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Productivity and profitability of rice hybrids at different nutrient management levels under semi-arid conditions of North Eastern Plains Zone

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ABSTRACT

The research work was undertaken at Student's Instructional Farm, Chandra Sekhar Azad University of Agriculture and Technology, Kanpur, India, with the objective of identifying most suitable rice hybrid in terms of yield and economics, and work out the optimum nutrient management level for different rice hybrids. The experiment comprised 12 treatment combinations of 3 nutrient management levels *viz*. Farmer's dose (80:30:30 N, P_2O_5, K_2O kg / ha), Recommended dose of fertilisers (RDF) (150:75:60:25 N, P_2O_5, K_2O, $ZnSO_4$ kg / ha) and 125% of RDF (187.5:93.75:75:31.25 N, P_2O_5, K_2O, $ZnSO_4$ kg / ha) and 4 rice hybrids namely, PHB 71, Pro-agro 6444, PAC 832 and Shri Ram Sonali. The experiment was conducted under split plot design with four replications. Hybrid PHB 71 produced significantly higher number of effective tillers, panicle length and grains per panicle as compared to Pro-agro 6444, PAC 832 and Shri Ram Sonali. The number of effective tillers, panicle length and grains per panicle increased significantly with increasing levels of nutrient management and maximised at 125% of RDF. Hybrid PHB 71 produced 6.5 t / ha grain yield which was computed to 8.4, 13.8 and 29.1% higher than the grain yield obtained from PAC 832, Pro-agro 6444 and Shri Ram Sonali, respectively. At 125 % of RDF the highest of 6.7 t / ha grain yield of rice was produced and recorded by 9.5 and 49.4% higher than the RDF and farmers dose, respectively. Gross return, net return and benefit: cost ratio were computed maximum in PHB 71 followed by PAC 832, Pro-agro 6444 and Shri Ram Sonali. At the same time gross return, net return and benefit: cost ratio were also obtained maximum at 125% of RDF as compared to RDF and farmers dose.

Key words: Economics, Hybrid rice, Nutrient management levels, Yield attributes.

Rice (*Oryza sativa* L.) is the staple food for three fourth of the Indian population. Although, the national food security heavily depends on rice and wheat (78 per cent), rice alone contributes to 43 per cent of food grain production and 46 per cent of cereal production in the country. In the global context India stands first in area with 43.95 m ha, second in production with 106.54 million tonnes during 2013-14 (Agricultural Statistics at a Glance, 2014). At the current rate of population growth (1.55%) in India, the rice requirements by 2020 would be around 120-150 million tonnes. Raising the rice production from present level to the anticipated 120-135 million tonnes is a herculean task especially in the backdrop of plateauing yield trend of high yielding varieties and declining resource base in terms of land, water, labour and other inputs (Subbaiah *et al.*, 2006). Under such situation, hybrid rice is the most practically feasible readily adoptable technology. Hybrid rice is an offspring of a cross between two genetically different rice varieties. The hybrids exhibit superiority over their parents or any other standard variety due to the

phenomenon called "heterosis" or "hybrid vigour". The hybrid vigour is confined to the first generation only, therefore, the farmers have to purchase fresh seeds every season unlike high yielding varieties rice hybrids are known to have an yield advantage of 15-20 per cent over the check varieties with almost the same inputs except the seed cost (Subbaiah *et al.*, 2006). Central Uttar Pradesh grows rice on large scale during *kharif* season, but area under hybrid rice is very limited. There is urgent need of increasing hybrid rice area in central part of Uttar Pradesh to increase the productivity level and total production of rice in the state. As different type of rice hybrids are available, farmers may choose as per their need and cultivate hybrid rice. For realizing the full potential of rice hybrids it is absolutely essential to follow appropriate crop management practices. Out of different management practices, optimum use of fertilizers is an important input and practice to realize the maximum possible yields from hybrid rice. Simultaneously, the selection of suitable hybrids is also of most importance. These practices are location specific. Not much work on these aspects of hybrid rice is available for central part of Uttar Pradesh and need further studies.

Keeping all above points in view, the present study was conducted on productivity and profitability of rice hybrids at different nutrient management levels under semi-arid conditions of North Eastern Plains Zone.

Materials and Methods

The field experiment was carried out during *kharif*, 2009-10 at Student's Instructional Farm, Chandra Sekhar Azad University of Agriculture and Technology, Kanpur. Three main plot treatments comprised nutrient management levels *viz*. Farmer's dose (80:30:30 N, P_2O_5, K_2O kg / ha), Recommended Dose of Fertilisers (RDF) (150:75:60:25 N, P_2O_5, K_2O, $ZnSO_4$ kg / ha) and 125% of RDF (187.5:93.75:75:31.25 N, P_2O_5, K_2O, $ZnSO_4$ kg / ha) and subplots treatments comprised rice hybrids namely, PHB 71 (Pioneer Hybrid Seed India Ltd), Pro-agro 6444 (Bayer Bio-Science, India Ltd), PAC 832 (Advanta India Ltd) and Shri Ram Sonali (Shri Ram fertilizer Ltd) were studies under split plot design with four replications. Geographically the experimental site falls in sub-tropical zone of Uttar Pradesh and comes under semi-arid conditions of North Eastern Plains Zone of India and is situated at latitude of 26°29′35″ N and longitude of 80°18′25″ E. The altitude level is 125.9 meters above mean sea level. It lies in the alluvial belt of Gangetic plains with average annual rainfall of about 816 mm. The soil of experimental field is of alluviam origin. To know the mechanical and physico-chemical properties of soil, samples were collected at 0-20 cm depth from 20 places before transplanting of crop. The soil of all samples was mixed together and a composite sample was prepared which was subjected to mechanical and chemical analysis for determining the different soil properties. The soil of experimental plot was loam (57.40% sand, 22.10% silt and 20.50% clay). The average soil reaction was slight alkali (pH 7.8 with soil and water ratio 1:2) and electrical conductivity was 0.28 mmhos / cm. The soil was low in organic carbon (0.40%), available nitrogen (185.0 kg / ha) and medium in available phosphorus (14.22 kg / ha), available potash (174.0 kg / ha). After harvest of preceeding crop, the field was ploughed once with soil turning plough. It was followed by cross ploughing with tractor drawn disc harrow. After proper watering, puddling was done with tractor drawn puddler for transplanting the crop. Fertilizers were applied as per treatment in different plots. The sources of nutrients used were DAP (46% P_2O_5 + 18% N), urea (46% N), MOP (60% K_2O) and zinc sulphate (21.5% Zn). Half of N and full of P, K and $ZnSO_4$ were applied as per treatments just before puddling. Remaining half of nitrogen was applied in two equal doses each at tillering and panicle initiation stages. Transplanting of 21 days old seedlings of test hybrids was done in standing water keeping row distance 20 cm and hill distance 10 cm. One seedlings / hill was transplanted. Irrigations were given as critical stages of crops considering rainfall during the crop period. To control weeds, 1 hand weedings was done with manual labour by hand *Khurpi*. The dusting of insecticide fenvelarate @ 40 kg / ha was done to save the crop from Gundhi bug and other insects. The crop was harvested with the help of sickle by manual labour excluding two border rows from each gross plot. After three

days, each net plot produce was tied in bundles and labeled properly with tags. Threshing of produce was done by mannual labour in the same experimental field. Before threshing, bundle weight of each net plot was taken for recording biological yield. After threshing and cleaning, grain produced in each net plot was weighed separately for recording economic yield of different treatments.

Results and Discussion

Yield attributes

The yield of rice crop is primarily governed by the yield contributing attributes. The higher values of such attributes indirectly indicate the potential yield or these values can be used to estimate the yield in advance. All yield attributing characters of rice hybrids significantly influenced by different nutrient management levels (Table 1). Hybrid PHB 71 produced significantly maximum number of effective tillers per unit area followed by Pro-agro 6444. However, differences in effective tillers of hybrid Shri Ram Sonali and PAC 832 and between PAC 832 and Pro-agro 6444 were non-significant. Hybrid PHB 71 had produced 7.0, 9.5 and 9.8% more number of effective tillers than Pro-agro 6444, PAC 832 and Shri Ram Sonali, repectively. The number of effective tillers increased significantly with increasing levels of nutrient management and thus maximised at 125% of RDF with 276.1 effective tillers / m^2. Hybrid PHB 71 produced significantly higher panicle length followed by Shri Ram Sonali and PAC 832. The panicle length of hybrid PHB 71 was found 7.9, 9.5 and 11.9% more than the panicle length of Shri Ram Sonali, PAC 832 and Pro-agro 6444, respectively. In case of nutrient management levels, 125% of RDF recorded significantly maximum panicle length as compared to farmers' dose and remain *at par* with RDF. Experiment finding revealed that PHB 71 produced significantly maximum number of total grains / panicle followed by Pro-agro 6444. Hybrid PAC 832 and Shri Ram Sonali being *at par* and produced lesser total grains / panicle than above hybrid. Hybrid PHB 71 had produced 8.6, 22.3 and 22.9% more number of total grains per panicle as compared to Pro-agro 6444, PAC 832 and Shri Ram Sonali,

Table 1. Yield and yield attributes of rice hybrids as influenced by different nutrient management levels

Treatment	Effective tillers (No./m^2)	Plant height (cm)	Panicle length (cm)	Total grains/ panicle	Productive or filled grains/ panicle	Grains wt/panicle (g)	1000-grain weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	HI (%)
Nutrient management level										
Farmers dose (80:30:30, N,P,K kg/ha)	183.6	73.2	25.3	162.4	138.8	3.30	23.9	4.5	7.0	39.3
RDF (150:75:60:25,N,P,K& Zn kg/ha)	254.1	81.1	26.1	177.1	148.7	3.60	24.5	6.1	9.0	40.4
125% RDF (187.5:93.75:75:31.25,N,P,K& Zn kg/ha)	276.1	86.0	26.9	186.9	156.6	3.92	25.3	6.7	9.2	42.2
CD (P=0.05)	5.3	2.4	0.8	0.9	1.5	0.04	0.06	0.3	0.5	1.5
Hybrid										
PHB 71	253.2	81.9	28.0	197.6	172.7	3.67	21.2	6.5	8.3	43.5
Pro-agro 6444	236.7	77.9	25.0	182.0	154.1	3.56	23.8	5.7	7.9	41.7
PAC 832	231.3	78.6	25.6	161.5	134.1	3.83	28.5	6.0	8.2	42.1
Shri Ram Sonali	230.5	82.0	25.9	160.8	131.3	3.36	25.4	5.0	9.2	35.3
CD (P=0.05)	6.0	3.3	0.6	2.5	2.0	0.05	0.04	0.4	0.3	1.0

respecti-vely. Increasing levels of nutrient management had significantly increased grains/panicle up to 125 % of RDF. The higher effective tillers, panicle length and grains per panicle may be due to the variation in potentiality of hybrids. Similar findings were also reported by Bhowmick and Nayak (2000), Singh, *et al.* (2004) and Singh and Singh (2008). In case of productive/filled grains per panicle, PHB 71 produced significantly maximum number of productive grains/panicle followed by Pro-agro 6444 while lowest were recorded in hybrid Shri Ram Sonali (table 1and Fig 1 (b)). Hybrid PHB 71 produced about 12.1, 28.8 and 31.5% more number of productive grains/panicle as compared to Pro-agro 6444, PAC 832 and Shri Ram Sonali, respectively. Number of productive grains might be attributing to fertility index which seems to be higher in PHB 71 and minimum in Shri Ram Sonali. Kumar and Verma (2004) had also reported the maximum number of filled grains/panicle in hybrid PHB 71 than the other six rice hybrids tested. Productive grains increased significantly with each increasing level of nutrient management up to 125% RDF (Fig 1(a)). Each hybrid varied significantly from each with respect to grains weight per panicle (table 1). Hybrid PAC 832 had produced significantly higher grains weight per panicle followed by PHB 71 and Pro-agro 6444, whereas minimum was recorded by Shri Ram Sonali. In case of nutrient management levels, significantly highest grains weight of 3.92 g/panicle was recorded under 125% RDF and found 8.9 and 19.1% higher than RDF and farmers dose. All hybrids differ significantly with respect to their 1000-grains weight. PAC 832 recorded highest 1000-grains weight followed by Shri Ram Sonali, Pro-agro 6444 and PHB 71. In case of nutrient management levels, each increasing level resulted in increased 1000-grains weight. Significant variation in grains weight per panicle and 1000-grains weight of different hybrid of rice have also been reported by Singh *et al.* (2004) and Singh and Singh (2008).

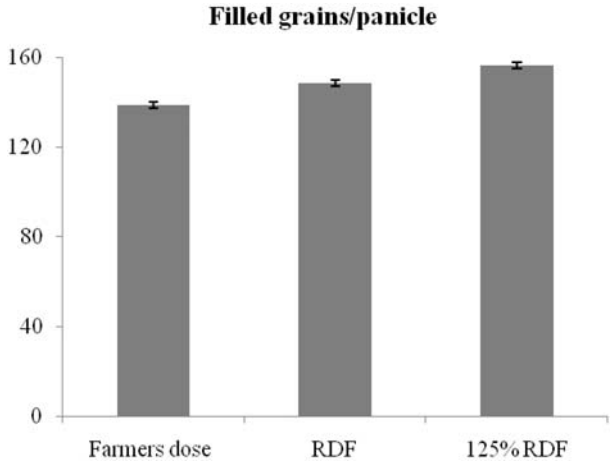

Fig. 1(a). Filled grains per panicle as influenced by Nutrient management level.

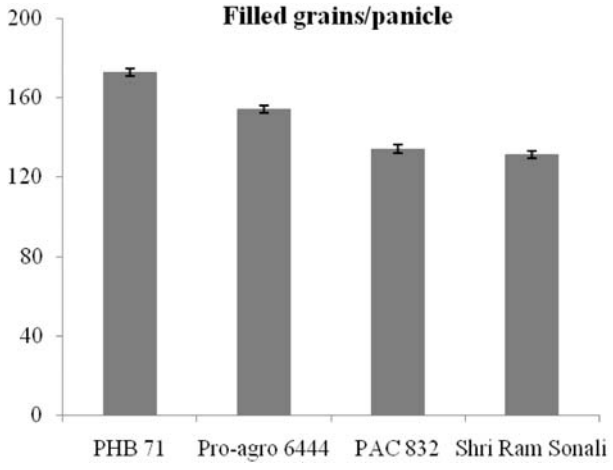

Fig. 1(b). Filled grains per panicle as influenced by rice hybrids.

Grain yield, straw yield and harvest index

PHB 71 had produced significantly higher grain yield followed by PAC 832 while significantly lower yield was obtained in Shri Ram Sonali (table 1). Hybrid PHB 71 produced 6.5 t/ha grain yield which was computed to 8.4, 13.8 and 29.1 % higher than the grain yield of PAC 832, Pro-agro 6444 and Shri Ram Sonali, respectively. In case of nutrient management levels grain yield increased significantly with each increasing level of nutrient management up to highest level. At 125% RDF highest of 6.7 t/ha grain yield was produced which was calculated to be 9.5 and 49.4% higher than the RDF and farmers dose, respectively. The results of grain yield can be further explained by the correlation matrix between yield attributes and yield. The linear correlation coefficients among various yield attributes and grain yield were computed to see the strength of their relationship. It was

found that almost all the yield attributes were highly correlated with grain yield (Table 3). The effective tillers per m^2 (r = 0.7774), panicle length (r = 0.6110), number of grains per panicle (r = 0.7129), filled grains per panicle (r = 0.7500) and panicle weight (r = 0.7835) have shown a highly significant and positive correlation with grain yield. Highest grain yield of PHB 71 seems to be attributed mainly to maximum number of effective tillers / m^2 and number of productive grains / panicle. Higher grain yield of hybrid PHB 71 than other rice hybrids had also been reported by Deshpande *et al.* (2003), Kumar and Verma (2004) and Yadav (2004).

Straw yield was affected by both treatment factors significantly (table 1). Among, hybrids Shri Ram Sonali produced significantly higher straw yield followed by PHB 71. Hybrid Pro-agro 6444 being at par with PAC 832 produced significantly lower straw yields than other two hybrids. The highest straw yield 9.2 t / ha was obtained with Shri Ram Sonali and was higher by 10.9, 12.2 and 15.6% than PHB 71, PAC 832 and Pro-agro 6444, respectively. The increasing levels of nutrient management increased straw yield significantly up to recommended nutrient management level beyond which increase in straw yield was not significant. Highest straw yield with Shri Ram Sonali might be attributed to higher biomass production and it was also proved from harvest index which was found minimum in this hybrid. Variation in straw yield of rice hybrids have also been observed by Bhowmick and Nayak (2000) and Chaturvedi *et al.* (2004).

Hybrid PHB 71 gave significantly highest harvest index while significantly lowest harvest index was workout in Shri Ram Sonali. Other two hybrids being at par with each other remain in between. In case of nutrient management levels,

Table 2. Economics of rice hybrids as influenced by different nutrient management levels.

Treatment	Cost of cultivation (x 10^3 ₹ / ha)	Gross returns (x 10^3 ₹ / ha)	Net returns (x 10^3 ₹ / ha)	Benefit: cost ratio
Nutrient management level				
Farmers dose (80:30:30, N,P,K kg / ha)	26.6	48.7	22.0	0.83
RDF (150:75:60:25,N,P,K& Zn kg / ha)	29.3	65.7	36.4	1.24
125% RDF (187.5:93.75:75:31.25,N,P,K& Zn kg / ha)	30.4	70.9	40.5	1.33
CD (P=0.05)	-	1.2	0.9	0.03
Hybrid				
PHB 71	28.8	67.4	38.6	1.33
Pro-agro 6444	28.8	60.2	31.5	1.08
PAC 832	28.8	63.0	34.3	1.18
Shri Ram Sonali	28.8	56.3	27.6	0.95
CD (P=0.05)	-	1.8	1.4	0.05

Table 3. Correlation matrix among yield attributes and grain yield of hybrid rice.

	ET	PL	GP	FG	PW	GY
ET	1					
PL	0.851654*	1				
GP	0.947418*	0.645367*	1			
FG	0.958434*	0.667943*	0.99838*	1		
PW	0.220341	0.141711	0.151982	0.200625	1	
GY	0.777411*	0.611007*	0.712973*	0.750057*	0.78351*	1

ET, Effective tiller; PL, Panicle length; GP, Grain per panicle; FG, Filled grains per panicle; PW, Panicle weight; GY, Grain yield.

*Correlation matrix is significant at the 0.05 level.

125 % of RDF gave significantly higher harvest index while both lower levels of nutrient management remained at par with each other.

Economics

Economics of hybrid rice was significantly influenced by different treatments (Table 2). Cost of cultivation of test hybrids were exactly same but it varied due to nutrient management levels. Maximum cost involved in 125% of RDF and minimum was at farmer's dose. Gross income was significantly maximum in PHB 71 followed by PAC 832, Pro-agro 6444 and Shri Ram Sonali. This hybrid had recorded 6.8, 11.9 and 19.6% higher gross return than the PAC 832, Pro-agro 6444 and Shri Ram Sonali, respectively. Increasing levels of nutrient management increased income significantly up to 125% of RDF.

Net return was also influenced significantly by both treatment factors. Hybrid PHB 71 earned maximum net returns followed by hybrid PAC 832, Pro-agro 6444 and Shri Ram Sonali. In case of nutrient management level, 125% RDF earned significantly highest profit of rupees 40450/ha followed by RDF (36412) and farmer's dose of nutrient management (22025). It is obvious from table 2 that hybrid PHB 71 attained significantly highest benefit: cost ratio followed by hybrid PAC 832 while significantly lowest was attained by hybrid Shri Ram Sonali. The benefit: cost ratio showed significant improvement with each increasing level of nutrient management up to 125% of RDF. Effect of nutrient management levels was more pronounced on benefit: cost ratio than hybrids. Gross returns of rice hybrids were attributed mainly to grain yield. These results may be similar to the findings of Bhowmick and Nayak (2000) and Singh and Singh (2008). Net returns and benefit: cost ratio was also worked out significantly highest at 125% of RDF attributed mainly due to higher gross return under this treatment. Though cost of cultivation was also highest at 125% of RDF than lower nutrient management levels, while margin of difference was found much higher in case of gross return which could not only compensated the higher cost but increased the net returns and benefit: cost ratio at higher nutrient management levels. Yadav *et al.* (2007) as well as Kumar and Yadav (2008) reported from Kanpur that increases in fertilizer level increase the economic parameters significantly in rice.

Conclusion

The results of present study could be concluded here as rice hybrid PHB 71 was found most suitable for producing highest grain yield. Nutrient management level of 125% of RDF *i.e.* 187.50 kg N/ha, 93.75 kg P_2O_5/ha, 75 kg K_2O/ha and 31.25 kg $ZnSO_4$/ha was worked out as optimum for rice hybrids. From economics point of view, growing of hybrid PHB 71 with 125 % nutrient management gradient was found most remunerative.

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