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NPK Fertilizers for Hybrid Rice (*Oryza sativa* L.) Productivity in Alfisols of Southern Districts of Tamil Nadu

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Abstract: To optimize the NPK fertilizers requirements with hybrid rice (CORH 2) and graded levels of NPK during (Pishanam) wet season (September 2000 to January 2001), a field experiment was conducted in Alfisols of Agricultural College and Research Institute, Killikulam, Tamil Nadu. The experiment was laid out with 14 treatments of NPK combinations. The results indicated that among the treatments, application of 150:75:50 kg N: P₂O₅: K₂O ha⁻¹ had registered the higher grain yield of hybrid rice. The 150:50:50 kg N, P₂O₅ and K₂O ha⁻¹ fertilizer treatment had the higher total Phosphorus and K uptake. The N, P₂O₅ and K₂O doses, respectively 200: 75:75; 200:10:100 and 200:50:75 kg ha⁻¹ resulted in higher soil available N, P and K, irrespectively in post harvest soils after the CORH2 rice hybrid. The physical optimum levels for getting the maximum grain yield for the medium duration rice hybrid CORH2 was found to be 151:66:57 kg N, P₂O₅ and K₂O ha⁻¹. The economic optima for N, P₂O₅ and K₂O are 149:62:56 kg ha⁻¹, respectively for obtaining the highest grain yield.

Key words: NPK fertilizer, CORH 2, hybrid rice, grain yield, NPK uptake

INTRODUCTION

Rice is the important staple food crop for more than half of the global population. In India, rice is cultivated in an area of 42.2 million ha with a production of 110.9 million tons of rice, while China produces 187.45 million tons of rice in 33.1 million ha. The productivity of rice in India and China are 2.69 and 5.73 kg ha⁻¹, irrespectively. The increase in rice productivity of China is mainly due to cultivation of hybrid rice^[1]. The average yield of hybrid rice was 6 to 7 t ha with an yield advantage of 30% over conventional varieties^[2].

Alfisols are red soils, generally productive occupying an area about 3.92 million ha⁻¹ (30.3%) in Tamil Nadu. The rice cultivable Alfisol area for Southern districts, Tamil Nadu, India accounts to 0.13 millions ha. Enhancing the productivity and production of rice through the improvement in yield potential of genotypes and use of chemical fertilizer has been main thrust of our rice policy. Inorganic fertilizer is one of the important key factors to increase the rice productivity particularly in transplanted conditions. The rice biomass increased rapidly during N (180 kg N)^[3]. The management of soil phosphorus (P) and potassium (K) is receiving greater attention in intensive, irrigated lowland rice systems of Asia because of concerns that fertilizer P and K rates are not optimally

adjusted to long-term needs^[4]. The treatments of inorganic fertilizer (urea) in split dose gave a better yield under intermittent irrigation. Both sources of nitrogen i.e. organic or inorganic or their combination proved better than control (no nitrogen)^[5]. The response of recent rice hybrids to various rates of NPK fertilizer has to be attempted to elicit information on the optimum level of NPK to rice hybrid. With this view, to have a better understanding of improving fertilizer NPK use efficiency and their effects on rice growth and yield, the present investigation was carried out.

MATERIALS AND METHODS

The experiment was laid out with 14 treatments of NPK combinations (five N levels viz., 0, 50, 100, 150 and 200 kg ha⁻¹; five P and K levels as P₂O₅ and K₂O viz., 0, 25, 50, 75 and 100 kg ha⁻¹) in three replications adopting Randomised Block Design. The graded levels of NPK fertilizers were superimposed in the plots according the level of treatment over a common dose of 500 and 25 kg ha⁻¹ at gypsum and zinc sulphate, respectively. The gypsum and FYM were basally applied and incorporated. Zinc sulphate was applied just before planting. A field experiment was conducted in Alfisols of Agricultural College and Research Institute, Killikulam,

Tamil Nadu to optimize the NPK fertilizers requirements with hybrid rice (CORH 2) and graded levels of NPK during (Pishanam) wet season (September 2000 to January 2001). All the N, P and K were applied as per treatments in the form of prilled urea (46% N), single super phosphate (16% P_2O_5), in the form of muriate of potash (60% K_2O). The full dose of P, half dose of K and one fourth of the level of N was applied as basal. The remaining N was applied in three equal splits viz., active tillering, panicle initiation and heading stages. The remaining 50% N was applied on panicle initiation stage.

At maturity, plot grain and straw yield were measured. The uptake of N, P and K by grain, straw and total dry matter was determined at maturity. The nutrient uptake was worked out by multiplying the dry matter weight with the respective nutrient content and expressed in $kg\ ha^{-1}$. The data thus generated from the experiment were subjected to statistical scrutiny by employing standard statistical procedures.

RESULTS AND DISCUSSION

Commercial hybrid rice production has prompted new research in economic nutrient management. Exploitation of hybrid vigour is one of the approaches by which productivity could be increased in areas, where the yield has already attained the potential level by the use of conventional varieties.

Grain and straw yield: Application of 150:75:50 kg N: P_2O_5 : $K_2O\ ha^{-1}$ recorded the highest grain yield ($7.060\ kg\ ha^{-1}$) of hybrid rice upto 135% over the no fertilizer application ($3.015\ kg\ ha^{-1}$) plot (Table 1). The increased grain yield was ascribed to combined favourable effects of improved leaf N concentration,

photosynthetic rate of flag leaves and increased filled grain percentage by delayed leaf senescence^[6]. Regarding the levels of N application $150\ kg\ N\ ha^{-1}$ found to increase the yield of grains ($8.769\ t\ ha^{-1}$) upto 51% over the no N fertilized plot ($4.400\ t\ ha^{-1}$). Application of N into three equal splits is to be more efficient for higher rice grain production. This might be due to late N application at flowering increased filled grain percentage and thousand grain weight. Application of 150:50:0 kg N: P_2O_5 : $K_2O\ ha^{-1}$ gave the highest straw yield (122% of hybrid rice over the unfertilized treatment).

NPK uptake: The uptake of N, P and K increased with increasing level of fertilizer application. The steady increase in N uptake during rice growing season indicated a rapid absorption of N by the hybrid rice crop (Table 1).

The higher N uptake obtained when application with 150:75:50 kg N: P_2O_5 : $K_2O\ ha^{-1}$ compared to control plot ($152.90\ kg\ ha^{-1}$). The rice crop absorbs N continuously upto maturity and the delayed N application at flowering stage expectedly results in relatively higher N accumulation in foliage including lower leaves, contributing to higher growth leading to larger cytokinin production^[7]. Cytokinin intern release senescence of the whole plant causing more dry matter production to adequately meet the needs arising on account of larger sink in hybrids. Among the N levels, $200\ kg\ N\ ha^{-1}$ applied plot have showed the higher total N uptake ($151.95\ kg\ ha^{-1}$) when compared to no N application ($45.13\ kg\ ha^{-1}$). This might be due to the split application of N and at high level of N fertilizer.

The total P uptake increased with increased NPK levels upto 150:50:50 kg N: P_2O_5 : $K_2O\ ha^{-1}$ ($30.06\ kg\ ha^{-1}$). The percentage increase in total P of NPK was 71, 34 and 28%, respectively. When more water soluble P was

Table 1: Total uptake of NPK ($kg\ ha^{-1}$), grain and straw yield as influenced by graded levels of NPK fertilizer

Treatments	Grain yield ($t\ ha^{-1}$)	Straw yield ($t\ ha^{-1}$)	N uptake ($kg\ ha^{-1}$)			P uptake ($kg\ ha^{-1}$)			K uptake ($kg\ ha^{-1}$)		
			Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
T ₁ ($N_0 : P_0 : K_0$)	3.015	4.037	31.03	91.11	45.13	8.04	5.73	13.75	7.39	45.79	53.18
T ₂ ($N_0 : P_{50} : K_{50}$)	4.400	4.613	46.53	19.37	65.88	11.85	7.26	17.61	12.36	85.96	98.22
T ₃ ($N_{50} : P_{50} : K_{50}$)	5.134	6.191	69.49	29.97	99.56	14.94	9.51	24.44	12.62	112.71	125.25
T ₄ ($N_{100} : P_{50} : K_{50}$)	5.810	6.766	86.81	31.92	118.76	15.31	10.17	25.48	14.53	130.69	145.32
T ₅ ($N_{150} : P_{50} : K_{50}$)	6.754	8.769	105.70	43.65	149.35	16.83	12.85	30.06	17.56	167.38	189.94
T ₆ ($N_{200} : P_0 : K_{50}$)	5.310	8.296	101.65	50.51	151.95	15.67	10.39	26.46	14.25	160.69	174.74
T ₇ ($N_{150} : P_0 : K_{50}$)	4.470	7.541	87.32	39.21	129.20	12.24	10.01	22.51	10.92	135.52	146.44
T ₈ ($N_{150} : P_{25} : K_{50}$)	6.086	6.400	96.44	37.95	134.37	15.92	9.82	25.74	14.42	116.01	130.43
T ₉ ($N_{150} : P_{75} : K_{50}$)	7.060	6.371	108.30	44.60	152.90	17.36	11.17	29.28	14.95	117.90	132.84
T ₁₀ ($N_{150} : P_{100} : K_{50}$)	6.246	5.987	99.54	38.89	127.75	15.80	10.21	26.01	14.12	112.25	126.37
T ₁₁ ($N_{150} : P_{50} : K_0$)	4.854	8.951	82.89	37.92	120.82	12.26	11.21	26.37	12.13	131.33	143.59
T ₁₂ ($N_{150} : P_{50} : K_{25}$)	6.260	6.265	104.02	35.90	139.92	14.27	10.20	25.55	14.08	122.11	136.18
T ₁₃ ($N_{150} : P_{50} : K_{75}$)	6.640	7.613	96.01	49.43	146.61	14.31	11.60	25.91	14.77	166.19	180.99
T ₁₄ ($N_{150} : P_{50} : K_{100}$)	5.466	7.906	102.41	36.70	139.14	14.13	11.13	25.26	15.52	149.34	165.07
SEd	0.32	0.78	6.60	7.73	9.75	0.94	1.32	1.46	1.10	14.6865	14.62
CD (0.5)	0.67	1.60	13.57	15.89	20.04	1.93	2.70	3.01	2.26	30.1888	30.06

applied, the available P content in the soil increased^[8]. Surekha *et al.*^[7] found that anion nutrients like H_2PO_4 are co-transported with NH_4^+ cations nutrients during nutrient absorption process. When NH_4^+ is absorbed by rice roots, counter release of protons (H^+) takes place to balance the charge. This decreases the pH inturn releases the dissolution of insoluble P compounds in oxidised rhizosphere, which helps absorb more P by rice. The nutrient uptake pattern was closely related with nitrogen fertilizer treatment. The 150:50:100 kg N: P_2O_5 : K_2O ha^{-1} had registered the higher K content in grain (15.52 kg ha^{-1}) of hybrid rice. The higher K recovery in $\text{NH}_4\text{-N}$ source might be due to higher dry matter production particularly straw in which bulk of the absorbed K is retained.

From the foregoing results, it is indicated that 150:75:50 kg N, P_2O_5 and K_2O ha^{-1} had registered higher grain yield of CORH 2 rice hybrid. The effect of NPK application on the uptake indicated that the maximum total NPK uptake values obtained at 200:75:50; 150:50:50; 150:50:50 kg N, P_2O_5 and K_2O ha^{-1} , respectively in CORH 2 hybrid rice.

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