1.038	1.000	1.004	1.242	1.050^{c}
		Two F.	1.277	1.164	1.200	1.251	0.965	1.202	1.163^{b}
Profenofos	Ch "a"	Control	1.242	1.059	0.607	0.621	0.593	0.569	0.782^{a}
		Half F.	0.632	0.815	0.591	0.549	0.673	0.543	0.634^{b}
		One F.	0.627	0.673	0.711	0.460	0.705	0.691	0.645^{b}
		Two F.	0.639	0.706	0.617	0.599	0.567	0.760	0.648^{b}
	Ch "b"	Control	0.743	0.704	0.402	0.375	0.344	0.414	0.497^{a}
		Half F.	0.457	0.629	0.460	0.539	0.333	0.400	0.470^{b}
		Ooe F.	0.457	0.517	0.554	0.583	0.473	0.504	0.498^{a}
		Two F.	0.476	0.455	0.473	0.365	0.403	0.556	0.455^{b}
	Tntal	Control	1.979	1.732	1.009	1.002	0.937	0.983	1.274^{a}
		Half F.	1.005	0.943	1.051	1.086	1.005	0.943	1.006^{d}
		One F.	1.178	1.195	1.265	0.934	1.178	1.195	1.157^{b}
		Two F.	0.970	1.316	1.090	0.964	0.970	1.316	1.104^{c}

F = Recommended field rate

Means followed by the same letter are not significantly different at $_{0.05}$ level according to L.S.D test.

Chlorophyll "b" Content: There was a reversible correlation between the age of cucumber leaves and their chlorophyll "b" content. All the tested rates of dimethoate and profenofos caused reduction in the chlorophyll "b" of cucumber leaves. On the other hand, it was found that, half and field rates of dimethoate in addition to half and double field rates of profenofos reduced the content of chlorophyll "b" of cucumber leaves at the end of experiment, whereas the double and field rates of dimethoate or profenofos were not affected the chlorophyll "b" content of cucumber leaves.

Total chlorophyll: The total chlorophyll content of cucumber leaves was decreased with increasing the age of leaves. All the tested rates of dimethoate decreased the content of total chlorophyll of cucumber leaves. The field rate of dimethoate was more active than the double field rate, whereas the half field rate was less effective in this respect. All rates of profenofos gave correlation with the time of spraying, although the half rate significantly decreased the amount of total chlorophyll followed by the double rate and field rate.

3-Effect of dimethoate and profenofos on carotenoid content of tomato and cucumber leaves:

Tomato carotenoid content: The effect of dimethoate and profenofos on carotenoid content of tomato leaves was presented in Table (3). There was a correlation between the carotenoid content and the leaf age of control plant. Dimethoate caused reduction to the carotenoid content of tomato leaves with its tested rates at the different time of experiment and profenofos gave the same trend of dimethoate for their effect except in case of the double rate of profenofos which caused stimulation of carotenoid. So, half and the field rates of both dimethoate and profenofos caused significant reduction of tomato leaves carotenoid wereas double rate of both compounds did not give significant effect on carotenoid content.

Cucumber carotenoid content: The results of the effect of dimethoate and profenofos on the carotenoid content of cucumber leaves are recorded in Table (3). The content of carotenoid of cucumber leaves (control) was decreased with increasing the age of leaves. All the tested rates of dimethoate caused reduction to the carotenoid content after one day of spray, followed by stimulation to the end of experiment. Both half and field rates of dimethoate significantly reduced the amount of carotenoid of cucumber leaves, whereas the double rate caused non significant reduction in this respect. Profenofos at all tested rates did not show regular effect on the carotenoid of cucumber leaves. Double rate gave higher reduction to carotenoid content in comparing to the other tested rates.

From the previous mentioned results, it could be concluded that, chlorophyll "a" of tomato leaves was found to be more sensitive to dimethoae, whereas that of cucumber leaves is more susceptible to profenofos. Profenofos is more effective against chlorophyll "b" of tomato leaves, whereas dimethoate is more active against cucumber chlorophyll "b".

Table(3): Effect of dimethoate and profenofos on Carotenoid content (mg/gm) of tomato and cuccumber leaves.

Insectiside	Crop	Concentration cm³/fed.	Days after spraying						Mean
			zero	1	3	5	7	9	
Dimethoate	Tomato	Control	0.190	0.189	0.185	0.163	0.150	0.120	0.165ᵃ
		Half.F.	0.172	0.172	0.135	0.145	0.136	0.111	0.145ᵇ
		One.F.	0.136	0.152	0.153	0.150	0.155	0.132	0.146ᵇ
		Two F.	0.153	0.159	0.125	0.179	0.130	0.208	0.159ᵃ
	Cucumber	Control	0.176	0.169	0.097	0.090	0.093	0.099	0.121ᵃ
		Half F.	0.102	0.105	0.105	0.077	0.114	0.114	0.103ᵇ
		One F.	0.084	0.121	0.106	0.086	0.112	0.123	0.105ᵇ
		Two F.	0.143	0.107	0.118	0.119	0.103	0.109	0.117ᵃ
Profenofos	Tomato	Control	0.190	0.189	0.185	0.163	0.150	0.120	0.166ᵃ
		Half F.	0.174	0.154	0.137	0.118	0.116	0.156	0.142ᵇ
		One F.	0.169	0.140	0.146	0.138	0.133	0.167	0.149ᵇ
		Two F.	0.146	0.132	0.143	0.148	0.171	0.180	0.159ᵃ
	Cucumber	Control	0.176	0.169	0.097	0.090	0.093	0.099	0.121ᵃ
		Half F.	0.109	0.149	0.110	0.130	0.080	0.096	0.112ᵇᶜ
		One F.	0.109	0.124	0.133	0.114	0.113	0.121	0.119ᵃᵇ
		Two F.	0.114	0.109	0.113	0.087	0.096	0.133	0.109ᶜ

F = Recommended field rate

Means followed by the same letter are not significantly different at .05 level according to L.S.D test.

Total chlorophyll is highly reduced with dimethoate and profenofos in tomato and cucumber leaves. Reduction of chlorophyll content in plant leaves in the present study may be caused by a reduced synthesis or an enhanced breakdown of the chlorophyll pigment. These findings are in full agreement with those reported by Nasef *et. al.*, 1982 & 1986 and El-Shahaat, 1993. They found that dimethoate and profenofos decreased the chlorophyll content on different crops.

Concerning the effect of both tested insecticides on carotenoid content of tomato and cucumber leaves, it was found that dimethoate caused reduction in the content of carotenoid in both tomato and cucumber leaves, whereas profenofos was more effective in reducing the carotenoid content of tomato leaves than in cucumber leaves.

The lowest tested rate (half field rate) of dimethoate or profenofos is very effective in inhibiting the different studied biosystems; inflecting notable damage on non-target leaves. The present results are supported with those reported by Radwan *et al.* (1995) who found that chlorpyrifos-methyl exhibited a significant decrease on carotene content in tomato fruits. But in anotner work carried out by Rouchaud and Meyer (1982) found that chlorfenvinphos increased carotene content in carrot roots. Also, a considerable increase in carotene content of pepper and cucumber fruits was indicated by Shahin *et al.* (1989) as a result of dimethoate application.

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محتويات نباتات الخيار و الطماطم من الكلوروفيل و الكاروتين و علاقتها بمبيدى الدايمثويت والبروفينوفوس

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بدراسة تأثير الدايمثويت والبروفينوفوس على المحتوى الكلوروفيلى والكاروتينات فى اوراق الطماطم والخيار وجد ان كلوروفيل "أ" فى اوراق الطماطم اكثر حساسية لتأثير الدايمثويت ، بينما أوراق الخيار كانت اكثر تأثرا باستخدام البروفينوفوس. وكان البروفينوفوس اكثر تأثيرا على كلوروفيل "ب" فى اوراق الطماطم بينما كان الدايمثويت اكثر تأثيرا على كلوروفيل "ب" لاوراق الخيار. نقص بشدة محتوى الكلوروفيل الكلى نتيجة تأثير الدايمثويت والبروفينوفوز فى أوراق الطماطم والخيار . وقد سبب استخدام الدايمثويت نقص متساوى فى محتوى الكاروتينات فى كل من أوراق الطماطم والخيار ، بينما البروفينوفوس كان اكثر نشاطا فى تقليل محتوى الكاروتينات فى أوراق الطماطم عن اوراق الخيار. وقد اتضح أن استخدام نصف الجرعة الموصى بها من كلا المبيدين كان مؤثرا على النظم الحيوية المختبرة مؤديا ضررا على المراكز الغير مستهدفة فى الأوراق.