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Effect of Phorate on Phosphomonoesterase Activity in Red and Black Soils using Cowpea as a Test Crop

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ABSTRACT

A pot culture experiment was conducted in red and black soil to evaluate the effect of insecticides on soil phosphomonoesterase (acid phosphatase and alkaline phosphatase) activity using Cowpea as a test crop. The soil applied insecticide viz., Phorate @ 1.0 and 2.0 kg ha^{-1} in red soil and Phorate @ 2.0 kg ha^{-1} and 4.0 kg ha^{-1} along with untreated control in black soil were used in the study. The results indicated that Phorate applied @ 1.0 kg ha^{-1} in red soil and 2.0 kg ha^{-1} in black soil resulted in significant increase in the acid and alkaline phosphatase activity from 0-45 days after sowing. Both the phosphatases exhibited three to four fold increased activity at its peak compared to control. Application of Phorate at higher rates resulted in reduced activity of acid and alkaline phosphatases. The decreased activity might be related to proteolysis of non-stabilized extra-cellular enzymes.

Key words : Cowpea, Phorate, Phosphomonoesterase activity.

Any compound which alters the number and activity of micro-organisms could affect the soil biochemical processes (Tu and Bollen,1968) and ultimately the soil fertility and plant growth. In recent years, insecticides have been applied to agricultural soils to control the soil borne pathogens. The effect of insecticides on soil enzyme complex are extremely varied, complex and often mediated through changes in microorganisms present in the soil. The present paper examines the effect of Phorate on phosphomonoesterase activity in red and black soils using Cowpea as test crop.

MATERIAL AND METHODS

Pot culture experiment was conducted using red and black soils at College of Agriculture, Rajendranagar, Hyderabad. The red soil has pH of 7.1, clay content of 18 per cent and organic carbon of 2.7 g kg^{-1}. The black soil has pH of 8.4, clay content of 47 per cent and organic carbon of 5.9 g kg^{-1}. Five kilograms of soil was taken into earthen pot and basal dose of 10 and 20 kg ha^{-1} of N and P_2O_5 were given in the form of urea and single super phosphate. Phorate, a soil applied systemic insecticide of Carbamate group was used in the study. The treatments in red soil comprised of untreated control, Phorate @ 1.0 and 2.0 kg ha^{-1} while the treatments in black soil comprised of untreated control, Phorate @ 2.0 and 4.0 kg ha^{-1}. The experiment was conducted in Randomized Block Design with four replications. Six seeds of Cowpea were sown and were later thinned to four per pot. Calculated quantities of the carbofuran were applied in the form of granules (one day after the sowing of crop) as per the treatment on the surface. The crop was irrigated as and when required. The initial soil sample was collected immediately after application of Carbofuran and subsequent samples were collected at 15 days interval till the harvest of the crop and were analysed for the activities of acid and alkaline phosphatase Tabatabai and Bremner (1969) and Eivazi and Tabatabai (1977), respectively and expressed as µg of 4-nitrophenol released g^{-1} soil h^{-1}. The data was subjected to two-way analysis of variance taking phorate treatments as one factor and stages of the crop growth as the second factor.

RESULTS AND DISCUSSION

The effect of Phorate on the activity of acid phosphatase and alkaline phosphatase under Cowpea in red soil and black soil are presented in Tables 1,2,3 and 4.

It is observed that acid phosphatase was higher in red soil while black soil contain more alkaline phosphatase and this may be due to variation in pH of these soils. At added levels of Phorate, both acid and alkaline phosphatase enzyme activity increased upto 45 days of crop growth and thereafter though the activity is higher than control it showed a decreasing trend.

Table 1. Effect of Phorate on soil acid phosphatase activity in red soil using Cowpea as a test crop.

Treatment	Acid phosphatase activity (μg of 4-nitrophenol released g^{-1} soil h^{-1})								
	0	15	30	45	60	75	90	105	Mean
	Days after sowing (DAS)								
Untreated Control	15.3	27.5	34.0	49.8	26.0	21.3	21.1	17.7	26.6
Phorate @ 1.0 kg ha^{-1}	17.7	36.4	52.0	84.2	55.2	46.2	36.0	27.9	44.5
Phorate @ 2.0 kg ha^{-1}	16.4	31.3	44.3	62.1	38.0	29.9	23.6	19.9	33.3
Mean	16.5	31.7	43.4	65.5	39.7	32.5	26.9	21.8	
Analysis of Variance			F test		CD at 5%		S.Ed		
Treatments			* *		3.5		1.8		
Days after sowing			* *		5.7		2.9		
Treatments X DAS			* *		9.9		5.0		

Table 2. Effect of Phorate on soil acid phosphatase activity in black soil using Cowpea as a test crop.

Treatment	Acid phosphatase activity (μg of 4-nitrophenol released g^{-1} soil h^{-1})								
	0	15	30	45	60	75	90	105	Mean
	Days after sowing (DAS)								
Untreated Control	13.1	20.0	27.9	37.3	26.9	20.2	18.3	12.9	22.1
Phorate @ 2.0 kg ha^{-1}	18.9	46.8	69.7	95.8	64.3	43.8	24.5	18.0	47.7
Phorate @ 4.0kg ha^{-1}	13.8	24.6	41.2	50.4	39.5	28.4	20.4	19.1	29.7
Mean	13.8	25.0	40.7	52.2	39.5	29.9	23.0	18.2	
Analysis of Variance			F test		CD at 5%		S.Ed		
Treatments			* *		2.2		1.1		
Days after sowing			* *		3.6		1.8		
Treatments X DAS			* *		6.2		3.2		

Table 3. Effect of Phorate on soil alkaline phosphatase activity in red soil using Cowpea as a test crop.

Treatment	Alkaline phosphatase activity (μg of 4-nitrophenol released g^{-1} soil h^{-1})								
	0	15	30	45	60	75	90	105	Mean
	Days after sowing (DAS)								
Untreated Control	26.6	35.9	56.2	79.9	65.4	49.5	28.9	20.0	45.3
Phorate @ 1.0 kg ha^{-1}	28.0	55.2	91.8	118.3	105.3	79.1	55.4	39.6	71.5
Phorate @ 2.0 kg ha^{-1}	28.9	40.7	70.2	101.5	83.7	62.8	36.0	27.9	56.5
Mean	27.8	43.9	72.7	99.9	84.8	63.8	40.1	29.2	
Analysis of Variance			F test		CD at 5%	S.Ed			
Treatments			* *		4.2	2.2			
Days after sowing			* *		6.9	3.5			
Treatments X DAS			* *		11.9	6.1			

Table 4. Effect of Phorate on soil alkaline phosphatase activity in black soil using Cowpea as a test crop.

Treatment	Alkaline phosphatase activity (μg of 4-nitrophenol released g^{-1} soil h^{-1})								
	0	15	30	45	60	75	90	105	Mean
	Days after sowing (DAS)								
Untreated Control	28.5	40.5	67.2	88.9	75.1	57.3	30.8	27.2	51.9
Phorate @ 2.0 kg ha^{-1}	30.9	66.4	93.5	140.2	82.6	70.7	49.9	36.7	70.7
Phorate @ 4.0 kg ha^{-1}	32.1	50.8	74.8	99.5	57.3	59.5	40.2	31.2	55.7
Mean	30.5	52.6	78.5	109.5	71.7	62.5	40.3	31.7	
Analysis of Variance			F test		CD at 5%	S.Ed			
Treatments			* *		4.3	2.2			
Days after sowing			* *		7.1	3.6			
Treatments X DAS			* *		12.3	6.3			

Acid phosphatase increased from 16.5 to 65.5 and 13.8 to 52.2 while the corresponding activity of alkaline phosphatase is 27.8 to 99.9 and 30.5 to 109.5 in red and black soils, respectively at 45 DAS. Phorate when applied at 1 kg *a. i* ha^{-1} and 2 kg *a. i.* ha^{-1} to red and black soils increased both acid and alkaline phosphatase activity while at higher level showed a decreasing trend indicating the negative effect.

Among the Phorate treatments, acid phosphatase in red and black soils was in the order of Phorate @1.0 g ha^{-1} > Phorate @ 2.0 kg ha^{-1} > Untreated Control. Similarly, the alkaline phosphatase activity in red and black soils was in the order of Phorate @ 2.0 kg ha^{-1} > Phorate @ 4.0 kg ha^{-1} > Untreated Control. Insecticides can affect soil enzymes through their action on soil microorganisms, which in turn contribute to accumulated enzyme activity. The observance of decreased activity of acid and alkaline phosphatases at higher levels of Phorate might be due to the toxic effect of these chemicals on soil microorganisms which inturn influence the extra-cellular enzyme activity. Similar results were reported by Perucci *et al.* (1988). A similar hypothesis has been put forth by Cerevelli *et al.* (1978). The subsequent decrease in phosphatase activity was probably related to proteolysis of non-stabilized extra-cellular enzymes. These effects are more evident at the higher herbicide application rate. The results also indicated that insecticides are not detrimental to enzyme levels when applied at lower levels or recommended doses but prolonged application in large quantities might alter the status of enzymes in soil. Similar results were reported by Smith (1982).

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