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P AND K FERTILIZATION ON RICE YIELD AND N EFFICIENCY AS INFLUENCED BY ADDED N

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Soil test crop response study with two rice varieties viz., Bhavani on Noyyal alluvium (Typic Haplustalf) and IR 20 on Kalathar alluvium (Entic Pellustalf) was conducted to find out the influence of P and K fertilization on N recovery and efficiency. The grain yield and uptake of N were utilized to calculate N efficiency and recovery. Application of P with N increased the grain yield as well as N uptake in both the varieties of rice - IR 20 and Bhavani, K fertilization did not increase the yield and uptake appreciably. Similar trend was noticed in the case of N recovery and efficiency. Among the varieties rice IR 20 showed higher N efficiency and recovery than rice Bhavani.

The efficacy of added nitrogen is very low under lowland rice cultures. Depending on the condition of use, the nitrogen applied in fertilizer is utilised to 20-60% (Brady *et al*, 1974). In the present day context of increasing cost of fertilizer, to ensure judicious and balanced fertilization it is all the more necessary to improve the efficacy to added nutrients. The fertilizer-nitrogen efficiency can be enhanced considerably by the addition of fertilizer-phosphorus and potassium. A large number of trials were conducted to study mainly the changes that occurred in respect of N-availability and recovery. An attempt has been made, in this study to project the effect of P and K fertilization on N use efficiency and recovery using the test crop of rice IR 20 and Bhavani on two soil orders-alfisol and vertisol.

MATERIALS AND METHODS

Soil Test Crop Response field trials were conducted with two rice varieties viz., Bhavani grown on Noyyal alluvium (Typic Haplustalf) and IR 20 on Kalathur alluvium (Entic Pellustalf). The data on yield, uptake of N have been utilised in this investigation for calculating N efficiency and N-recovery. N efficiency and recovery were calculated for 50 kg and 100 kg N/ha alone and for combination with/without 50 kg P₂O₅/ha and K₂O/ha. Entire dose of P and K were applied basally and N was applied in three splits.

The N-efficiency was calculated from total N-uptake, soil test value of N for treated plots and average soil efficiency was arrived by following STCR methodology (Ramamoorthy, 1973) as given below :

$$\text{Fertilizer efficiency} = \frac{\text{Total uptake} - \text{Average soil efficiency} \times \text{Soil test value}}{\text{Fertilizer level}} \times 100$$

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The percent N recovery for these data was calculated as given by Bartholomew and Clark (1965).

$$\text{N recovery} = \frac{\text{Total uptake of treated plot} - \text{Total uptake of control plot}}{\text{Fertilizer level}} \times 100$$

RESULTS AND DISCUSSION

The grain yield, total N uptake, efficiency and recovery of added N as affected by P and K additions are given in Tables 2 to 4 and the soil fertility status for these two soils is given in Table 1.

Grain Yield

The control recorded the lowest grain yield of 2704 kg/ha for rice IR 20 while the application of 100 kg N/ha increased the grain yield markedly to 4491 kg/ha. Application of phosphorus had a positive effect on yield. Phosphorus at 50 kg P₂O₅/ha in combination with 100 kg N/ha recorded the highest grain yield of 4592 kg/ha. This is in line with the findings of Nandi and Mandal (1979). The influence of added 'P' was much pronounced at higher level of N compared to the lower N level. The grain yield was not improved appreciably due to the added K. This is obvious, as the soil is having sufficiently higher available K to meet the K requirement (Mean values of Kalathur series: 392 kg/ha; Noyyal serie: 714 kg/ha). The combined application of P and K with N showed a mild enhancement of grain yield at 100 kg N level. A similar trend was noticed for N and P combination in Bhavani rice also.

N uptake

The nitrogen uptake was increased with increased in levels of nitrogen.

Application of P increased the uptake. Addition of P at 50 kg/ha enhanced the N uptake by 4.0 per cent at N₅₀ level and 2.0 per cent at 100 kg N level. The reason may be that P application could have favoured the root growth, which in turn could have resulted in the increased absorption of N. Similar results were reported by Muthiah (1978). Potash application had a negative influence on the N-uptake. This may be due to lack of response to added K as well as a depression of N availability to crop. Sinha (1977) reported that K application either singly or in combination with N and P led to decrease of N availability. Even though the highest N uptake of 85.5 kg/ha was observed in the treatment combination of N₁₀₀P₅₀K₀, it was on par with N₁₀₀P₅₀K₅₀ (84.7 kg/ha).

Rice Bhavani also followed a similar trend with N levels and P application. The influence of P addition showed a perceptible increase in N uptake in rice Bhavani (14-16%).

N efficiency

The N efficiency ranged from 23.5 to 29.8 per cent at N₅₀ level and from 27.1 to 32.1 per cent at N₁₀₀ level. Addition of N at 50 kg/ha recorded 23.5 per cent N efficiency and it was increased to 27.1 per cent at 100 kg N/ha level. Application of P had a marked influence on N use efficiency. Due to P addition, N efficiency was increased from 23.5 to 29.9 per cent at N₅₀ level and from

Table 1. Fertility status of the soil

Crop	: Rice IR 20	Crop	: Rice Bhavani
Season	: Rabi	Season	: Rabi
Soil Series	: Kalathur alluvium	Soil Series	: Noyyal alluvium
Nomenclature	: Entic Pellustert	Nomenclature	: Typic Haplustalf

Treatment	Aduthurai			Coimbatore						
	KMnO ₄	N	Olsen P	NH ₄ OAC	K	KMnO ₄	N	Olsen P	NH ₄ OAC	K
N ₀ P ₀ K ₀	251		7.84	392		251		11.65		714
N ₈₀ P ₀ K ₀	286		10.53	414		266		12.99		750
N ₈₀ P ₂₀ K ₀	282		8.96	384		294		12.99		750
N ₈₀ P ₀ K ₅₀	287		8.96	365		267		13.44		784
N ₈₀ P ₂₀ K ₅₀	235		10.53	370		267		10.53		745
N ₁₀₀ P ₀ K ₀	294		8.96	365		250		13.44		717
N ₁₀₀ P ₂₀ K ₀	294		6.72	403		266		12.59		765
N ₁₀₀ P ₀ K ₅₀	247		8.96	392		240		14.22		784
N ₁₀₀ P ₂₀ K ₅₀	280		10.53	341		251		11.65		784

Table 2. P and K fertilization on grain yield and N uptake

Treatment	IR 20 (kg/ha)		Bhavani (kg/ha)		N efficiency(%)		N recovery(%)	
	Grain yield	Total N uptake	Grain yield	Total N uptake	Varieties		Varieties	
					Bhavani	IR 20	Bhavani	IR 20
N ₀ P ₀ K ₀	2704	44.3	2011	40.2	—	—	—	—
N ₈₀ P ₀ K ₀	4108	63.3	2479	51.4	17.0	23.5	22.1	36.6
N ₈₀ P ₂₀ K ₀	4185	65.2	2014	59.4	24.0	28.9	38.8	42.0
N ₈₀ P ₀ K ₅₀	4088	64.5	2612	52.9	19.6	25.3	23.7	38.4
N ₈₀ P ₂₀ K ₅₀	4205	67.2	2912	65.1	20.4	29.8	24.3	39.8
N ₁₀₀ P ₀ K ₀	4491	83.0	3222	64.8	21.5	27.1	24.6	38.0
N ₁₀₀ P ₂₀ K ₀	4592	84.7	4481	73.3	30.8	31.8	44.6	39.4
N ₁₀₀ P ₀ K ₅₀	4425	73.8	3314	62.0	22.6	29.3	23.4	27.8
N ₁₀₀ P ₂₀ K ₅₀	4615	85.5	3304	65.0	25.2	32.1	25.2	40.2
CD (P=0.05)	82	2.1	86	1.8	1.6	1.0	2.0	1.5

Table 3. Relationship between yield and efficiency / recovery

Relationship		between	r
y	x		
yield	efficiency	N	0.55*
		NP	0.69*
		NK	0.34 NS
		NPK	0.62*
yield	recovery	N	0.48*
		NP	0.55*
		NK	0.30 NS
		NPK	0.51*

27.1 to 31.8 per cent at N_{100} level. This effect could be ascribed to the better root proliferation and development due to P addition and consequent higher absorption and utilization of N by rice crop. Increased availability of N due to P addition might be also be resulted in increased N efficiency. Chaudhary *et al* (1981) observed an increase in N availability with P applications. The influence of K on N use efficiency was not impressive. combined application of P and K with the addition of N recorded the highest N efficiency which may be mainly due to additive effect of added phosphorus. The N use efficiency of Bhavani was comparatively lower than that of IR 20. The increased efficiency

to added P over N alone was marked due in rice Bhavani (9.3%), while rice IR 20 recorded only a marginal increase (4.7%) at 100 kg N level. However, the combined effect of P and K on N use efficiency was higher in rice IR 20 than in rice Bhavani.

N-recovery.

The N-recovery ranged from 22.1 to 44.6 per cent in rice Bhavani and from 36.6 to 42.0 per cent in rice IR 20 respectively. Increasing the level of N from 0 to 50 and from 50 to 100 Kg/ha increased the recovery from 22.1 to 24.6 per cent and 36.6 to 38.0 per cent for rice Bhavani and rice IR 20 respectively. In rice Bhavani the addition of P in combination with N_{50} , enhanced the N recovery by 16.6 per cent and 20.0 per cent in combination with 100 Kg N over N alone. Potash application had no apparent effect on N recovery and combined effect of P and K also exhibited only a negligible influence on N-recovery.

Though the rice varieties, exhibited a similar trend, the magnitude of recovery was higher in rice IR 20 than in rice-Bhavani because of its higher yield potential and uptake. However, the influence of P on N recovery was much pronounced in Bhavani compared to rice IR 20 (at 100 Kg N level- the per cent increase: 20 for Bhavani; 5.4 for IR 20).

The grain yield, total N uptake efficiency and recovery were increased with the increase in N level from 50 to

100 Kg/ha. Application of 50 Kg P_2O_5 /ha with 100 Kg N/ha enhanced not only the grain yield and uptake but also the N recovery by 20.0 per cent in Bhavani and 9.5 per cent in IR 20 over N application alone. The effect of added K on these parameters was not impressive. Both the varieties behaved similarly to the application of N and NP. However, the magnitude of increase on N use efficiency was higher in Bhavani than in IR 20 (Bhavani from 7.2 to 30.8; IR-20 from 23.5 to 32.1).

The correlation studies indicated that efficiency of N showed a higher degree of correlation with yield compared to that of N-recovery. Among the different combinations (N, NP, NK and NPK), the NP combination gave the highest correlation value for yield and N-efficiency (0.9*). Similar trend was noticed for N-recovery and yield (0.55*) while NK combination did not show any significant relationship with N efficiency/recovery.

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