

Original Research Article

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## Cultivars and Phosphorus Fertilization Effects on Growth Parameters of Direct-Seeded Rice

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### ABSTRACT

#### Keywords

Cultivars, Direct-seeded Rice, Microbial inoculants, Phosphorus fertilization

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A field experiment was conducted to study the effect of cultivars and phosphorus (P) applications on growth parameters of direct-seeded rice (DSR) during *kharif* 2016 at the research farm of ICAR- Central Rainfed Upland Rice Research Station, Hazaribag, Jharkhand. The experiment was laid out in split plot design with three replications. The rice cultivars 'Vandana' 'Anjali' and 'CR Dhan 40' were included in main plots, and seven different P rates through SSP and microbial inoculants viz., 0 kg ha<sup>-1</sup>, PSB+AM, 30 kg P<sub>2</sub>O<sub>5</sub>, 30 kg P<sub>2</sub>O<sub>5</sub> + PSB+AM, 60 kg P<sub>2</sub>O<sub>5</sub>, 60 kg P<sub>2</sub>O<sub>5</sub>+ PSB+AM and 90 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> were applied in subplot. Results obtained from the experiment showed that all the growth parameters like plant height, plant tillers m<sup>-2</sup>, dry matter accumulation (g m<sup>-2</sup>) and crop growth rate (g m<sup>-2</sup> day<sup>-1</sup>) were recorded higher in rice cultivar 'CR Dhan 40' compared to 'Anjali' and 'Vandana'. Likewise, highest values for all growth parameters were observed with P application of 90 kg P<sub>2</sub>O<sub>5</sub> through SSP which remained at par with 60 kg P<sub>2</sub>O<sub>5</sub> supplied through SSP along with microbial inoculants.

### Introduction

Rice is grown under various types of ecologies in India. The transplanting of rice seedlings in puddled soil (PTR) followed by flooding is the most common practice of rice cultivation. This practice consumes lot of water, labour and energy (Kumawat *et al.*, 2016). Moreover, deleterious effect of puddling on soil physical properties is also seen on the subsequent wheat crop grown in rotation. The dry direct-seeded rice (DSR) is a resource conservation technology which requires less labour, water and often matures earlier than transplanted crops (Mahajan *et al.*, 2017). The higher weed and nematode infestation and iron deficiency

are the major problems for achieving higher grain yield of DSR (Kumar *et al.*, 2017).

The Availability of phosphorus is a major concern under direct seeded upland fields in clay loam soils where it is deficient and is a major factor contributing to low yield of rice. The Phosphorus deficiency is more common in dry seeded rice because of more fixation and decreased mobility in the soil. The poor phosphorus acquisition is a major constraint, and therefore use efficiency of P is very low (15-20 %). However, P efficiency can be improved by enhancing internal utilisation efficiency with the use of microbial inoculants (Richardson *et al.*, 2011a). Maiti *et al.*, (2011)

conducted an experiment to improve P nutrition of upland rice by application of AM fungi and found that phosphorus uptake and rice yield was significantly increased. Application of PSB has been reported to stimulate nitrogen fixation, production of plant growth promoting substances such as siderophores and lytic enzyme (Stephen *et al.*, 2011). Therefore, a study was conducted to understand the effect of cultivar and P rates on growth and quality parameters of DSR.

### Materials and Methods

A field experiment was conducted during the *kharif* season of 2016 at research farm of ICAR- Central Rainfed Upland Rice Research Station, Hazaribag, Jharkhand (23°56' N, 85°21' E, and 614 m above the mean sea level). The soil was clay loam in texture with medium in organic C (0.62%), low in available N (153 kg ha<sup>-1</sup>), available P (10.30 kg ha<sup>-1</sup>) and high in available K (380 kg ha<sup>-1</sup>) with pH of 6.8. The annual rainfall of the experimental site was 1450 mm.

The experiment was laid out in split plot design having three cultivars in the main plots as Vandana, Anjali and CR Dhan 40 and seven different P fertilization practices in sub plots viz., P1: No P; P2: PSB+AM; P3: 30 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> through SSP; P4: 30 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> through SSP+PSB+AM; P5: 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> through SSP; P6: 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> through SSP+PSB+AM and P7: 90 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> through SSP. The rice was directly sown with the help of multi-row crop planter using a seed rate of 30 kg ha<sup>-1</sup> at row to row spacing of 20 cm. The recommended dose of N and K as 60 kg N ha<sup>-1</sup> and 40 kg K<sub>2</sub>O ha<sup>-1</sup>, respectively were applied. The half dose of N and full dose of K was applied as basal through urea and Muriate of potash, respectively. The various doses of P were applied as basal through the different combinations of single super phosphate, phosphorus solubilising bacteria

(PSB) and arbuscular mycorrhizae (AM). PSB was inoculated on seeds whereas AM was applied in soil before sowing. The plant height was measured from the base of the plant at ground surface up to the tip of the growing tip of the plant. The five plants were selected randomly from each plot, tagged permanently and plant height was measured at 30 days interval. The number of tillers were counted from one square meter area starting from 30, 60 and 90 DAS and ultimately averaged into tillers m<sup>-2</sup>. For dry matter accumulation, rice plants from one square meter were cut close to the ground level in each plot at 30, 60 and 90 DAS. The samples were then sun-dried for 2-3 days followed by oven drying at 60-65 ± 2°C for 24 hours. Thereafter weighing was done.

### Results and Discussion

All the growth parameters were significantly influenced by different rice cultivars as well as P fertilization practices. The rice cultivar 'Vandana' recorded highest plant height compared to 'Anjali' and 'CR Dhan 40' at 60 DAS and 90 DAS due to genetically tall nature of 'Vandana' cultivar. Inverse linear relationship between plant height and grain yield had been reported by Anwar *et al.*, (2010). The plant height was influenced significantly by the various P fertilization practices. Among various P levels, application of 90 kg P<sub>2</sub>O<sub>5</sub> through SSP recorded significantly highest plant height which remained at par with 60 kg P<sub>2</sub>O<sub>5</sub> through SSP along with PSB and AM. However, no P fertilization had lowest plant height (Table 4.1). Moreover, application of only microbial inoculants was not effective compared to no P application but it was found more efficient when applied along with P through water soluble fertilizers. The application of P enhanced the water absorption and nutrient uptake from the soil (Kato *et al.*, 2006). This might be one of the reasons behind higher growth of rice plants due to P fertilization.

**Table.1** Effect of cultivars and phosphorus fertilization on plant height (cm) and plant tillers ( $m^{-2}$ ) of DSR at various growth stages

Treatment	Plant height (cm)			Plant tillers $m^{-2}$	
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS
<b>Cultivars (C)</b>					
Vandana	40.09	70.47	102.65	143	299
Anjali	39.38	66.62	97.45	144	326
CR Dhan 40	39.58	68.93	97.24	146	367
SEm±	1.17	0.99	1.42	1.08	2.92
CD (P=0.05)	NS	3.00	4.30	NS	8.85
<b>Phosphorus levels (P)</b>					
P1	38.51	65.70	95.32	142	317
P2	38.68	66.23	95.79	143	319
P3	39.37	67.82	98.32	144	326
P4	39.65	68.26	98.91	145	328
P5	40.11	70.24	101.18	146	338
P6	40.60	70.84	101.85	147	342
P7	40.87	71.64	102.41	148	344
SEm±	0.59	0.68	0.90	2.08	1.98
CD (P=0.05)	NS	2.06	2.73	NS	6.00

P<sub>1</sub>; 0 kg P<sub>2</sub>O<sub>5</sub>; P<sub>2</sub>; PSB+AM; P<sub>3</sub>; 30 kg P<sub>2</sub>O<sub>5</sub> through SSP; P<sub>4</sub>; 30 kg P<sub>2</sub>O<sub>5</sub> through SSP+PSB+AM; P<sub>5</sub>; 60 kg P<sub>2</sub>O<sub>5</sub> through SSP; P<sub>6</sub>; 60 kg P<sub>2</sub>O<sub>5</sub> through SSP+PSB+AM; P<sub>7</sub>; 90 kg P<sub>2</sub>O<sub>5</sub> through SSP

**Table.2** Effect of cultivars and phosphorus fertilization on dry matter accumulation ( $g m^{-2} day^{-1}$ ) and CGR ( $g m^{-2} day^{-1}$ ) of DSR at various growth stages

Treatment	Dry matter accumulation ( $g m^{-2}$ )			Mean CGR ( $g m^{-2} day^{-1}$ )		
	30 DAS	60 DAS	90 DAS	30 DAS	60DAS	90DAS
<b>Cultivars (C)</b>						
Vandana	68	320	1013	2.29	8.39	23.10
Anjali	68	329	1073	2.28	8.71	24.77
CR Dhan 40	69	364	1155	2.31	8.94	26.35
SEm±	0.43	4.41	6.72	0.04	0.08	0.18
CD (P=0.05)	NS	13.36	20.36	NS	0.22	0.57
<b>Phosphorus levels (P)</b>						
P1	66	321	1046	2.22	8.47	24.16
P2	67	323	1053	2.24	8.54	24.32
P3	68	333	1073	2.27	8.84	24.67
P4	68	336	1080	2.29	8.91	24.79
P5	69	349	1096	2.31	9.33	24.88
P6	70	351	1106	2.34	9.36	25.16
P7	70	353	1109	2.36	9.40	25.21
SEm±	1.03	3.17	3.77	0.01	0.04	0.15
CD (P=0.05)	NS	9.60	11.42	NS	0.12	0.43

P<sub>1</sub>; 0 kg P<sub>2</sub>O<sub>5</sub>; P<sub>2</sub>; PSB+AM; P<sub>3</sub>; 30 kg P<sub>2</sub>O<sub>5</sub> through SSP; P<sub>4</sub>; 30 kg P<sub>2</sub>O<sub>5</sub> through SSP+PSB+AM; P<sub>5</sub>; 60 kg P<sub>2</sub>O<sub>5</sub> through SSP; P<sub>6</sub>; 60 kg P<sub>2</sub>O<sub>5</sub> through SSP+PSB+AM; P<sub>7</sub>; 90 kg P<sub>2</sub>O<sub>5</sub> through SSP.

Similarly, numbers of plant tillers  $m^{-2}$  were also influenced significantly by different rice cultivars as well as P fertilization practices. The rice cultivar 'CR Dhan 40' registered significantly higher number of tillers  $m^{-2}$  followed by 'Vandana' and 'Anjali' at 60 and 90 DAS. This might be due to faster vigorous growth and genetic characteristic of the variety. The application of 90 kg  $P_2O_5$  through SSP recorded significantly higher number of plant tillers  $m^{-2}$  at 60 and 90 DAS which remained at par with 60 kg  $P_2O_5$  through SSP+ PSB+AM (Table 4.1).

Dry matter accumulation was significantly influenced by the different cultivars and P fertilization practices. The rice cultivar 'CR Dhan 40' recorded significantly highest dry matter accumulation followed by 'Vandana' and 'Anjali' at 60 (364  $g\ m^{-2}$ ) and 90 DAS (1155  $g\ m^{-2}$ ). This was mainly due to higher synthesis and translocation of photosynthates which resulted in higher dry matter accumulation (Mahajan *et al.*, 2017). In general, the dry matter accumulation was increased with increasing P rate along with microbial inoculants. Among various P levels, application of 90 kg  $P_2O_5$  through SSP recorded significantly highest dry matter accumulation at 60 (353  $g\ m^{-2}$ ) and 90 DAS (1109  $g\ m^{-2}$ ), which remained at par (1106  $g\ m^{-2}$ ) with 60 kg  $P_2O_5$  through SSP+ PSB+AM.

Likewise, The CGR of rice plants was significantly influenced by the different cultivars of rice and P fertilization (Table 2). The highest CGR was observed in a rice variety 'CR Dhan 40' as compared to other varieties at 31 - 60 DAS (8.94  $g\ m^{-2}day^{-1}$ ) and 61 - 90 DAS (26.35  $g\ m^{-2} day^{-1}$ ). However, there was statistically no considerable difference among different varieties of rice at 0-30 DAS. The P fertilization with 90 kg  $P_2O_5$  through SSP recorded significantly higher crop growth rate over no P fertilization at 31-

60 DAS and 61-90 DAS which remained at par with 60 kg  $P_2O_5$  through SSP along with PSB and AM.

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