

Integrated nutrient management in transplanted hybrid rice (*Oryza sativa*)

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ABSTRACT

A field experiment was conducted on clay-loam soil at research farm of Indira Gandhi Agricultural University, Raipur during rainy season 1999 and 2000, to find out suitable nutrient-management strategies for hybrid rice (*Oryza sativa* L.). Application of inorganic fertilizer level of 100, 60 and 40 kg/ha N, P₂O₅ and K₂O along with 10 tonnes farmyard manure (FYM) gave the grain yield and B:C ratio comparable to that of 100, 60 and 40 kg/ha N, P₂O₅ and K₂O + FYM + 25 kg ZnSO₄/ha or 150, 75 and 60 kg/ha N, P₂O₅ and K₂O + FYM. The application of potassium 60 per cent as basal and 40 per cent at maximum tillering stage significantly increased the grain yield, uptake of N, P and K and the net return than its whole amount applied basal. Nitrogen treated with neem extract proved significantly better than untreated nitrogen.

Key words: Hybrid rice, FYM, Potassium, Slow release

Rice (*Oryza sativa* L.) is the most important cereal of Chhattisgarh plains, but its productivity is only 1.8 tonnes/ha, which is much less than in many states of India. Hybrid rice has potential to produce 15-20 per cent higher yield than the existing varieties (Mahadevappa *et al.*, 1996). Owing to high grain yield, hybrid rice removes a substantial amount of major and minor nutrients from the soil, and deficiency of either nutrients reduces its grain yield. The price of inputs, mainly inorganic fertilizers, is increasing day by day; therefore emphasis is needed to maximize the nutrient-use efficiency and grain yield, and minimize the cost of production. The efficiency of nutrient use may be raised by the combined use of organic and inorganic fertilizers, application of nitrogen in slow release form or supplying the nutrients as the peak period of absorption. Organic fertilizer not only acts as the source of nutrients, but also provides micronutrients and modifies soil-physical behaviour as well as increases the efficiency of applied nutrients. However, it is imperative to use technologies in integrated manner so that the potential yield of hybrid rice could be realized on sustained basis. Hence the present investigation was conducted to find out suitable nutrient-management strategies for hybrid rice in Chhattisgarh.

MATERIALS AND METHODS

A field study was carried out during wet season of

1999 and 2000 at the research farm of Indira Gandhi Agricultural University, Raipur. The soil was clay loam, low in available nitrogen (235 kg/ha), medium in available phosphorus (23 kg/ha) and exchangeable potassium (308 kg/ha) with pH 6.8. The experiment was laid out in randomized block design with 10 treatments and three replications. Ten treatments were: (i) 100, 60 and 40 kg/ha N, P₂O₅ and K₂O (N₁₀₀P₆₀K₄₀); (ii) N₁₅₀P₇₅K₆₀; (iii) N₁₅₀P₇₅K₆₀ (K applied in splits in the ratio of 60:40 as basal (B) and at maximum tillering (MT) stage); (iv) N₁₀₀P₆₀K₄₀ (K applied in splits in the ratio 60:40 as B + MT) (v) N₁₅₀P₇₅K₆₀ + FYM @ 10 tonnes/ha; (vi) N₁₀₀P₆₀K₄₀ + FYM @ 10 tonnes/ha; (vii) N₁₀₀P₆₀K₄₀ + 33 per cent extra plant population; (viii) N₁₀₀P₆₀K₄₀ + 25 kg/ha ZnSO₄; (ix) N₁₀₀P₆₀K₄₀ + N applied in slow-release form; (x) N₁₀₀P₆₀K₄₀ + FYM @ 10 tonnes/ha + 25 kg ZnSO₄/ha. The whole amount of P, K and ZnSO₄ was applied as basal dressing, whereas N was applied 40 per cent basal, 25 per cent at active tillering, 25 per cent at panicle initiation, and 10 per cent at flowering. To make N in slow-release form, urea was treated with neem-extract powder and kept in shade for 48 hr before the application. FYM was applied 3 days before transplanting the hybrid rice. Oven-dried grain and straw samples were digested in diacid mixture and zinc content was analysed by atomic-absorption spectrophotometer. One seedling (22 days old) of rice hybrid 'Proagro 6201' was transplanted at a spacing of 20 cm ×

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15 cm during both the years of experimentation.

RESULTS AND DISCUSSION

Yield components

The application of FYM at $N_{150}P_{75}K_{60}$ or $N_{100}P_{60}K_{40}$ or inorganic fertilizer level of $N_{100}P_{60}K_{40}$ + FYM + Zn, being at par, produced significantly higher panicles/m² than those of other nutrient management practices (Table 1). It could be due to slow release of nutrients for longer period after decomposition of FYM, which favoured better plant growth and improved the yield components of hybrid rice. Parihar (2004) also reported similar effect of FYM on rice. The inorganic fertilizer level of $N_{100}P_{60}K_{40}$ + FYM + Zn increased the grains/panicle and test weight, followed by $N_{150}P_{75}K_{60}$ + FYM and $N_{100}P_{60}K_{40}$ + FYM respectively. The application of K in splits (60% B + 40% MT) produced more number of panicles, grains/panicle and test weight than the whole amount applied basal at both the levels. The application of K in split doses might have caused higher mobilization of nutrients in the plant, increased the enzymatic activities and translocation of photosynthates in plant system, which favoured the yield components. These results are in agreement with the findings of Pandey *et al.* (1993). N applied after treating with neem extract under inorganic fertilizer level of $N_{100}P_{60}K_{40}$ produced more yield attributes than untreated nitrogen due to reduced loss of nitrogen. In comparison, under inorganic fertilizer level, increased significantly with increase in the level of fertilizer from $N_{100}P_{60}K_{40}$ to $N_{150}P_{75}K_{60}$.

Grain and straw yields

The application of $N_{100}P_{60}K_{40}$ + FYM + Zn gave the highest grain yield, which was on a par with that of $N_{150}P_{75}K_{60}$ + FYM or $N_{100}P_{60}K_{40}$ + FYM (Table 1). However, a saving of 50 kg N, 15 kg P₂O₅ and 20 kg K₂O could be possible due to application of FYM, because it

might have supplied these nutrients and micronutrients, as reported by Pandey and Tripathi (1993). Among inorganic fertilizer levels, application of $N_{150}P_{75}K_{60}$ gave significantly higher (14.5%) grain yield than that of $N_{100}P_{60}K_{40}$. These results are in conformity with the findings of Rajarathinam and Balasubramaniyan (1999). The split application of potassium gave significantly higher yield than that of whole amount applied basal at both the levels. The application of K in split doses was associated with the efficient absorption and transportation of nutrients from the soil (Pandey *et al.*, 1993). The inherent limitation associated with full application at transplanting, viz. dilution, penetration and fixation, were efficiently circumvented by split application (Majumdar and Ghosh, 1980). The nitrogen applied after treating with neem extract gave 8.4 per cent higher grain yield than that applied in untreated form. Perhaps less denitrification in anaerobic soil layer helped in better utilization of nitrogen and increased the grain yield. Singh and Singh (1994) also reported similar effect of slow-release nitrogen on rice. The application of zinc increased the grain yield by 5.2 per cent compared with lower level of inorganic fertilizer. Kulandaivel *et al.* (2004) also opined that the application of zinc in hybrid rice increased its grain yield over the control. On the contrary, when Zn was applied with $N_{100}P_{60}K_{40}$ + FYM, it did not bring about additional increase in grain yield, indicating that FYM might meet the requirement of Zn to the crop. Increasing the plant population by 33 per cent, inorganic fertilizer level of $N_{100}P_{60}K_{40}$ is unable to make any improvement in grain yield of hybrid rice. The trend of straw yield was almost identical to that of grain yield.

Economics

The cost of cultivation of hybrid rice varied from Rs 15,894 to Rs 18,305/ha. Owing to the use of different doses and sources of fertilizers. The cost of cultivation

Table 1. Effect of integrated sources of nutrients on yield components, yield and economics of hybrid rice (mean data of 2 years)

Treatment	Panicles/ m ²	Grains/ panicle	Test weight (g)	Grain yield (q/ha)	Straw yield (q/ha)	Cost of cultivation (Rs/ha)	Net returns (Rs/ha)	Benefit: cost ratio
T ₁ : $N_{100}P_{60}K_{40}$	248	142	21.6	53.1	58.9	15,894	12,423	1.8
T ₂ : $N_{150}P_{75}K_{60}$	255	157	22.4	62.1	65.6	16,677	16,341	2.0
T ₃ : $N_{150}P_{75}K_{60}$ (K 60% B + 40% MT)	262	163	23.4	65.9	70.1	16,702	18,351	-2.1
T ₄ : $N_{100}P_{60}K_{40}$ (K 60% B + 40% MT)	255	152	22.4	56.9	63.8	15,919	14,445	1.9
T ₅ : $N_{150}P_{75}K_{60}$ + FYM	272	170	23.5	71.1	77.6	18,305	19,573	2.1
T ₆ : $N_{100}P_{60}K_{40}$ + FYM	269	168	23.3	69.7	74.3	17,536	19,543	2.1
T ₇ : $N_{100}P_{60}K_{40}$ + 33% EPP	251	151	22.2	54.4	58.2	16,878	12,068	1.7
T ₈ : $N_{100}P_{60}K_{40}$ + Zn	253	164	23.1	56.0	61.4	16,329	13,513	1.8
T ₉ : $N_{100}P_{60}K_{40}$ + N as slow release	255	155	22.4	58.0	65.8	16,003	14,971	2.1
T ₁₀ : $N_{100}P_{60}K_{40}$ + FYM + Zn	270	177	23.8	71.3	76.1	17,893	20,040	2.1
CD (P=0.05)	34	4.4	0.3	2.8	3.3		779	

EPP = Extra plant population; B=basal; MT = maximum tillering; FYM = farmyard manure

Table 2. Effect of integrated sources of nutrients on NPK and Zn uptake of hybrid rice (mean data of 2 years)

Tretment	Nutrient uptake (kg/ha)			
	N	P	K	Zn (g/ha)
T ₁	94.8	21.7	162.4	79.5
T ₂	125.1	31.1	193.4	104.7
T ₃	132.9	33.9	215.4	143.4
T ₄	104.9	25.4	183.4	121.4
T ₅	152.1	44.2	252.9	150.3
T ₆	143.2	40.7	239.5	142.4
T ₇	100.1	21.6	160.1	90.1
T ₈	111.1	25.2	170.3	153.7
T ₉	115.6	26.0	184.7	112.8
T ₁₀	148.1	43.1	247.6	215.6
CD (P=0.05)	5.9	3.5	14.1	62.0

DAT = Days after transplanting; Treatment details given in table 1

was the lowest for inorganic fertilizer level of $N_{100}P_{60}K_{40}$ applied to hybrid rice, whereas it was the highest when $N_{150}P_{75}K_{60}$ was combined with FYM.

Owing to production of grain yield and comparatively lower cost, the net returns were the highest under the application of inorganic fertilizers of $N_{100}P_{60}K_{40}$ + FYM + Zn, followed by inorganic fertilizer level of $N_{150}P_{75}K_{60}$ + FYM and $N_{100}P_{60}K_{40}$ + FYM respectively. The B:C ratio of inorganic fertilizer level of $N_{150}P_{75}K_{60}$ (K applied in splits) was significantly higher than that of $N_{150}P_{75}K_{60}$ or $N_{100}P_{60}K_{40}$. Bhowmick and Nayak (2000) also reported similar results.

N, P, K and Zn uptake

The application of $N_{150}P_{75}K_{60}$ + FYM gave the highest N, P, K uptake than other management practices except $N_{100}P_{60}K_{40}$ + FYM + Zn and $N_{100}P_{60}K_{40}$ + FYM for K uptake (Table 2). This might be due to the realization of higher yield. Higher uptake due to the application of $N_{150}P_{75}K_{60}$ was also observed in comparison with $N_{100}P_{60}K_{40}$. However, split application of potassium led to significantly higher K uptake than its basal application at both the levels due to efficient absorption and utilization by the plant. The findings closely confirm the results of Yadav *et al.* (2005).

Zinc uptake (90 DAT) was significantly influenced by

the different sources of nutrients. The application of $N_{100}P_{60}K_{40}$ + FYM + Zn led to the highest Zn uptake over the remaining treatments except application of inorganic fertilizer level of $N_{100}P_{60}K_{40}$ + Zn at both the stages, Kulandaivel *et al.* (2004) also reported similar results. Moreover, lower fertility level applied along with FYM recorded significantly higher Zn uptake than its application alone, indicating that application of FYM might have modified the physical condition of the soil and helped in its absorption and translocation from the soils.

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