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Evaluation of different nutrient management practices on the performance of rice hybrid during dry season

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ABSTRACT

A field experiment was conducted during the dry seasons of 1999 and 2000 to find out suitable nutrient management strategies for hybrid rice. Application of 200:100:80 kg N:P:K ha^{-1} along with 10 tonnes of farm yard manure maintained nitrogen concentration in plants throughout life cycle and produced the highest grain yield (8.1 t ha^{-1}) and uptake of nitrogen, phosphorus and potassium in hybrid rice, but was comparable with fertilizer level of 150:75:60 kg N:P:K ha^{-1} applied along with 10 tonnes of farm yard manure. The uptake of nitrogen, phosphorus and potassium increased with increasing level from 150:75:60 to 200:100:80 kg N:P:K ha^{-1}. The application of 150:75:60 kg N:P:K ha^{-1} (K 60% as basal and 40% at maximum tillering stage) significantly increased grain yield and uptake of N, P and K than whole amount of K applied as basal. The K applied 60% as basal and 40% at maximum tillering stage reduced sterility percentage of hybrid rice. In absence of farm yard manure, application of 25 kg $ZnSO_4$ ha^{-1} found to be beneficial for increasing nitrogen and zinc concentration in plants and grain yield of hybrid rice grown during dry season.

Key words:Rice hybrid, grain yield, nitrogen, phosphorus and potassium uptake

The heterosis of rice hybrids has been established as an important tool to raise the productivity of rice, but its fullest advantage is possible only under favorable input managed system. However, appropriate nutrient management strategies are extremely important and needs to be worked out on the potential yield of rice hybrid grown under favourable soil and climatic environments. The research information available in China, where rice hybrids have been under commercial cultivation, indicated considerable differences in management strategies adopted between hybrids and conventional cultivars (Zhende, 1988). The plant nutrients such as nitrogen, phosphorus, potassium and zinc greatly influence the yields of rice. But its quantity along with other sources especially organic manure has to be worked out to obtain the desirable advantages of heterosis present in rice hybrids. In general, rice hybrid utilizes these nutrients in greater quantities due to high yield potential therefore nutrient efficiency becomes exceedingly important in order to make production cost effective. The application of above plant nutrients through chemical fertilizer ensure higher yield instantly, but causes poor economic conditions of the farmers, possible pollution hazards and undesirable effect on soil sustainability (Natarajan *et al*, 2005). It is also established fact that organic source such as farm yard manure alone can not meet the nutrients needs of modern agriculture due to less quantity of nutrients present on it (Parihar, 2004). The integration of chemical fertilizer with organic fertilizer such as farm yard manure not only enhances the productivity because of nutritional and growth stimulating substances (Sharma and Mittra, 1988), but also provides greater stability in crop production and increases the nutrient use efficiency due to modifying soil physical behavior (Nambiar and Abrol, 1992). Therefore, present study was undertaken to study the performance of rice hybrid under different nutrient management practices.

MATERIALS AND METHODS

A field study was carried out during the dry seasons of 1999 and 2000 at Raipur, in a clay loam soil with pH of 6.8, organic carbon 0.52%, and available nitrogen, phosphorus and potassium content in the soil was 235, 23 and 308 kg ha^{-1}, respectively. Ten treatments viz., 150:75:60 kg N:P:K ha^{-1} (N_{150} P_{75} K_{60}); 200:100:80 kg

N:P:K ha^{-1} (N_{200} P_{100} K_{80}); 200:100:80 kg N:P:K ha^{-1} (K 60 % as basal (B) + 40% at maximum tillering (MT) stage); 150:75:60 kg N:P:K ha^{-1} (K 60 % as B + 40% at MT stage); 200:100:80 kg N:P:K ha^{-1} + FYM @ 10 tonnes ha^{-1} (FYM_{10t}); 150:75:60 kg N:P:K ha^{-1} + FYM_{10t} ; 150:75:60 kg N:P:K ha^{-1}+33% extra plant population (EPP) ; 150:75:60 kg N:P:K ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} (Zn_{25}); 150:75:60 kg N:P:K ha^{-1} + N applied as slow release form (SRN); 150:75:60 kg N:P:K ha^{-1} + FYM_{10t} + Zn_{25} were laid out in randomized block design with 3 replications. The whole amount of phosphorus and $ZnSo_4$ was applied as basal. Irrespective of the treatments, nitrogen was applied 40% as basal, 25% at active tillering, 25% at panicle initiation and 10% at flowering. In case of potassium, it was applied as per treatments i.e. whole amount as basal and 60% as basal and 40% at maximum tillering stage of the crop. To make N in slow release form (SRN), urea was treated with neem cake powder and kept in shade for 48 hours before the application. The well decomposed farm yard manure was applied 4 days before transplanting. 21 days old seedlings of rice hybrid, Proagro 6201 was transplanted at a spacing of 20 cm x 15 cm. The N, P and K content in plant, grain and straw was determined. The Zn concentration in plant was analyzed. The uptake of nutrients was computed by multiplying dry matter with respective nutrient concentration.

RESULTS AND DISCUSSION

Application of nutrients significantly influences the yield components and grain yield of hybrid rice (Table 1). Grain yield of rice increased significantly with increasing levels of fertilizer from $N_{150}P_{75}K_{60}$ to $N_{200}P_{100}K_{80}$. Due to more number of panicles m^{-2}, grains $panicle^{-1}$ and test weight and reduced sterility percentage. K applied in splits i.e. 60% as basal and 40% at maximum tillering stage showed significant effect at lower level ($N_{150}P_{175}K_{60}$) and increased grain yield by 6.30%. At higher level ($N_{200}P_{100}K_{80}$), whole amount of K applied either as basal or 60% as basal and 40% at maximum tillering stage maintained steady release and difference was not discernible on grain yield. This indicated that when 80 kg K_2O ha^{-1} was applied even as basal maintained steady release to meet the crop demand. The results are in conformity with the findings of Pandey *et al.* (1993). The K applied 60% as basal and 40% at maximum tillering stage at either level reduced sterility percentage of hybrid rice.

The highest grain yield, (8.1 t ha^{-1}) was obtained with the application of $N_{2oo}P_{1oo}K_{80}$+ FYM_{10t}, but it was at par to the treatments of $N_{150}P_{75}K_{60}$ + FYM_{10t} (7.8 t ha^{-1}) and $N_{150}P_{75}K_{6O}$ + FYM_{10t} + Zn_{25} (7.9 t ha^{-1}). The harvest index remained unchanged under these treatments. The application of FYM and inorganic nutrient levels together was more effective in promoting the growth of the crop and increased yield components

Table 1. Effect of nutrient management practices on yield components and grain yield of hybrid rice during dry season (pooled for two years)

Treatments	Panicle (m^{-2})	Grains $panicle^{-1}$	Test weight (g)	Sterility (%)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index
$N_{150}P_{75}K_{60}$(K100% basal)	288	110	20.44	30.94	6.67	6.65	0.43
$N_{200}P_{100}K_{80}$(K100% basal)	324	124	20.85	28.28	7.55	10.60	0.43
$N_{200}P_{100}K_{80}$ (K60% basal + 40% maximum tillering)	326	126	20.74	25.48	7.70	10.16	0.43
$N_{150}P_{75}K_{60}$ (K60% basal + 40% maximum tillering)	308	120	20.72	25.92	6.98	9.32	0.43
$N_{200}P_{100}K_{80}$ (K100% basal)+ FYM_{10t}	337	133	21.70	25.91	8.06	10.53	0.43
$N_{150}P_{75}K_{60}$ (K100% basal) + FYM_{10t}	333	130	20.68	29.98	7.84	10.22	0.43
$N_{150}P_{75}K_{60}$ (K100% basal) + 33% EPP	291	111	20.25	26.36	6.76	8.63	0.44
$N_{150}P_{75}K_{60}$ (K100% basal) + Zn	309	118	21.48	26.59	7.05	9.24	0.43
$N_{150}P_{75}K_{60}$ (K100% basal) + SRN	301	119	20.87	27.73	6.83	8.87	0.43
$N_{150}P_{75}K_{60}$ (K100% basal) + FYM_{10t} + Zn_{25}	335	132	20.95	27.71	7.93	10.16	0.44
CD (P=0.05)	5.66	4.23	0.20	2.06	0.29	0.37	NS

and grain yield of rice hybrid as also evidenced by Sharma and Mittra (1988). The response of FYM combined with inorganic fertilizer was quite substantial (19.3%) at lower level ($N_{150}P_{75}K_{60}$). The application of Zn_{25} along with $N_{150}P_{75}K_{60}$ increased grain yield by 7.4% as compared to $N_{150}P_{75}K_{60}$ mainly due to increase in panicle m^{-2}, grain $panicle^{-1}$, test weight and reduced sterility percentage. The similar results have been also reported by Kulandaivel et al (2004). The difference in yield component and grain yield under $N_{150}P_{75}K_{60}$ + FYM_{10t} and $N_{150}P_{75}K_{60}$ + FYM_{10t} + Zn_{25} was not significant because requirement of Zn to rice hybrid might have been fulfilled by changes occurred in the soil due to soil modifying capacity of FYM.

There was change in concentration of N and Zn at different stages and application of FYM with either levels of inorganic fertilizer being at par, produced significantly higher N concentration in plant at 30, 60 and 90 days after planting (DAT) (Table 2). The concentration of Zn in plant at 60 and 90 DAT significantly increased under the treatments of $N_{150}P_{75}K_{60}$ + Zn_{25} and $N_{150}P_{75}K_{60}$ + FYM_{10t} + Zn_{25} due to supply of $ZnSO_4$. Kulandaivel *et al.* (2004) also reported that Zn uptake increased with increasing the amount Zn application up to 30 kg ha^{-1}. The concentration and uptake of N, P and K by grain and straw significantly increased due to nutrient management practices (Table 3). The N uptake by grains increased significantly under $N_{200}P_{100}K_{80}$ + FYM_{10t} as compared to other treatments mainly due to increased concentration of N by grain, which was followed by $N_{200}P_{100}K_{80}$(K 60% B+40% MT), $N_{150}P_{75}K_{60}$ + FYM + Zn_{25}, $N_{150}P_{75}K_{60}$ + FYM and $N_{200}P_{100}K_{80}$. The uptake of N by straw, P by grains + straw and K by straw were comparable when FYM combined with either level of inorganic fertilizer together. In addition to these treatments, K applied 60% as basal + 40% at MT of either level produced the comparable uptake of K by straw. The increase in uptake of these nutrients was mainly associated with the increase in dry matter production and concentration of nutrients (Yadav *et al*., 2005).

Thus, application of 150:75:60 kg N:P:K ha^{-1} in combination with 10 tonnes of FYM maintained N status in plant throughout life cycle and produced grain yield very close to that of the highest grain yield obtained in the experiment. Among inorganic nutrient levels crop responded up to 200:100:80 kg N:P:K ha^{-1}. The application of K, 60% as basal and 40% at maximum tillering stage under lower levels (150:75:60 kg N:P:K ha^{-1}) reduced sterility percent of rice grains and increased grain yield.

Table 2. Effect of nutrient management practices on N and Zn concentration in plants at different stages of hybrid rice during dry season (pooled for two years)

Treatments	N content in plant (%)			Zn content in plant (ppm)	
	30 DAT	60 DAT	90 DAT	60 DAT	90 DAT
$N_{150}P_{75}K_{60}$(K100% basal)	2.95	2.45	0.73	27.13	11.41
$N_{200}P_{100}K_{80}$(K100% basal)	3.27	2.88	0.85	30.85	13.55
$N_{200}P_{100}K_{80}$ (K60% basal + 40% maximum tillering)	3.24	2.96	0.90	37.50	18.13
$N_{150}P_{75}K_{60}$ (K60% basal + 40% maximum tillering)	2.93	2.54	0.68	34.53	14.98
$N_{200}P_{100}K_{80}$ (K100% basal)+ FYM_{10t}	3.52	3.21	1.01	38.14	18.50
$N_{150}P_{75}K_{60}$ (K100% basal) + FYM_{10t}	3.45	2.19	0.96	37.66	18.09
$N_{150}P_{75}K_{60}$ (K100% basal) + 33% EPP	2.96	2.44	0.70	27.49	11.95
$N_{150}P_{75}K_{60}$ (K100% basal) + Zn_{25}	3.19	2.94	0.87	45.14	22.71
$N_{150}P_{75}K_{60}$ (K100% basal) + SRN	3.11	2.73	0.75	33.55	14.77
$N_{150}P_{75}K_{60}$ (K100% basal) + FYM_{10t} + Zn_{25}	3.49	3.21	0.76	49.85	24.67
CD (P=0.05)	0.14	0.08	0.05	8.21	5.29

Table 3. Effect of nutrient management practices on concentration and uptake of N, P and K in grain and straw of hybrid rice during dry season (pooled for two years)

Treatments	Grain N Uptake (kg ha^{-1})	Straw N Uptake (kg ha^{-1})	Grain P Uptake (kg ha^{-1})	Straw P Uptake (kg ha^{-1})	Grain K Uptake (kg ha^{-1})	Straw K Uptake (kg ha^{-1})
$N_{150}P_{75}K_{60}$(K100% basal)	108.25(1.65)	36.29(0.42)	14.78(0.23)	7.35(0.11)	21.67(0.33)	205.89(2.38)
$N_{200}P_{100}K_{80}$(K100% basal)	132.10(1.75)	49.19(0.49)	21.14(0.28)	10.56(0.11)	28.32(0.38)	245.62(2.44)
$N_{200}P_{100}K_{80}$ (K60% basal + 40% maximum tillering)	135.46(1.76)	46.61(0.46)	23.49(0.31)	11.18(0.11)	33.50(0.44)	253.63(2.50)
$N_{150}P_{75}K_{60}$ (K60% basal + 40% maximum tillering)	113.35(1.63)	42.27(0.46)	17.11(0.25)	9.75(0.13)	26.19(0.38)	226.95(2.44)
$N_{200}P_{100}K_{80}$ (K100% basal)+ FYM_{10t}	143.42(1.76)	55.26(0.51)	30.24(0.38)	13.69(0.13)	35.88(0.45)	262.23(2.49)
$N_{150}P_{75}K_{60}$ (K100% basal) + FYM_{10t}	131.11(1.68)	50.53(0.50)	28.20(0.36)	12.78(0.08)	33.71(0.43)	253.96(2.49)
$N_{150}P_{75}K_{60}$ (K100% basal) + 33% EPP	108.08(1.60)	33.66(0.39)	15.20(0.23)	6.91(0.10)	21.98(0.33)	205.12(2.38)
$N_{150}P_{75}K_{60}$ (K100% basal) + Zn_{25}	119.34(1.70)	41.05(0.45)	17.27(0.25)	8.77(0.11)	25.40(0.36)	222.63(2.41)
$N_{150}P_{75}K_{60}$ (K100% basal) + SRN	110.05(1.62)	40.85(0.46)	18.80(0.28)	9.32(0.13)	24.90(0.37)	215.46(2.43)
$N_{150}P_{75}K_{60}$ (K100% basal) + FYM_{10t}+ Zn_{25}	133.88(1.69)	55.43(0.50)	28.15(0.36)	12.70(0.02)	35.70(0.45)	252.53(2.49)
CD (P=0.05)	7.13(0.05)	6.40(0.04)	3.10(0.04)	2.65(0.04)	4.12(0.04)	10.20(0.06)

Figures in parentheses indicated concentration in respective nutrient

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