

Effect of Phosphorus Fertilization on the Respiratory Rate, Activity of Enzymes and Photosynthetic Rate of ADT 27 Rice (*Oryza sativa* L.)

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ABSTRACT

The effect of five levels of phosphorus viz., 15, 30, 45, 60 and 75 kg P_2O_5 /ha along with a control on the respiratory rate, activity of enzymes and photosynthetic rate on ADT 27 rice was studied at different stages of crop growth. Irrespective of the treatments phosphorus levels reduced the respiratory rates in young seedlings of 15 days as well as in the crop of 75 days after transplanting. Regarding the other intermediate stages in respect of this aspect, there was no consistency in the results obtained and the pattern of respiration did not indicate any direct relationship with phosphorus levels. There was a direct relationship between β -glycerophosphatase activity and phosphorus supply in various stages. A similar trend was noted in acid pyrophosphatase also. As regards alkaline pyrophosphatase, a progressive increasing tendency was seen from stage to stage in all the treatments. The ATPase activity was higher at flowering than at tillering stage. The effect of phosphorus levels on photosynthetic rate varied from stage to stage in the treatments. Irrespective of the levels of phosphorus used, an increase in photosynthetic rate at the second stage was noticed and there was a decline with the aging of the crop. There was a clear indication that 45 kg P_2O_5 /ha to be favourable in enhancing the photosynthetic activity.

INTRODUCTION

The essentiality of phosphorus for growth, tillering and root development and other desirable traits is well known. Since, it is one of the key elements in plant nutrition its absorption by plant depends largely on its available form in the soil. The time of application, the stage of the crop, climate, moisture and the other factors control the absorption, movement and utilization of this element. The various physiological processes as uptake of nutrient elements, photosynthetic rate,

enzyme activities, respiration and other phenomena are to a great extent conditioned by this element. With a view to elucidate the physiological effects on respiratory rate, enzyme activities and photosynthetic rate at different levels of phosphorus, the present study was undertaken utilizing ADT 27 rice.

MATERIALS AND METHODS

Investigations were carried out during 1968-69 under field condition at wet lands, Agricultural College and Research Institute, Coimbatore with ADT 27 rice. The design adopted was

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a randomised block design with four replications and six treatments viz., O (C), 15 (T_1), 30 (T_2), 45 (T_3), 60 (T_4), 75 (T_5) kg P_2O_5 /ha as basal dressing. Nitrogen and K were applied at 60 and 45 kg/ha as respectively along with 5000 kg of green leaf manure per/ha. The respiratory rate, activity of enzymes and photosynthetic rate were estimated at 15, 30, 45, 60 and 75 days after transplanting. As outlined by Umbreit *et al.* (1964) the respiratory rate of foliage was estimated by the Warburg's constant volume respirometer method and photosynthetic rate by manometric method. The activities of

β -glycerophosphatase acid and alkaline pyrophosphatases were determined in the leaf colorimetrically as suggested by Promekanon *et al.* (1963). The ATPase activity was estimated by the method after Umbreit *et al.* (1964) at tillering and flowering stages which corresponded with 30 and 60 days subsequent to transplanting.

RESULTS AND DISCUSSION

(i) **Respiratory rate:** The different levels of phosphorus did not have any particular influence on the respiratory rate (Table 1). At the first stage all

TABLE 1. Effect of Phosphorus levels on Respiratory rate expressed as μ l of O_2 absorbed/hr/mg of dry weight of leaf

Treatments	1	2	3	4	5 Stages
	15	30	45	60	75 days after transplanting
C	2.58	3.39	1.94	2.78	2.85
T_1	2.56	4.25	2.56	2.79	2.59
T_2	1.68	4.77	2.83	2.56	3.46
T_3	1.72	4.06	1.88	2.45	3.69
T_4	2.02	4.15	2.28	2.24	4.30
T_5	1.94	4.84	2.37	3.35	3.78

the treatments reduced the respiratory rates particularly T_2 (30 kg P_2O_5 /ha) and T_3 (45 kg P_2O_5 /ha). At the second stage all the treatments increased the value, the maximum rate being noted in plants which received the level of phosphorus viz., 75 kg P_2O_5 /ha. In the third stage except T_3 (45 kg P_2O_5 /ha) others increased the rates. At the fourth stage except the treatment T_5 (75 P_2O_5 /ha) others increased the

rates. At the fourth stage except the treatment T_5 (75 kg P_2O_5 /ha, the others indicated a low respiratory rate. The final samples showed that except the treatment T_1 (15 kg P_2O_5 /ha) others recorded a higher respiratory rate than the control. The respiratory rate at five stages of the crop indicated that phosphorus levels reduced the rates in young plants.

(ii) **Phosphatases and ATPase enzymes** : The trend of β -glycerophosphatase (Table 2) activity clearly showed a positive relationship with phosphorus supply. At all the five stages the treatments increased the activity cor-

responding to the level of phosphorus. This pattern of activity was more prominent at the first stage but reduced in the last two stages in all the treatments even though it was proportional to the progressive level of treatments.

TABLE 2. Effect of phosphorus levels on β -glycerophosphatase activity expressed as μ g of inorganic phosphorus liberated/mg dry weight of tissue

Treatments	1	2	3	4	5 Stages
	15	30	45	60	75 days after trans-planting
C	14.14	18.26	19.66	24.27	32.36
T ₁	16.30	19.03	20.32	24.58	32.86
T ₂	16.60	19.20	20.45	25.16	32.96
T ₃	16.70	19.82	20.98	25.78	33.23
T ₄	17.00	19.91	21.22	25.93	33.89
T ₅	17.27	19.99	21.49	26.21	33.99

The activity of acid pyrophosphatase (Table 3) showed a general increase from stage to stage to in respect of each treatment. At the same time

a steep increase in activity was evident at the first stage as a result of phosphorus levels. At the later stages however, the effect of treatment was not so high as in early stages.

TABLE 3. Effect of phosphorus levels on Acid pyrophosphatase activity, expressed as μ g of inorganic phosphorus liberated/mg dry weight of tissue.

Treatments	1	2	3	4	5 Stages
	15	30	45	60	75 days after trans-planting
C	15.26	16.26	17.28	21.38	22.76
T ₁	17.00	17.23	18.11	21.79	22.89
T ₂	17.26	17.78	18.47	22.14	22.99
T ₃	18.30	17.92	18.89	22.63	23.18
T ₄	18.60	18.02	18.98	22.83	23.54
T ₅	18.98	18.28	19.29	23.15	23.68

A proportional increase in the activity of alkaline pyrophosphatase (Table 4) was recorded in relation to the treatments. The rate of activity

nevertheless was more influenced by the phosphorus levels at the first three stages than the later stages of the crop.

TABLE 4. Effect of phosphorus levels on Alkaline pyrophosphatase activity expressed as μ g of inorganic phosphorus liberated/mg dry weight of tissue

Treatments	1 15	2 30	3 45	4 60	5 Stages 75 days after trans- planting
C	18.74	20.24	20.84	27.29	27.32
T ₁	19.52	21.75	22.34	27.92	27.68
T ₂	20.27	21.92	23.12	28.13	27.87
T ₃	20.58	22.20	23.33	28.59	27.92
T ₄	20.88	22.31	23.62	28.93	28.14
T ₅	20.96	22.46	24.13	29.04	28.54

Regarding the ATPase activity (Table 5) the flowering stage recorded higher value than the tillering stage irrespective of the treatments. Both at tillering and flowering stages an increase in activity was prominent with progressive levels of phosphorus supply. Ignatieef and Wasteneys (1936) and Promekanon *et al.* (1963) recorded that the enzyme activity was proportional to the phosphorus levels.

TABLE 5. Effect of phosphorus levels on ATPase activity expressed as μ g of inorganic phosphorus released/hr/g of fresh leaf

Treatments	Tillering Stage	Flowering Stage
C	3.9	5.2
T ₁	6.1	7.1
T ₂	6.4	7.4
T ₃	6.5	7.7
T ₄	6.8	8.1
T ₅	7.6	8.5

(iii) **Photosynthetic rate:** The photosynthetic rate (Table 6) was higher under medium phosphorus levels (30 and 45 kg P₂ O₅/ha) than in higher treatments (60 and 75 kg P₂ O₅/ha.) At the first stage the higher treatments *viz.* T₄ (60 kg P₂ O₅/ha) and T₅ (75kg P₂ O₅/ha) reduced the value below the control while in the rest of the stages an enhanced rate which was not proportional to the dosages used. At the second stage, there was an increase in photosynthetic rate but a gradual decline in the rate with the aging of the crop. Pirson *et al.* (Quoted by Brown and Frenkel, 1953) in *Ankistrodesmus* cultures and Lindeman (quoted by Brown and Frenkel, 1953) in *Lemnaminor* recorded that "addition of phosphate to phosphorus deficient culture increases the photosynthetic rate". The increase in photosynthetic rate in various

TABLE 6. Effect of phosphorus levels on Photosynthetic rate expressed as μ of O_2 evolved/hr/g dry weight of leaf

Treatments	1 15	2 30	3 45	4 60	5 Stages 75 days after trans- planting
C	2082	4580	4021	3138	2030
T ₁	2519	4836	4833	3193	2928
T ₂	2532	6480	5039	3416	2698
T ₃	2766	4745	4189	4582	2719
T ₄	2001	5802	4553	2434	2528
T ₅	1715	4938	4674	3869	2512

stages of the crop was not proportional to the levels of phosphorus tried. However, there was an indication that 45 kg P_2O_5 /ha was favourable in enhancing the photosynthetic rate.

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