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NUTRIENT MANAGEMENT IN RICE *(ORYZA SATIVA* L.)

Exploitation of the production potential of high yielding rice varieties through agronomic management is the only alternative to fulfill the growing food needs of the large expanding population. It is observed that the high yielding varieties are responding to higher levels of nitrogen, phosphorus and potassium than what is recommended today (Channabasavanna *et al.*, 1996). The secondary nutrient sulphur is found to be absorbed by rice crop in amounts equal to phosphorus and is considered essential for the attainment of 90 per cent optimum yield of rice. Since higher inorganic nutrient levels alone deteriorate soil health, an integration of organic manures and inorganic nutrients is the best solution for yield improvement.

Table 1. Effect of manures, fertilizers and sulphur on the dry matter production (DMP) and uptake of nutrients at harvest

Effect	DMP ($t\ ha^{-1}$)	Nutrient uptake ($kg\ ha^{-1}$)			
		N	P	K	S
MO	10.031	126.65	19.90	129.55	8.70
M1	10.58	146.89	21.51	144.99	10.65
M2	10.58	141.07	20.78	133.43	9.66
CD (0.05)	0.484	5.759	0.342	5.392	0.456
F0	9.76	112.80	19.71	119.40	8.31
F1	10.42	140.43	20.75	138.92	11.24
F2	11.00	161.38	21.74	149.64	9.46
CD (0.05)	0.484	5.759	0.342	5.392	0.456
SO	9.74	120.84	18.58	124.47	6.94
S1	10.69	142.31	21.22	139.43	10.19
S2	10.75	151.46	22.39	144.06	11.87
CD (0.05)	0.484	5.759	0.342	5.392	0.456

The present study based on integrated nutrient management was carried out at the Cropping Systems Research Centre, Karamana, with the objective of finding out the efficacy of organic manures along with varying levels of $N:P_2O_5:K_2O$ and sulphur, in improving rice yield. The experiment was conducted during the kharif season of 1998, on sandy loam soil having 1.19% organic carbon, 244, 26 and 162 kg ha^{-1} available N, P_2O_5 and K_2O with pH 5.3. Three levels each of organic manures (M), fertilizers (F) and sulphur (S) were tested in 3^3 partially confounded factorial RBD. The organic manure levels were 5 t ha^{-1} farmyard manure (M_0), 10 t ha^{-1} farmyard manure (M_1) and 5 t ha^{-1} vermicompost (M_2). The fertilizer levels included the recommended dose of 70:35:35 kg N, P_2O_5, K_2O ha^{-1} (F_0) as well as 25 and 50 per cent increase over the recommended level (F_1 and F_2 respectively). The various sulphur levels were no-sulphur (S_0), 12.5 kg ha^{-1} S (SO and 25 kg ha^{-1} S (S_2). The short duration (105-110 days) rice variety Kanchana was tried at a spacing of 15x10 cm in a gross plot size of 4.5 x 4 m^2. Composite soil samples were collected before and after the experimentation, to determine the available nitrogen, phosphorus and potassium. Plant samples at the harvest stage were analyzed for nitrogen, phosphorus and potassium as suggested by Jackson (1958). The total sulphur content in the plant sample was determined by diacid digestion followed by estimation of sulphur turbidimetrically (Chesnin and Yien, 1950).

Among the different levels and sources of organic manure addition, application of farmyard manure @10 t ha^{-1} proved superior in improving the uptake of N, P, K and S (Table 1). The improvement in soil environment with organic manure addition probably encouraged root proliferation to draw more nitrogen. The organic acids produced from the degradation of organic materials might have resulted in the solubility and release of native and applied P to result in higher P uptake. Improvement in the uptake of nutrients was also mainly associated with the increase in dry matter production with increased levels of organic matter addition (Table 1). Increased uptake of P and K with higher doses of organic manure has been reported by Sharma and Mittra (1991) and that of N by Mishra and Sharma (1997). The richness of organic manures in secondary nutrients including sulphur and its steady supply throughout the growth period might have resulted in higher uptake of S. The dry matter production also was favourably influenced by higher levels of organic manure to result in more uptake of the nutrient.

Higher uptake of N, P and K were observed with the highest level of NPK addition (Table 1) probably due to the increased availability of the nutrients. However the uptake of sulphur was reduced at the highest N, P_2O_5, K_2O dose of 105 : 52.5 : 52.5 kg ha^{-1} which is attributed to the antagonistic effect of P on S uptake at higher levels of P (Table 1). The high uptake of S at lower N, P_2O_5 , K_2O levels may be due to the

synergestic relationship between the nutrients.

Table 2. Effect of manures, fertilizers and sulphur on the yield of rice

Effect	Grain yield	Straw yield
	(t ha^{-1})	
MO	4.445	4.786
Ml	4.545	4.988
M2	4.542	5.146
CD (0.05)	NS	NS
FO	4.269	4.652
F1	4.363	4.877
F2	4.90	5.390
CD (0.05)	0.196	0.324
SO	4.258	4.671
S1	4.6	5.128
S2	4.673	5.121
CD (0.05)	0.196	0.324

Aulakh *etal.* 1990, observed synergestic effect of P and S on the uptake of both when the nutrients were supplied at lower rates. A higher P level of 52.5 kg ha^{-1} had an antagonistic effect on S uptake in rice as reported by Nair (1995). Sulphur addition up to the highest level of 25 kg ha resulted in the increased uptake of NPKS nutrients (Table 1). The positive increase in S uptake due to increased availability of the nutrients and production of more dry matter with increasing S level has also been reported by Sakal *et al.* (1999).

Vermicompost is rich in most of the major nutrients, which are readily available to the crops, and therefore the effect of 5 t ha^{-1} vermicompost is comparable to the effect of farmyard manure. Increase in fertilizer level up to F_2 significantly increased both grain and straw yields (Table 2). S_2 recorded higher grain yield but was on par with S_1. S_1 and S_2 recorded comparable and higher straw yields also (Table 2). The improvement in yield attributing characters due to enhanced NPKS uptake might have reflected in grain and straw yields. Similar reports of increased rice yield with enhancement in NPKS levels have been made by Channabasavanna *et al.* (1996) and with S addition by Nair (1995) respectively.

It was concluded that enhanced NPK levels up to 105 : 52.5 : 52.5 kg ha^{-1} and sulphur levels up to 25 kg ha^{-1} along with organic manures either as 10 t ha^{-1} farmyard manure or vermicompost @ 5 t ha^{-1} were good in producing better grain yield of rice.

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