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Growth Pattern of Three High Yielding Rice Varieties under Different Phosphorus Levels

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Abstract: An experiment was carried out at the Agronomy Field of the Sher-e-Bangla Agricultural University, Dhaka during the period from December, 2006 to June, 2007 study the relative performance of inbred and hybrid rice varieties at different levels of phosphorus. Three varieties of inbred and hybrid rice (BRRI dhan 29, Aloron and Hira-2) and five levels of phosphorus (0, 24, 48, 72 and 96 Kg P_2O_5 ha^{-1}) were the treatment variables. The experiment was laid out fallowing spilt plot design with three replications having varieties in the main plot and phosphorus rate in the sub-plot. Plant height and growth rate varied significantly due to the variations of variety. At all the growth stages the tallest plant was observed with 96 kg P ha^{-1} which was statistically at par with other P doses except 25 DAT where the maximum plant height with 96 kg ha^{-1} followed by with 72 kg ha^{-1}. At harvest the tallest plant was observed from V_1P_4 (102.63 cm) while the shortest plant was found with V_1P_0 (97.23 cm). The maximum CGR (33.24 g m^{-2} d^{-1}) was observed with Hira-2 which was statistically similar with Aloron. Application of 72 kg P_2O_5 ha^{-1} produced significantly highest CGR value (30.49 33.24 g m^{-2} d^{-1}) and the lowest in control (without P) at all the growth duration. Maximum CGR was observed with the combination of V_3P_3 which was statistically identical with V_3P_4 while the lowest CGR value at this duration was observed with V_1P_0 and V_1P_1. RGR was not significantly affected by varieties. Among the P levels, the highest RGR value was observed with P_0 and the lowest RGR was observed from P_4. The highest RGR was noticed by the treatment V_2P_0 and the lowest RGR was found with V_1P_3.

Key words: Oryza sativa · Dry matter · CGR · RGR · Productivity

INTRODUCTION

Rice (*Oryza sativa* L.) is the most important food crop of the tropical world. They occupy an area of 15.32 million ha with a production over 60.84 million metric tones [1]. Global average yield is 3.97 t ha^{-1} [1]. In Bangladesh majority of food grain come from rice. About 80% of cropped area of this country is used for rice production, with annual production of 2.51 million metric tons [2] in total acreage of 1.02 million ha. The average yield of rice in Bangladesh is 2.45 t ha^{-1} [2]. This is almost less than 50% of the world average yield. The principal causes of low productivity are poor crop husbandry, inadequate as well as lack of manuring, use of low yielding varieties and traditional method of cultivation, inadequate as well as lack of manuring. Among the production factors selection of variety plays an important role in the productivity if rice in any location. It was found that yield is differed significantly among varieties [3,4]. Nitrogen (N), phosphorus (P) and potassium (K) are the primary plant nutrients on which nitrogen plays an important role in growth and yield of rice plant and the demand of this nutrient is more than other nutrients [5]. Phosphorus deficiency symptoms appear in the lower part of the plant and results decreased leaf number, decreased leaf blade length, reduced panicles $plant^{-1}$, reduced seeds $panicle^{-1}$ and reduced filled seeds $panicle^{-1}$ [6]. Phosphorus not only enhances the yield of rice but also reduce the spikelet sterility. But the main problem concerning phosphatic fertilizers is its fixation with soil complex within a very short period of application rendering mare than two-thirds unavailable [7]. So it is necessary to know the optimum dose of phosphorus fertilizer for maximum yield and to reduce spikelet sterility of rice.

In view of these facts, an experiment was undertaken at Sher-e-Bangla Agricultural University, Dhaka during winter season to determine the effect of different varieties and phosphorus levels on the growth rate of rice plant.

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MATERIALS AND METHODS

The experiment was conducted in Boro season from December 2006 to June 2007 at the Agronomy field of Sher-e-Bangla Agricultural University, Dhaka-1207. The climate of this area is subtropical. The soil of the experimental site was clay loam in texture with pH of 5.47-5.63. There were two factors in this experiment viz., variety (V) and phosphorus levels (N). The three varieties were BRRI dhan29 (V_1), Aloron or HB-8 (V_2) and Hira-2 or HS-273 (V_3). Different P levels were 0 kg P_2O_5 ha^{-1} (P_0), 24 kg P_2O_5 ha^{-1} (P_1), 48 kg P_2O_5 ha^{-1} (P_2), 72 kg P_2O_5 ha^{-1} (P_3) and 960 kg P_2O_5 ha^{-1} (P_4). The experiment was laid out in a split-plot design with three replications. Varieties were placed in main plots and phosphorus treatments were placed in sub-plots.

Seedlings were transplanted on January 11, 2007 in the well-puddled experimental plots. Spacing's were given 20cm × 15cm for BRRI dhan29 and 20cm × 20cm for hybrid varieties. Soil of the plots was kept moist without allowing standing water at the time of transplanting. Two seedlings for BRRI dhan29 and one seedling for hybrid varieties were transplanted $hill^{-1}$. Seedlings of 30 days old for BRRI dhan29 and 25 days old hybrid varieties were uprooted from the nursery beds carefully. A fertilizer dose of 250-120-70-10 kg N, K, S and Zn ha^{-1} as urea, muriate of potash, gypsum and zinc sulphate were applied in the field. Phosphorus fertilizer was need as per treatment from triple super phosphate. Full dose of triple super phosphate, muriate of potash, gypsum and zinc sulphate were applied as basal dose at the time of final land preparation and incorporated well into the soil. Besides, cowdung at the rate of 10 t ha^{-1} was applied before final ploughing. Urea was applied in three equal splits at 15, 30 and 55 days after transplanting (DAT) for all varieties. Weeding, irrigation, plant protection measures and other intercultural operations were done as when ever necessary. Data were recorded from 25 days of transplantation and continued up to harvest. The following data were recorded during the study period.

Three hills were collected randomly from each plot hill for collecting data. Dry weights of different parts were taken by drying them in electric oven (Perkin-Elmer Corporation, USA) at 60°C for 72 hours followed by weighing by digital balance (Kaifeng Group Co., Ltd., China). CGR and RGR values for the crop during the sampling intervals have been computed by using the formulae of Brown [8] and Radford [9].

$$CGR = \frac{W_2 - W_1}{SA(t_2 - t_1)} \text{ g m}^{-2} \text{ d}^{-1}$$

Where, SA= Ground area occupied by the plant at each sampling. W_1 and W_2 are the total dry matter production in grams at the time t_1 and t_2 respectively.

$$RGR = \frac{L_n W_2 - L_n W_1}{T_2 - T_1} \text{ g g}^{-1} \text{ d}^{-1}$$

Where, W_1 and W_2 is initial and final dry matter weight at the time T_1 and T_2 respectively. L_n refers to Natural Logarithm.

The data were analysed following Analysis of Variance (ANOVA) technique and mean separations were adjusted by the Multiple Comparison test [10] using the statistical computer programme MSTAT-C v.1.2 [11]. Means were compared by using LSD test at 5% level of significance.

RESULTS AND DISCUSSION

Plant Height: A significant difference in plant height at different growth stage was observed due to the varietal difference (Table 1). Plant height increased progressively over time attaining the highest at maturity. The rate of increase of increase, however, varied depending on the growth stages. At all the growth stages, maximum plant height was observed with BRRI dhan 29 which was followed by Aloran. Two hybrid varieties viz. 'Aloron' and 'Hira-2' resulted statistically similar plant height up to 100 days after transplanting (DAT). The increase rate of plant height was very first from 50 DAT to 75 DAT. The plant height was varied mainly due to its genetic characters and thus the differences were observed in such cases.

Significant variation in plant height was observed due to different levels of phosphorus at all growth stages except 50 DAT (Table 1). Regardless of treatment differences, plant increased progressively up to maturity. A rapid growth rate followed after 25 DAT that continued till at all the P levels. The plants grown with 96 kg P ha^{-1} produced maximum height at all growth stages which was statistically at a with other P doses except 25 DAT. At 25 DAT, the maximum plant height was obtained with 96 kg P ha^{-1} and it was statistically similar with 72 kg P ha^{-1}. It revealed that when rice plant attained the vegetative stage then the differences in P did not affect the plant height significantly. It can be said that P can increase the plant height at initial stage of rice life cycle. Morgan [12] also reported the similar effect of phosphorus on the plant height. Plants grown without P fertilizer produced the shortest plant irrespective of

Table 1: Effect of variety and phosphorus on plant height at different days after transplantation (DAT)

	Plant height (cm) at different DAT				
Treatments	25	50	75	100	At Harvest Variety
BRRI dhan 29	36.83 a	47.01 a	72.00 a	99.40 a	100.26 a
Aloron	35.05 b	45.58 ab	70.22 ab	97.80 b	99.63 a
Hira-2	35.04 b	45.03 b	70.01 b	97.70 b	98.24 b
$S\bar{x}$	0.39	0.48	0.48	0.39	0.28
CV (%)	5.30	8.35	8.42	6.35	7.36
Levels of Phosphorus					
P_0	35.23 b	47.03	70.22 b	97.76 b	99.70 b
P_1	35.93 b	47.25	71.11 ab	98.96 ab	100.40 ab
P_2	36.08 b	47.59	71.52 ab	99.01 ab	100.80 ab
P_3	37.80 a	48.22	72.45 a	99.99 a	100.90 ab
P_4	37.85 a	48.33	72.70 a	100.23 a	101.40 a
$S\bar{x}$	0.497	NS	0.59	0.50	0.50
CV (%)	6.30	7.20	9.67	7.02	8.06

Means sharing common letters are not significantly different at alpha=0.05 as per DMRT

P_0 = No phosphorus (control), P_1= 24 Kg P_2O_5 ha^{-1}, P_2 = 48 Kg P_2O_5 ha^{-1}, P_3 = 72 Kg P_2O_5 ha^{-1} and P_4 = 96 Kg P_2O_5 ha^{-1}

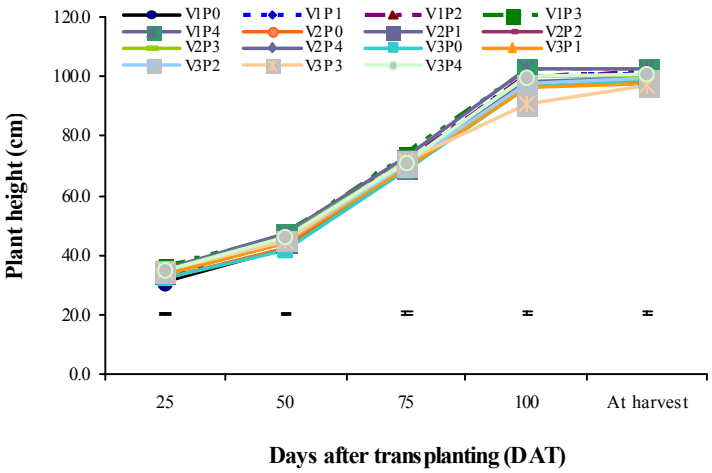

Fig 1: Interaction effect of variety and phosphorus on plant height at different days after transplantation (Vertical bars indicate the standard errors or means at P=0.05) V_1= BRRI dhan 29, V_2= Aloron (HB-8), V_3= Hira-2 (HS-273)
P_0= No phosphorus (control), P_1= 24 Kg P_2O_5 ha^{-1}, P_2 = 48 Kg P_2O_5 ha^{-1}, P_3 = 72 Kg P_2O_5 ha^{-1} andP_4 = 96 Kg P_2O_5 ha^{-1}

growth stages. De Datta [13] reported stunted plant height due to deficiency of phosphorus.

Varieties and P levels interaction effect on plant height was also statistically significant (Fig 1). At 25 DAT, the tallest plant (36.40 cm) was recorded by the interaction effect of BRRI dhan 29 and 72 kg P_2O_5 ha^{-1} which was statistically similar with all the interactions except where no P was applied. The lowest plant height (30.77 cm) was observed from the treatment combination of V_1P_0. Similar trend was observed at 50 and 75 DAT. At 50 DAT, the tallest plant height was observed from V_1P_4 (47.28 cm) and the shortest from V_3P_0 (41.11 cm). At 75 DAT, the tallest plant (73.75 cm) was resulted by V_1P_3 where the lowest plant height was found with V_3P_0. At 100 DAT, the tallest plants were observed from V_1P_4 which was at par with V_1P_2, V_1P_2, V_1P_3, V_2P_3, V_2P_4, P_3P_3 and V_3P_4. At harvest, the tallest plant was observed from V_1P_4 (102.63 cm) while the shortest plant was found with V_1P_0 (97.23 cm). Application of phosphorus at any doses increases the plant metabolism and thus the cell growth was increased compared to control. This result was supported by Morgan [12].

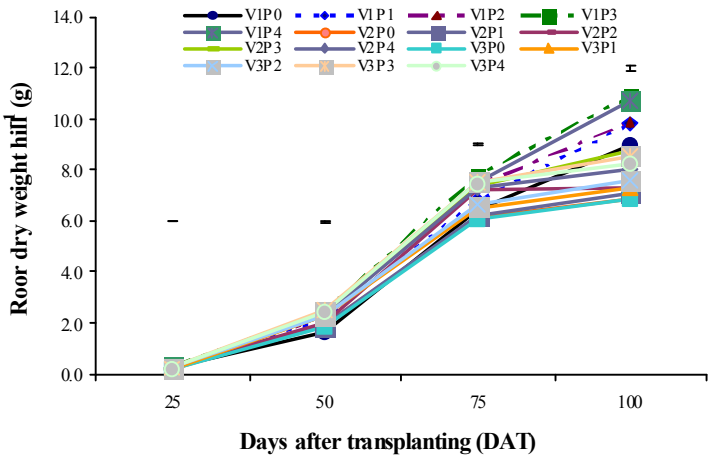

Fig. 2: Interaction effects of variety and phosphorus on root dry weight hill^{-1}different days after transplantation (Vertical bars indicate the standard errors or means at P=0.05) V_1= BRRI dhan 29, V_2= Aloron (HB-8), V_3= Hira-2 (HS-273) P_0= No phosphorus (control), P_1= 24 Kg P_2O_5 ha^{-1}, P_2 = 48 Kg P_2O_5 ha^{-1}, P_3 = 72 Kg P_2O_5 ha^{-1} and P_4 = 96 Kg P_2O_5 ha^{-1}

Table 2: Effect of variety and phosphorus on total dry weight of plant at different days after transplantation

	Total Dry weight of plant hill^{-1} (g) at different DAT			
Treatments	25	50	75	100
Variety				
BRRI dhan29	0.59	5.53	15.91 b	34.70 b
Aloron	0.56	5.64	16.06 b	39.91 a
Hira-2	0.60	5.64	17.28 a	42.22 a
S$\bar{x}$	NS	NS	1.12	2.36
CV (%)	6.30	5.68	9.36	6.44
Levels of Phosphorus				
P_0	0.45 b	4.53 b	15.83 b	34.61 d
P_1	0.60 a	4.71 b	17.15 ab	36.20 cd
P_2	0.62 a	4.94 b	17.92 a	37.87 bc
P_3	0.74 a	5.57 a	18.61 a	41.48 a
P_4	0.74 a	5.51 a	18.19 a	40.03 ab
S$\bar{x}$	0.04	0.18	0.62	0.86
CV (%)	6.43	8.36	5.86	6.45

V_1= BRRI dhan 29, V_2= Aloron (HB-8), V_3= Hira-2 (HS-273)
P_0= No phosphorus (control), P_1= 24 Kg P_2O_5 ha^{-1}, P_2 = 48 Kg P_2O_5 ha^{-1}, P_3 = 72 Kg P_2O_5 ha^{-1} and P_4 = 96 Kg P_2O_5 ha^{-1}

Total Dry Matter Plant^{-1}: The significant effect of variety on total dry matter production in plant was observed at 75 DAT and 100 DAT (Table 2). At 25 and 50 DAT, dry matter plant^{-1} was influence non-significantly across the varieties. But numerically the highest dry matter of plant was observed with the variety Hira-2 and the lowest from BRRI dhan 29 at all the growth stages except 25 DAT. At 75 DAT the maximum dry weight (17.28 g) was found with Hira-2 variety followed by Aloron (16.06 g). At 100 DAT the highest dry weight was obtained by Hira-2 (42.2 g) which was statistically similar with Aloron (39.91 g). Main [14] also observed that hybrid rice produced more dry matter in plant than inbred varieties.

In case of different phosphorus levels, a significant variation was found in the total dry matter accumulation at different growth stages. Accumulation of dry matter increased progressively over time attaining the highest at 100 DAT. The rate of increase, however, varied depending on variety and the stage of growth. At 25 DAT except the control all the levels of P has no significant difference to accumulate the total dry matter in rice plant. At 50 DAT the significantly higher total dry matter was found with 72 (5.57 g) and 96 kg P_2O_5 ha^{-1} (5.51 g). Plants grown without P fertilizer (P_0) produced the lowest dry matter yield which was statistically similar with P_1 and P_2. At 75 DAT, 24 kg to 96 kg P_2O_5 ha^{-1} gave identical results, where the lowest dry matter was observed with control (15.83 g). At 100 DAT, the highest dry matter was observed from P_3 treatment which was at par with P_4. The second highest dry matter was found with 48 kg P_2O_5 ha^{-1}. Generally the control treatment where no phosphorus was applied produced the lowest dry matter. Positive influence of phosphorus on total dry matter in rice was also reported by Gupta and Bhadra [15] and Shasrkar and Chowdhury [16].

Significant interaction effect of variety and phosphorus was observed to accumulate dry mater in plant at all the growth stages (Fig. 2). Regardless of the treatment difference, TDM increased progressively over time. In the beginning of the growth cycle, the difference in TDM was not significant due to varieties and P levels.

Table 3: Effect of variety and phosphorus on crop growth rate at different days after transplantation

	CGR (g m^{-2} d^{-1}) at different DAT		
Treatment	25 to 50	50 to 75	75 to 100
Variety			
BRRI dhan29	6.58	13.83	25.05 b
Aloron	6.72	13.89	31.79 a
Hira-2	6.77	15.51	33.24 a
$S\bar{x}$	NS	NS	1.114
CV (%)	6.58	6.89	7.50
Levels of Phosphorus			
P_0	5.43 b	15.06 c	25.03 d
P_1	5.48 b	16.58 b	25.39 cd
P_2	5.75 b	17.30 a	26.60 c
P_3	6.44 a	17.38 a	30.49 a
P_4	6.35 a	16.91 ab	29.12 b
$S\bar{x}$	0.14	0.20	0.45
CV (%)	8.65	5.36	7.25

V_1= BRRI dhan 29, V_2= Aloron (HB-8), V_3= Hira-2 (HS-273)

P_0= No phosphorus (control), P_1= 24 Kg P_2O_5 ha^{-1}, P_2= 48 Kg P_2O_5 ha^{-1}, P_3= 72 Kg P_2O_5 ha^{-1} and P_4= 96 Kg P_2O_5 ha^{-1}

Table 4: Interaction effect of variety and phosphorus on crop growth rate at different days after transplantation

	CGR (g m^{-2} d^{-1}) at different DAT		
Treatment	25 to 50	50 to 75	75 to 100
V_1P_0	4.71 e	15.58 cde	24.02 i
V_1P_1	5.61 de	15.28 de	25.91 hi
V_1P_2	5.64 de	16.47 a-d	27.07 gh
V_1P_3	6.41 b-d	17.88 a	28.62 f-g
V_1P_4	6.30 b-d	17.28 a-c	28.48 f-g
V_2P_0	5.51 de	14.00 e	30.74 d-f
V_2P_1	6.64 a-d	15.08 de	30.02 e-g
V_2P_2	7.03 a-d	15.72 b-e	33.22 cd
V_2P_3	7.63 ab	17.65 a	36.78 ab
V_2P_4	7.22 a-c	17.52 ab	35.02 bc
V_3P_0	5.58 de	13.89 e	29.03 e-h
V_3P_1	6.08 cde	15.36 de	31.88 de
V_3P_2	6.68 a-d	17.92 a	35.19 bc
V_3P_3	8.03 a	18.15 a	38.61 a
V_3P_4	7.66 ab	17.77 a	38.48 a
$S\bar{x}$	0.45	0.58	0.97
CV (%)	8.65	5.36	7.25

V_1= BRRI dhan 29, V_2= Aloron (HB-8), V_3= Hira-2 (HS-273)

P_0= No phosphorus (control), P_1= 24 Kg P_2O_5 ha^{-1}, P_2= 48 Kg P_2O_5 ha^{-1}, P_3= 72 Kg P_2O_5 ha^{-1} and P_4= 96 Kg P_2O_5 ha^{-1}

Sharp differences among the varieties in TDM emerged from 50 DAT and it progressively irrespective of P levels. At all the growth stages significantly highest total dry matter was observed with the treatment combination of V_3P_3. At 25 DAT the highest total dry matter was obtained with V_3P_3 (0.72 g) which was statistically similar with all other treatments except V_1P_0 and V_3P_0. At 50 DAT the highest total dry matter (6.74 g) was found with V_3P_3, where the lowest dry matter was found with V_1P_0. Significantly highest dry matter accumulation was also observed at 75 DAT with V_3P_3 (20.36 g) while the lowest dry matter was noticed with V_3P_0. At 100 DAT highest total dry matter was observed with V_3P_3 (49.33 g) which was statistically at par with V_3P_4, V_3P_2, V_2P_3 and V_2P_4. The lowest total dry matter in this stage was observed with the interaction of V_1P_0. Sarkar and Chowdhury [16] observed more dry matter with increased P doses combined with hybrid varieties.

Crop Growth Rate: Among three different sampling dates only significant differences in crop growth rate (CGR) due to variety was observed at 75 to 100 DAT (Table 3). However, the CGR values increased progressively with time reaching the highest at 75-100 DAT regardless of variety. Numerically the maximum crop growth rate was observed with Hira-2. At 75-100 DAT the maximum CGR (33.24 g m^{-2} d^{-1}) was observed with Hira-2 and it was statistically identical with Aloron (31.79 g m^{-2} d^{-1}), which revealed that hybrid variety got more growth habit than inbred variety. BRRI dhan 29 showed the lowest CGR value during the whole growth period, Main (2006) also observed the similar result in respect of CGR with rice varieties.

Different levels of phosphorus had significant effect on crop growth rate of rice varieties (Table 3). Irrespective P levels, CGR values increased progressively with the advancement of plant age. The highest CGR value was associated with 72 kg P_2O_5 ha^{-1} (P_3) at all the growth duration. Addition of P fertilizer beyond 72 kg P_2O_5 ha^{-1}decreased CGR value irrespective of growth stages. During 25-50 DAT the maximum CGR value was observed with P_3 (6.44 g m^{-2} d^{-1}) which was statistically at par with P_4 (6.35 g m^{-2} d^{-1}). At 50-75 DAT the highest CRG was obtained from P_3 (17.38 g m^{-2} d^{-1}) and it was statistically identical with P_2 (17.30 g m^{-2} d^{-1}) and P_4 (16.91 g m^{-2} d^{-1}). Plant grown without P fertilizer had the CGR values at all the growth stages. Such information of rice was also reported by Fageria *et al.* [17].

The interaction effect of variety and phosphorus had a significant influence on crop growth rate at all the growth duration (Table 4). Regardless of treatment, CGR values increased progressively with time reaching the highest at 75-100 DAT. From 25 to 50 DAT the highest CGR was observed with the treatment V_3P_3 (8.03 g m^{-2} d^{-1}) and the

Table 5: Effect of variety and phosphorus on relative growth rate at different days after transplantation

Treatment	RGR (g g^{-1} d^{-1}) at different DAT		
	25 to 50	50 to 75	75 to 100
Variety			
BRRI dhan29	0.089	0.042	0.031
Aloron	0.092	0.045	0.036
Hira-2	0.089	0.042	0.036
$S\bar{x}$	NS	NS	NS
CV (%)	6.45	6.38	6.35
Levels of Phosphorus			
P_0	0.092 a	0.050 ab	0.031
P_1	0.082 b	0.052 a	0.030
P_2	0.083 b	0.052 a	0.030
P_3	0.081 b	0.048 b	0.032
P_4	0.080 b	0.048 b	0.032
$S\bar{x}$	0.0014	0.0010	NS
CV (%)	5.64	5.68	9.23

V_1= BRRI dhan 29, V_2= Aloron (HB-8), V_3= Hira-2 (HS-273)

P_0= No phosphorus (control), P_1= 24 Kg P_2O_5 ha^{-1}, P_2= 48 Kg P_2O_5 ha^{-1}, P_3= 72 Kg P_2O_5 ha^{-1} and P_4= 96 Kg P_2O_5 ha^{-1}

Table 6: Interaction effect of variety and phosphorus on relative growth rate at different days after transplantation

Treatment	RGR (g g^{-1} d^{-1}) at different DAT		
	25 to 50	50 to 75	75 to 100
V_1P_0	0.086 cde	0.055 a	0.031 bc
V_1P_1	0.086 cde	0.049 bc	0.031 bc
V_1P_2	0.083 de	0.051 ab	0.031 bc
V_1P_3	0.082 e	0.049 bc	0.030 c
V_1P_4	0.083 de	0.049 bc	0.031 bc
V_2P_0	0.087 b-e	0.047 b-d	0.037 a
V_2P_1	0.092 ab	0.045 cd	0.034 ab
V_2P_2	0.094 a	0.044 d	0.035 a
V_2P_3	0.090 a-c	0.045 cd	0.035 a
V_2P_4	0.089 a-c	0.046 cd	0.034 ab
V_3P_0	0.089 a-c	0.047 b-d	0.036 a
V_3P_1	0.087 b-e	0.047 b-d	0.036 a
V_3P_2	0.088 b-d	0.049 bc	0.035 a
V_3P_3	0.089 a-c	0.044 d	0.035 a
V_3P_4	0.088 b-d	0.045 cd	0.036 a
$S\bar{x}$	0.0015	0.0014	0.0010
CV (%)	5.64	5.68	9.23

V_1= BRRI dhan 29, V_2= Aloron (HB-8), V_3= Hira-2 (HS-273)

P_0= No phosphorus (control), P_1= 24 Kg P_2O_5 ha^{-1}, P_2= 48 Kg P_2O_5 ha^{-1}, P_3= 72 Kg P_2O_5 ha^{-1} and P_4= 96 Kg P_2O_5 ha^{-1}

lowest (4.71 g m^{-2} d^{-1}) from the treatment V_1P_0. During 50 to 75 DAT the highest CGR was found with V_3P_3 (18.15 g m^{-2} d^{-1}) where the lowest CGR was observed with V_3P_0 (13.89 g m^{-2} d^{-1}). Maximum CGR during 75 to 100 DAT was observed with V_3P_3 (38.61 g m^{-2} d^{-1}) which was statistically identical with V_3P_4 (38.48 g m^{-2} d^{-1}) and V_2P_3 (36.78 g m^{-2} d^{-1}). The lowest CGR value at this duration was observed with V_1P_0 (24.02 g m^{-2} d^{-1}) and V_1P_1 (25.91 g m^{-2} d^{-1}).

Relative Growth Rate: Variety did not influence the relative growth rate at all the growth duration (Table 5). However, numerically the highest RGR value was observed with Aloron variety and the lowest from the variety BRRI dhan 29 at all the growth duration.

Relative growth rate (RGR) at different growth durations significantly influenced by phosphorus levels (Table 5). Irrespective of P levels, RGR was more at early stage (25-50DAT) and showed a decreasing trend with the advancement of plant age. At 25 to 50 DAT the highest RGR was observed with P_0 (0.092 g g^{-1} d^{-1}) where the lowest RGR (0.08 g g^{-1} d^{-1}) was observed from P_4. During 50 to 75 DAT P_1 and P_2 (0.052 g g^{-1} d^{-1}) showed the highest RGR values followed by P_0. Generally the highest RGR was observed with 72 and 96 kg P_2O_5 ha^{-1} (0.032 g g^{-1} d^{-1}) but the effect was not statistically different. The trend of RGR was partially supported by Fageria and Baligar [18] in rice plant.

Significant effect of the interaction of variety and phosphorus was observed in relation to relative growth rate in this study (Table 6). RGR values were more at early stage in the season and showed a decreasing trend with the advancement of plant age irrespective of treatments. The decrease RGR was probably due to the increase of metabolically active tissue and as obtained less to the plant growth. During 25 to 50 DAT the highest RGR was observed with the treatment V_2P_2 (0.094 g g^{-1} d^{-1}) which was followed by the interaction effect of V_2P_1, V_2P_3, V_2P_4, V_3P_0 and V_3P_3. The lowest RGR was observed by V_1P_3 (0.082 g g^{-1} d^{-1}). During 50 to 75 DAT V_1P_0 resulted the highest RGR (0.055 g g^{-1} d^{-1}) followed by V_1P_2 (0.051 g g^{-1} d^{-1}). The lowest RGR (0.044 g g^{-1} d^{-1}) was found with V_2P_2 and V_3P_3. During 75 to 100 DAT the highest RGR (0.037 g g^{-1} d^{-1}) was noticed by the treatment V_2P_0 and the lowest RGR (0.030 g g^{-1} d^{-1}) from V_1P_3.

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