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Effect of Soil and Foliar Application of Phosphorus on Phosphatases Activity in the Leaves of CO 34 Rice

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ABSTRACT

In the present study, enzyme activities due to soil and foliar application of phosphorus at four levels viz., 20, 40, 60 and 80 kg/ha on CO 34 Rice, was investigated. Phosphatase activity showed a low value at initial stages, but at latter stages an increase was recorded which was proportional to the levels of phosphorus. ATPase activity was higher at flowering stages. Direct correlation existed between their activity and phosphorus levels in the case of β-glycerophosphatase and acid pyrophosphatase. Alkaline pyrophosphatase activity increased gradually in all the treatments irrespective of mode of application.

INTRODUCTION

Naganna and Sripathi (1954) reported the presence of acid pyrophosphatase and alkaline pyrophosphatase in green leaves. Alkaline pyrophosphatase was found to be always greater than that of the acid pyrophosphatase whereas in seeds the reverse was the case. Hackett (1959) stated that the ATPase activities in pea stem mitochondria, was increased by lower concentration of phosphatase. Hewitt and Tatham (1960) observed that the acid pyrophosphatase activity in tomato leaves was increased apparently by phosphorus deficiency. Promekanon *et al.* (1963) reported a continuous increase in β glycerophosphatase activity during the reproductive period; acid pyrophosphatase was the highest in leaf during flowering; a slight increase in alkaline pyrophosphatase activity in the leaf during the post flowering stage.

MATERIALS AND METHODS

Experiment was laid in pot culture to study the effect of soil and foliar application of phosphorus on phosphatases activity in the leaves of CO 34 rice. The levels of P_2O_5 in the form of monocalcium phosphate ($Ca\ [H_2So_4]_2$) given as top dressing.

Level of P_2O_5	Soil application P_2O_5 kg/ha	Foliar application P_2O_5 kg/ha
Control	—	—
T_1	20	20
T_2	40	40
T_3	60	60
T_4	80	80

Foliar spray of aqueous solution of the above concentrations of mono calcium phosphate was given at the rate of 50 ml per pot on 25th day after transplanting. Soil application was

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done on the same day as top dressing at the same rate. Alkaline pyrophosphatase is associated with the anabolic process in the leaf while the acid pyrophosphatases participate in catabolic process taking place during translocation of the carbohydrate synthesis in the leaf. The ATPase activity serves as an index of the energy available in plant tissues.

The enzyme activity of ATPase and β Glycerophosphatase, Acid pyrophosphatase and alkaline pyrophosphatase were analysed in the leaves at four stages of crop growth i. e., vegetative, tillering, flowering and maturity. These correspond to 30, 45, 60 and 75 days after transplanting.

Pyrophosphatases: (Promekanon *et al.* (1963). The enzyme extracts obtained by the maceration of weighed fresh leaf tissue with cold double distilled water were centrifuged and kept in the ice box. The incubation mixture (5 ml) contain 0.5 ml of enzyme extract in each case and 4 ml of acetate buffer pH 5.32 and 0.5 ml of neutralised sodium pyrophosphate (0.1 M) for acid pyrophosphatase, 3.0 ml of buffer pH 8.68, 0.1 ml magnesium chloride (1.0 M) and 0.5 ml of unneutralised sodium pyrophosphate (0.1 M) for alkaline pyrophosphatase, 0.4 ml of buffer pH 5.32 and 0.5 ml of sodium glycerophosphate (0.1 M) for acid phosphatase. The incubation were carried out at 40°C for 10 minutes as the case of pyrophosphatases and 20 minutes in the case phosphates. The enzyme action was stopped by trichloroacetic acid and liberated orthophosphate estimated by Sumners (1944).

ATPase: ATPase was estimated in the leaf as suggested by Umbreit *et al.* (1964). One gram of sample was taken and cold homogenete enzyme extract was made with 0.125 M sucrose solution. The following reagents i. e., 0·02 M Adenosine triphosphate (pH 7.6) and 0.25 M sucrose, 0.02 M Magnesium chloride and 0.2 M calcium chloride, were added to the enzyme extract at zero time. This was kept in water bath maintained at 37°C for 20 minutes. The reaction was stopped by adding 1.5 M Trichloro acetic acid and the content analysed for inorganic phosphorus.

RESULTS AND DISCUSSION

The activity of ATPase increased upto the flowering stage in all the treatments, in both the modes of application and decreased at the final stage. There was no particular relationship between the levels of phosphorus and enzyme activity (Table 1).

There was appreciable increase in the activity of β glycerophosphatase with the aging of the crop phosphorus levels as well as the modes of application did not influence the enzyme activity to greater extent (Table 2).

The activity of acid pyrophosphatase and alkaline pyrophosphatase showed a similar pattern of distribution as β glycerophosphatase (Table 1, Table 2).

TABLE 1. Effect of monocalcium phosphate as soil and foliar application and ATPase activity and alkaline pyrophosphatase expressed as μg of inorganic phosphorus liberated/ 100 mg of leaf.

Mode of application	Treatment	I 30 Activity	II 45 Activity	III 60 Activity	IV 75 days after transplanting activity
ATPase					
Soil	C	30	80	91	19
	T_1	35	88	100	37
	T_2	37	92	101	42
	T_3	51	98	103	40
	T_4	55	100	108	27
Foliar	C	30	80	91	19
	T_1	55	104	103	50
	T_2	55	88	108	35
	T_3	43	92	110	33
	T_4	47	92	113	24

C=Control, T_1=20, T_2=40, T_3=60, T_4=80 kg P_2O_5/ha.

Alkaline pyrophosphatase					
Soil	C	199	220	259	269
	T_1	208	224	262	274
	T_2	210	229	264	278
	T_3	224	231	268	282
	T_4	226	239	271	280
Foliar	C	199	220	259	268
	T_1	208	228	268	271
	T_2	215	234	270	281
	T_3	220	229	269	278
	T_4	218	225	264	275

C=Control, T_1=20, T_2=40, T_3=60, T_4=80 kg P_2O_5/ha.

The ATPase activity increased at the second and final stage, due to levels of phosphorus. Perhaps, as suggested by Mosolov *et al.* (1969) ATPase activity serves as on index of the energy available in plant tissues rather giving any indication of phosphorus requirements. A notable feature in

TABLE 2. Effect of monocalcium phosphate as soil and foliar application β-glycerophosphatase and Acid pyrophosphatase activity expressed as μg of inorganic phosphorus 100 mg of leaf.

Mode of application	Treatment	I 30 Activity	II 45 Activity	III 60 Activity	IV 75 days after transplanting Activity
β — glycerophosphatase					
Soil	C	162	189	222	253
	T_1	175	192	228	256
	T_2	179	189	234	261
	T_3	181	195	241	269
	T_4	183	196	242	267
Foliar	C	162	186	222	253
	T_1	179	191	231	256
	T_2	182	199	242	271
	T_3	169	194	250	269
	T_4	168	189	252	267
Acid pyrophosphatase					
Soil	C	170	190	209	214
	T_1	184	200	218	220
	T_2	191	199	224	225
	T_3	194	209	228	229
	T_4	199	211	229	231
Foliar	C	170	190	209	214
	T_1	198	200	219	224
	T_2	208	210	228	234
	T_3	189	212	214	230
	T_4	188	215	210	225

C=Control, T_1=20, T_2=40, T_3—60, T_4=80 kg P_2O_5/ha.

the case of β glycerophosphatase was the gradual increase in its activity with the aging of crop as in wheat during reproduction phase. Promekanon et *al.* (1963). Acid pyrophosphatase and alkaline pyrophosphatase showed similar trend as β glycerophosphatase. This may be as suggested by Naganna and Sripathi (1954) due to the association of alkaline pyrophosphatase with anaerobic process and the participation of acid pyrophosphatase in the catabolic process during the translocation of carbohydrates in the leaves.

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REFERENCES

HACKETT, D. P., 1959. Respiratory mechanism in higher plants. *Ann. Rev. Pl. Physiol.* **10**: 113—40.

HEWITT, E. J. and P. THATHAM, 1960. Interaction of mineral deficiency and nitrogen source on acid phosphatase activity in leaf extracts. *J. Expt. Bot.* **11**: 367—76.

MOSOLOV, I. V., A. I. CHEBAN and V. A. ALEKSANDROVSKAYA, 1969. Effects of various levels of 'N' and 'P' nutrition on ATPase of barley leaves. *Fld. Crop Abstr.* **22**: 3251.

NAGANNA, B. and E. E. SRIPATHI, 1954. Pyrophosphatase in plants during growth. *Nature*, **174**: 4430.

PROMEKANON, J., G. K. BARAT and N. B. DAS, 1963. Distribution of phosphatases in leaf, stem and root of wheat plant during the reproductive period. *Indian J. Expt. Biol.* **11**: 95—7.

SUMNER, J. B., 1944. A method for the colorimetric determination of phosphorus. *Science* **100**: 415.

UMBREIT, W. W., R. H. BURRIS and J. F. STANFFER, 1964. *Monometric technique*. Burgress Publishing Company. Minnessots. 305.