



RESEARCH PAPER

Effect of phosphorus levels and bio-organic sources on growth and yield of rice (*Oryza sativa* L.)

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Abstract : A field experiment was conducted during rainy season of 2013 at Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi to evaluate the effect of phosphorus levels and bio-organic sources on growth and yield of wetland rice cv. HUR-105. Factorial experiment was laid out in Randomized Complete Block Design involving four levels of phosphorus *viz.*, control, 50 per cent RDP, 75 per cent RDP and 100 per cent RDP and three bio-organic sources *i.e.* PSB, PSB + BGA and PSB + BGA + FYM (5 t ha⁻¹) replicated thrice. Increase in the levels of phosphorus application upto 100 per cent RDP (60 kg P₂O₅ ha⁻¹) improved growth attributes, yield attributes, grain and straw yields. Combined use of PSB + BGA + FYM (5 t ha⁻¹) proved superior to PSB alone and PSB + BGA. Economic analysis indicated that integration of moderate phosphorus level (75% RDP *i.e.* 45 kg ha⁻¹) along with the use of PSB + BGA + FYM (5 t ha⁻¹) gave highest net return and B:C ratio.

Key Words : Phosphorus levels, Bio-organics, FYM, BGA, PSB, Rice

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INTRODUCTION

Rice is one of the most important staple food crops in India grown on 44.01 million hectares with a total production of 105.30 million tonnes and an average productivity of 23.93 q ha⁻¹ (Anonymous, 2011). Present rice productivity is not enough to feed ever increasing population of this country thus, the only alternative left is vertical increase in yield since expansion of area is not possible. Integrated nutrient management in wetland rice is a needed strategy involving conjunctive use of chemical fertilizers and bio-organic sources for realization of potential yield on sustained basis. Farmyard manure or

compost and use of blue green algae in wetland rice are the common practices (Begum *et al.*, 2009). Phosphorus is a major component in ATP, the molecule that provides energy to that plant for such processes as photosynthesis, protein synthesis, nutrient translocation, nutrient uptake and respiration (Wilson *et al.*, 1998). Slow mobility of applied phosphorus and its marked fixation results in low crop recoveries in the order of 20-25 per cent. Phosphate solubilizing bacteria (PSB) solubilize and mineralize the residual or fixed phosphorus, increases phosphorus availability in the soil and also the overall phosphate use efficiency (Chhonkar and Tilak, 1997). Indian farmers

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are unable to afford the heavy expenditure on chemical fertilizers however, it is imperative to use technologies such as phosphorus management in an integrated manner for its increased use efficiency. The present investigation was carried out with a view to evaluate the effect of phosphorus levels and bio-organic sources on growth and yield of wetland rice under conditions of eastern Uttar Pradesh to suggest any suitable pattern for integrated management of phosphorus.

MATERIAL AND METHODS

An experiment was conducted during rainy season of 2013 at Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi to study the effect of phosphorus levels and bio-organic sources on growth and yield of rice (*Oryza sativa* L.) under eastern Uttar Pradesh conditions. Factorial experiment was laid out in Randomized Complete Block Design with four levels of phosphorus viz., control, 50 per cent RDP, 75 per cent RDP and 100 per cent RDP and three bio-organic sources *i.e.* PSB, PSB + BGA and PSB + BGA + FYM (5 t ha⁻¹) replicated thrice. Recommended dose of fertilizers (RDF) used was N₂-P₂O₅-K₂O (120-60-60 kg ha⁻¹). Half of the recommended dose of nitrogen and full dose of potassium were applied as basal application and remaining half nitrogen was applied in two equal splits at active tillering and panicle initiation stages uniformly to all the treatments. Variable rates of phosphorus were applied as per treatment. The experimental field was sandy clay loam in texture with pH 7.35, low in available organic

carbon (0.39%), available nitrogen (198.03 kg ha⁻¹) and medium in available phosphorus (23.7 kg ha⁻¹) and potash (188.32 kg ha⁻¹). Four week old seedlings cv. HUR-105 was transplanted on the puddled field keeping two seedlings hill⁻¹ at a spacing of 20 cm × 15 cm. Blue green algae (BGA) was applied @ 10 kg ha⁻¹ in their respective treatments at 10th day after transplanting. Before transplanting, seedlings were treated by root dipping in PSB solution for 30 minutes followed by transplanting. Required quantity of well decomposed FYM was applied basally as per treatments. Rainfall received throughout the crop period was 825.0 mm and about ± 5 cm water level was continuously maintained till flowering then after field was kept under saturated condition. Recommended agronomic practices were followed to raise the experimental crop. The data recorded were analyzed following standard statistical analysis of variance procedure as suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

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

Yield attributes :

The yield attributing characters *viz.*, number of tillers hill⁻¹, panicle length, number of panicles m⁻², number of grains panicle⁻¹ and 1000 grains weight increased significantly with increase in the levels of phosphorus upto the maximum level of 100 per cent RDP except at harvest stage where 50 per cent, 75 per cent

Table 1: Effect of phosphorus levels and bio-organics on yield attributes and yields of rice

Treatments	Tillers/ hill	Panicle length (cm)	Panicles/ m ²	Grains/ panicle	1,000-grain weight (g)	Grain yield (q ha ⁻¹)	Straw yield (q ha ⁻¹)
P levels (% RDP)							
0	8.80	20.44	240.78	108.59	21.72	42.59	57.50
50	9.47	21.26	247.56	113.26	21.87	45.06	60.91
75	9.96	21.90	265.33	115.26	22.53	49.91	61.91
100	10.22	22.79	280.56	125.58	23.09	50.97	62.93
S.E. ±	0.19	0.12	4.92	0.95	0.21	0.93	0.98
C.D. (P=0.05)	0.56	0.36	12.93	2.78	0.60	2.73	2.86
Bio-organics							
PSB	8.87	21.14	246.25	109.53	21.75	45.37	59.06
PSB+BGA	9.65	21.70	257.17	116.36	22.34	46.76	60.82
PSB+BGA+FYM (5 t ha ⁻¹)	10.32	21.95	272.25	121.34	22.82	49.27	61.76
S.E. ±	0.17	0.11	3.82	0.82	0.18	0.81	0.85
C.D. (P=0.05)	0.49	0.31	11.19	2.41	0.52	2.37	2.48

RDP: Recommended dose of phosphorus (60 kg ha⁻¹)

and 100 per cent RDP were found at par in producing number of tillers hill⁻¹ and phosphorus levels, 0 per cent and 50 per cent RDP and 50 per cent and 75 per cent RDP were found statistically at par in producing number of panicles m⁻² and number of grains panicle⁻¹, respectively (Table 1). However, treatment control (0% RDP) recorded 1000 grains weight at par with the treatment (50% RDP) but these treatments produced significantly lower 1000 grains weight as compared to 75 per cent RDP and 100 per cent RDP and which remained at par with each other. Ishizuka (1971) opined that phosphorus plays an important role in the translocation of assimilates to the panicles and also as a constituent of protoplasm. This explains the reason for the increased length of the panicle, panicle weight and number of grains per panicle.

Application of bio-organic sources had noticeable influence on yield attributes and conjunctive use of PSB + BGA + FYM (5 t ha⁻¹) produced highest number of tillers hill⁻¹, panicle length, number of panicles m⁻², number of grains panicle⁻¹ and 1000-grains weight which was significantly superior than application of PSB alone and it remained statistically at par with the PSB + BGA in case of panicle length and 1000-grains weight. Magnitude of increase in number of panicles m⁻² over PSB or PSB+BGA was 10.55 per cent and 5.86 per cent, respectively. Yield attributes of rice closely confirms the finding of Yogesh *et al.* (2013).

Grain and straw yield :

The highest grain yield (50.97 q ha⁻¹) was recorded with the application of 100 per cent RDP which exhibited a superiority of 19.67, 13.11, 2.12 per cent over 0, 50 and 75 per cent RDP, respectively. Addition of 100 per

cent RDP to rice crop at par with 75 per cent RDP but both were significantly superior over 50 per cent RDP and control treatment (Table 1). Maximum straw yield was registered under application of highest phosphorus level (100% RDP) closely followed by 75 per cent RDP and 50 per cent RDP. However, increase in level of phosphorus from 50 per cent RDP to 100 per cent RDP could not exhibit significant effect on straw yield and the above treatments were observed significantly superior only to control treatment.

Combined application of PSB + BGA + FYM (5 t ha⁻¹) recorded the maximum grain yield (49.27 q ha⁻¹) which was significantly superior to other bio-organic sources. However, difference between treatments PSB and PSB + BGA was not significant. Maximum straw yield was noted with the combined use of PSB + BGA + FYM (5 t ha⁻¹) which proved significantly superior to application of PSB alone but found statistically at par with PSB + BGA. Increase in grain and straw yield might be due to higher photosynthetic activity because of increased leaf area index, which ultimately promoted dry matter production resulting higher grain and straw yield. Quyen and Sharma (2003) also reported similar results. The interaction effects between two factors were found non-significant in respect of yield attributes and yield.

Economics :

A perusal of the data (Table 2) clearly indicates that cost of cultivation, gross return, net return and benefit: cost ratio increased with increasing levels of phosphorus as well as due to integration of bio-organic sources. Maximum cost of cultivation (Rs. 38350.94) and gross return (Rs. 85109.37) obtained with 100 per cent RDP + PSB + BGA + FYM (5 t ha⁻¹). Net return and B:C ratio

Table 2: Effect of treatments on the economics of rice

Treatments	Cost of cultivation (Rs. ha ⁻¹)	Net returns (Rs. ha ⁻¹)	Benefit : cost ratio
Control + PSB	33750.62	34185.89	1.01
Control + PSB + BGA	34310.62	34996.26	1.02
Control + PSB + BGA + FYM (5 t ha ⁻¹)	35060.62	38206.58	1.09
50% RDP + PSB	35310.62	35927.48	1.02
50% RDP + PSB + BGA	35870.62	38803.98	1.08
50% RDP + PSB + BGA + FYM (5 t ha ⁻¹)	36780.62	40087.10	1.09
75% RDP + PSB	36090.62	40906.73	1.13
75% RDP + PSB + BGA	36650.62	43764.72	1.19
75% RDP + PSB + BGA + FYM (5 t ha ⁻¹)	37550.62	47288.00	1.26
100% RDP + PSB	37244.62	43385.01	1.16
100% RDP + PSB + BGA	37440.94	43792.43	1.17
100% RDP + PSB + BGA + FYM (5 t ha ⁻¹)	38350.94	46758.43	1.22

exhibited the same trend due to integration of phosphorus level with bio-organics only upto 75 per cent P level while net return (Rs. 47288.00) and benefit:cost ratio (1.26) was maximum under integration of phosphorus level of 75 per cent RDP with PSB + BGA + FYM (5 t ha⁻¹) followed by higher phosphorus level (100% RDP) in combination with PSB + BGA + FYM (Rs. 46758.43).

On the basis of above findings and economical analysis it may be concluded that the integration of moderate phosphorus level (75% RDP *i.e.* 45 kg ha⁻¹) along with the use of PSB + BGA + FYM (5 t ha⁻¹) proved most remunerative for rice variety HUR-105 under eastern Uttar Pradesh conditions.

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