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RESEARCH ARTICLE

Studies on phenological characters and yield attributes of rice genotypes at graded levels of phosphorus

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SUMMARY

Phosphorus is one of the most limiting nutrients for plant growth in soil in both acidic and alkaline soils. To screen the genotypes for their P use efficiency and response to its application the genotypes need to be grown under different gradients so as to compare their performance under different regimes of P application. Therefore, low P plots were divided into 4 sub-plots with different gradients (0,20,40 and 60 kg P_2O_5 /ha, respectively). Results showed that at 0 (absolute control) level of P_2O_5, rice genotypes differed widely among all the phenological and yield attributing characters studied. Root length measured was recorded lowest for Mahsuri cultivar (18cm) whereas highest root length at maturity stage was recorded for Vikas and Vasumati cultivars (26cm each). At 20 Kg P_2O_5/ha level, root length measured was recorded lowest for Mahsuri cultivar (19cm) whereas highest root length at maturity stage was recorded for Akshaydhan cultivar (30cm). At 40 Kg P_2O_5/ha level, root length measured was recorded lowest for MTU 1010 cultivar (20cm) whereas highest root length at maturity stage was recorded for Vasumati cultivar (30cm). Similarly At 60 Kg P_2O_5/ha level, for plant height the values ranged from a low of 58cm for Rp-bio-226 cultivar to a high of 99cm for Vardhan cultivar. Significant but not steep variations were noticed among cultivars for root length, flag leaf length and effective number of tillers characteristics at maturity stage.

Key Words : Phenological characters, Yield attributes, Rice genotypes, Phosphorus

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Phosphorus is one of the most limiting nutrients for plant growth in soil. Both acid and alkali soils are P deficient. P deficiency is perhaps one of the most important factors that limit plant yields on many soils. It is estimated that P availability to plant roots is limited in two thirds of the cultivated soil in the world (Batjes, 1997). Development of efficient genotypes with a great ability to grow and yield in P-deficient soil is, therefore, an important goal in plant breeding (Rengel, 1999; Hash *et al*., 2002; Wissuwa *et al*., 2002; Yan *et al*., 1992 and 1995; Elser, 2012; Ramaekers *et al.*, 2010; Rao, 2010 and Tiwari, 2001). Release of P efficient genotypes in both high and low-input farming systems would reduce the production costs associated with P fertilizer

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applications, minimize environmental pollution and contribute to the maintenance of P resources globally (Cakmak, 2002; Vance *et al*., 2003). Plant species and genotypes of a given species develop diverse adaptive responses to P deficiency. To improve growth under P-deficient conditions, P-efficient plants have evolved two major mechanisms: (i) increasing P acquisition (root morphology, root exudation and P uptake mechanisms), and (ii) enhancing P utilization (internal mechanisms associated with conservable use of absorbed P at the cellular level) (Raghothama, 1999; Bates and Lynch, 2000 and Vance *et al*., 2003).

The development of rice cultivars capable of using a higher portion of the fixed P already present in soils may be an attractive and cost effective approach to increasing rice yields where P deficiency is the major constraint. Developmental and physiological aspects of PUE are being unraveled by genetics and molecular biology, which suggest that significant improvement in internal PUE is possible. More efficient use of P within the plant adds to the gains that can be made by improving P-acquisition efficiency, but also reduces P fluxes on crop land and in the environment. The largest yield benefits of improved PUE are expected for crops growing in soils that have very low P content and where little or no P fertilizer is applied. The largest savings in P fertilizer are expected on productive land where conditions for crop growth are near optimal.

Based on these considerations, the present investigation was conceptualized.

MATERIAL AND METHODS

The I.I.R.R. plot selected for the purpose was D-5 containing 1.24 per cent organic matter; available N at 191 kg ha^{-1}; graded levels of available P plots varying from 2.5 kg/ha to 25 kg ha^{-1}; and available K at 389 kg ha^{-1}. Furthermore, available calcium and magnesium levels were high and available sulphur was low (8 kg ha^{-1}). Soil levels of the micronutrients Zn and Cu were high and Fe and Mn status was low. Initial soil analysis characterization was carried out for which previous soil analysis shows that the soil pH varies from neutral (pH 7.2 to 8.2) with an available phosphorus ranging from low to medium to high. This augmented well as a gradient was to be selected. To screen the genotypes for their P use efficiency and response to its application the genotypes need to be grown under different gradients so as to compare their performance under different regimes of P application. Therefore, low P plots were divided into 4 sub-plots with different gradients (0,20,40 and 60 kg P_2O_5 /ha, respectively) and were separated with barrier which blocked water movement from one gradient to another. All the standard agronomic management practices were followed as applicable for the field experiment. We selected randomly for initial phenological studies some 10 rice genotypes. The genotypes were characterized for root length (cm), plant height (cm), flag leaf length (cm), panicle length (cm) and no of effective tillers as some initial studies on their phenological cum yield attributing characters. Excel software was used for data analysis.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

When no phosphorus was applied therefore, at P_2O_5 at 0 (absolute control) level :

Rice genotypes differed widely among all the phenological and yield attributing characters studied. Root length measured was recorded lowest for Mahsuri cultivar (18 cm) whereas highest root length at maturity stage was recorded for Vikas and Vasumati cultivars (26 cm each).Very high variation (approximately 40%) for root length measurement among all the genotypes under studies were recorded. Similarly for plant height the values ranged from a low of 50cm for Tellahamsa cultivar to a high of 69 cm for Mahsuri cultivar. Significant but not steep variations were noticed among cultivars for plant height, flag leaf length, panicle length and effective number of tillers characteristics at maturity stage (Table 1).

When phosphorus was applied therefore, at P_2O_5 at 20 kg/ha level :

Rice genotypes differed widely among all the phenological and yield attributing characters studied. Root length measured was recorded lowest for Mahsuri cultivar (19 cm) whereas highest root length at maturity stage was recorded for Akshaydhan cultivar (30 cm).Very high variation (approximately 36%)each for root length and for effective number of tillers measurement among all the genotypes under studies were recorded. Similarly for plant height the values

Table 1 : Some phenological characters and yield attributes of rice genotypes at graded levels of phosphorus

Sr. No.	Rice genotypes	Root length (cm)	Plant height (cm)	Flag leaf length (cm)	Panicle length (cm)	No. of effective tillers
P_2O_5 at 0 (absolute control) level						
1.	Akshaydhan	24	59	22	20	4
2.	Vasumati	26	68	23	19	4
3.	Sugandhamati	20	59	26	15	5
4.	T. hamsa	22	50	18	14	5
5.	Vardhan	22	62	29	18	4
6.	Vikas	26	56	22	17	4
7.	Tulasi	23	51	16	17	4
8.	Mahsuri	18	69	19	21	5
9.	MTU 1010	19	68	22	21	5
10.	RP Bio 226	20	50	18	17	4
	Range	18-26	50-69	16-29	14-21	4-5
	Mean	21.8	59.3	21.6	17.6	4.5
	Std	7.4	7.5	4.0	2.4	0.5
	CV(%)	33.9	12.6	18.3	13.5	11.6
P_2O_5 at 20 kg/ha level						
1.	Akshaydhan	30	88	30	25	9
2.	Casumati	24	85	24	22	10
3.	Sugandhamati	23	84	20	21	10
4.	T. hamsa	24	79	19	19	8
5.	Vardhan	21	74	24	19	9
6.	Vikas	20	64	26	21	8
7.	Tulasi	22	58	16	18	9
8.	Mahsuri	19	78	24	18	5
9.	MTU 1010	20	73	21	17	10
10.	RP Bio 226	21	60	22	17	9
	Range	19-30	58-88	16-26	17-22	5-10
	Mean	72.0	21.6	19.2	8.5	72.0
	Std	25.6	3.9	2.5	1.5	25.6
	CV (%)	35.6	18.1	13.2	17.7	35.6
P_2O_5 at 40 kg/ha level						
1.	Akshaydhan	27	88	39	25	7
2.	Vasumati	30	70	30	23	8
3.	Sugandhamati	27	81	30	23	14
4.	T. hamsa	26	81	20	20	9
5.	Vardhan	22	76	25	22	10
6.	Vikas	28	67	28	20	9
7.	Tulasi	26	52	16	13	17
8.	Mahsuri	24	95	35	22	14
9.	MTU 1010	20	74	20	21	8
10.	RP Bio 226	22	64	21	18	7
	Range	20-30	52-95	16-35	13-23	7-17
	Mean	73.4	25.1	19.8	10.9	73.4
	Std	12.4	7.3	3.3	3.5	12.4
	CV (%)	16.9	29.2	16.8	31.8	16.9
P_2O_5 at 60 kg/ha level						
1.	Akshaydhan	23	72	34	22	8
2.	Vasumati	30	89	23	24	9
3.	Sugandhamati	26	95	23	26	8
4.	T. hamsa	27	71	19	20	11
5.	Vardhan	23	99	30	23	12
6.	Vikas	20	68	31	23	12
7.	Tulasi	20	62	17	16	5
8.	Mahsuri	19	89	25	20	7
9.	MTU 1010	20	83	21	22	8
10.	RP Bio 226	21	58	22	17	8
	Range	19-30	58-99	17-31	16-26	5-12
	Mean	79.2	23.5	21.2	8.8	79.2
	Std	14.3	5.5	3.1	2.3	14.3
	CV (%)	18.0	23.4	14.6	25.5	18.0

ranged from a low of 58cm for Tulasi cultivar to a high of 88 cm for Akshaydhan cultivar. Significant but not steep variations were noticed among cultivars for plant height, flag leaf length and panicle length characteristics at maturity stage (Table 1).

When phosphorus was applied, therefore, at P_2O_5 at 40 kg/ha level :

Rice genotypes differed widely among all the phenological and yield attributing characters studied. Root length measured was recorded lowest for MTU 1010 cultivar (20 cm) whereas highest root length at maturity stage was recorded for Vasumati cultivar (30 cm). Very high variation (approximately 30%) for plant height and (approximately 32%) for panicle length measurement among all the genotypes under studies were recorded. Gahoonia and Nielsen (2004); Lambers *et al*. (2006) similarly for plant height the values ranged from a low of 52 cm for Tulasi cultivar to a high of 95cm for Mahsuri cultivar. Significant but not steep variations were noticed among cultivars for root length, flag leaf length and effective number of tillers characteristics at maturity stage (Table 1).

When phosphorus was applied therefore, at P_2O_5 at 60 kg/ha level :

Rice genotypes differed widely among all the phenological and yield attributing characters studied. Root length measured was recorded lowest for Mahsuri cultivar (19cm) whereas highest root length at maturity stage was recorded for Vasumati cultivar (30cm). Very high variation (approximately 24%) for plant height and (approximately 26%) for panicle length measurement among all the genotypes under studies were recorded. Lynch (2011) similarly for plant height the values ranged from a low of 58cm for Rp-bio-226 cultivar to a high of 99cm for Vardhan cultivar. Significant but not steep variations were noticed among cultivars for root length, flag leaf length and effective number of tillers characteristics at maturity stage (Table 1).

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