

Organics in the improvement of nutrient use efficiencies in white ponni

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Abstract: A field experiment was carried out during the rabi seasons on 1996-97 and 1997-98 to study the sustainability of rice cv. White ponni to green manuring and N and K levels. The grain and straw yields obtained from green manuring along with the application of 50 per cent of the recommended N and K and application of 100 per cent N and K applied alone were on par with each other. Agronomic efficiency of the applied N and K were higher in green manuring with 50 per cent of the recommended N and K. However, non-green manured treatments recorded higher physiological efficiency than green manured treatments. The treatments with green manuring registered positive nutrient balance compared to non-green manuring.

Key words : Green manuring, Agronomic efficiency, Physiological efficiency, Nutrient balance.

Introduction

White ponni is a ruling variety for rabi season with its fine grain quality but because of its long stature and poor responsiveness to organic fertilizers, it is prone to lodging. Periyar - Vaigai command area in which the study area situates, single crop wetlands are kept fallow during the months of July and August when there is a possibility of receiving approximately 150 mm of rainfall from South West Monsoon. Using the initial rains, a green manure like dhaincha can be grown. Daincha can effectively substitute part of inorganic N and thus can save some amount of nonrenewable resource of energy needed for the manufacture of urea. Potassium has an indirect influence on rice grain yield as it increases the utilization efficiency of nitrogenous fertilizers. It also imparts lodging and diseases resistance to crop plants by encouraging strong shoot and root system at times of excess N application. Keeping the above objectives in view, the present study was undertaken.

Materials and Methods

A field experiment was conducted during the rabi seasons of 1996-97 and 1997-98 at Agricultural College and Research Institute, Madurai. The soil of the experimental field was low in available N (232 kg ha^{-1}), medium available P (13.5 kg ha^{-1}) and high in available K (290 kg ha^{-1}). The experiment was conducted in Randomised Block Design with four replications.

The treatment details are as follows :

- F_1 - recommended N and K fertilizer alone
- F_2 - 75% of recommended N and K alone
- F_3 - 50% of recommended N and K alone
- F_4 - Green manure + recommended N and K
- F_5 - Green manure + 75% of recommended N and K
- F_6 - Green manure + 50% of recommended N and K.

Recommended fertilizer dose for white ponni of 75:37.5:37.5 kg ha^{-1} of N, P_2O_5 and K_2O was followed. N and K fertilizers were applied according to the treatment schedule while entire P was applied as basal uniformly to all the treatments. The green manure crop viz. dhaincha (*Sesbania aculeata*) was grown with a seed rate of 60 kg ha^{-1} and ploughed *in situ* at 45 days after sowing.

Grain and straw yields of rice were recorded and N and K use efficiencies were calculated as follows :

Agronomic Efficiency (AE)

The AE is the response in yield per unit of fertilizer nutrient applied and as calculated by the following formula suggested by Yoshida (1981).

Table 1. Yield in rice (kg ha⁻¹)

Treatments	1996-97		1997-98	
	Grain yield	Straw yield	Grain yield	Straw yield
F ₁	4904	8827	5218	9451
F ₂	4646	8362	4964	8897
F ₃	4466	8022	4749	8513
F ₄	5318	9571	5631	10044
F ₅	5114	9204	5427	9702
F ₆	4847	8729	5165	9258
SEd	72	155	77	135
CD (P=0.05)	159	313	171	302

Table 2*. Agronomic efficiency (AE) and physiological efficiency (PE) of N and K

Treatments	1996-97				1997-98			
	AE		PE		AE		PE	
	N	K	N	K	N	K	N	K
F ₁	25.9	51.9	34.4	37.9	26.3	52.5	35.2	39.2
F ₂	30.0	60.0	54.2	47.6	29.8	59.5	51.8	41.6
F ₃	39.9	79.9	40.9	45.7	39.2	78.4	53.1	37.1
F ₄	22.3	44.6	25.8	28.6	22.5	45.0	25.2	28.7
F ₅	26.1	52.7	26.1	28.8	52.2	52.2	25.2	26.1
F ₆	32.2	64.3	25.6	27.5	31.9	63.7	25.4	23.5

* - Data not analysed

Grain yield in fertilized plot (kg ha⁻¹) -
Grain yield in unfertilized plot (kg ha⁻¹)

$$AE = \frac{\text{Quantity of fertilizer nutrient applied (kg ha}^{-1}\text{)}}{\text{Grain yield in fertilized plot (kg ha}^{-1}\text{)} - \text{Grain yield in unfertilized plot (kg ha}^{-1}\text{)}}$$

Physiological Efficiency (PE)

The PE also known as efficiency of utilization as indicated by kg of grain per kg of absorbed nutrient and was computed as given below (Yoshida, 1981).

Grain yield in fertilized plot (kg ha⁻¹) -
Grain yield in unfertilized plot (kg ha⁻¹)

$$PE = \frac{\text{Nutrient uptake in fertilizer plot (kg ha}^{-1}\text{)} - \text{Nutrient uptake in unfertilized plot (kg ha}^{-1}\text{)}}{\text{Grain yield in fertilized plot (kg ha}^{-1}\text{)} - \text{Grain yield in unfertilized plot (kg ha}^{-1}\text{)}}$$

Nutrient Balance

The nutrient balance was worked out as per the procedure suggested by Yadav (1981).

$$\text{Nutrient Balance} = \frac{\text{Total nutrients added} - \text{total nutrients removed}}{\text{Increase or decrease in the available nutrient status before the cropping system}}$$

Results and Discussion

Grain and Straw Yields (Table 1)

Green manure plus half of the recommended N and K (F₆) was able to produce comparable economic yield with 100 per cent recommended N and K (F₁) alone (Table 1). This is because green manure on decomposition increased the availability of N in the soil (Fleming *et al.* 1981) which enhanced the uptake of N by the crop and thereby increased the grain yield of rice (Kundu *et al.* 1991).

Table 3*. N balance sheets (kg ha⁻¹) during 1996-97 and 1997-98

Treatments	Initial soil available N	Total N added through		Final soil available N	Total N removed	Net gain or Net loss of N
		Fertilizer	GM			
1996-97						
F ₁	232	75	-	221	81	-5
F ₂	232	56	-	203	78	-7
F ₃	232	38	-	184	71	-15
F ₄	232	75	39	240	121	+15
F ₅	232	56	39	228	111	+12
F ₆	232	38	39	215	104	+31
1997-98						
F ₁	232	75	-	223	81	-3
F ₂	232	56	-	204	79	-5
F ₃	232	38	-	187	73	-10
F ₄	232	75	45	241	130	+19
F ₅	232	56	45	231	111	+15
F ₆	232	38	45	221	106	+12

- Data not analysed

Table 3*. K balance sheets (kg ha⁻¹) during 1996-97 and 1997-98

Treatments	Initial soil available K	Total K added through		Final soil available K	Total K removed	Net gain or Net loss of K
		Fertilizer	GM			
1996-97						
1	290	38	-	272	96	+40
2	290	28	-	266	82	+30
3	290	18	-	257	72	+21
4	290	38	12	284	115	+59
5	290	28	12	276	106	+52
6	290	18	12	267	84	+31
1997-98						
1	290	38	-	277	97	+46
2	290	28	-	271	87	+39
3	290	18	-	263	75	+30
4	290	38	15	292	120	+69
5	290	28	15	284	112	+63
6	290	18	15	275	92	+44

- Data not analysed

Nutrient use efficiencies (Table 2)

In the present study, Agronomic Efficiency (AE) of N was improved when green manure was combined even with low level of N (50% of N). This shows that green manure, apart

from contributing organic nitrogen, improved the efficiency of fertilizer N (Table 2). Such positive effect of green manuring was seen with 100 per cent N also, though the efficiency gets decreased at higher levels of N. Budhar

et al. (1994) reported such integration of organic and inorganic sources of N leading to higher AE. The AE of K also followed the same trend when applied in combination with green manure as that of N.

In physiological efficiency (PE), uptake of N and K is related with the grain yield. The uptake was maximised when fertilizer N was combined with green manuring, while green manuring alone could not increase the uptake substantially. This means the difference in uptake between green manure plus 50 per cent N and K or green manure plus 100 per cent N and K is wider.

Nutrient balance studies (Table 3 & 4)

It was obviously seen that cultivation of green manure preceding to rice and incorporation of the same resulted in a positive N and K balance position. The increased N and K balance in green manure applied plots might due to large amount of N and K addition through green manuring over and above the amount required by the crop. Every incremental increase in N and K level resulted in successive increase in the N and K balances. The results corroborate with the findings of Wankhade and Pandrangi (1993) and Velu and Ramanathan (1996).

Conclusions

Green manuring with 50 per cent of the recommended N and K produces comparable results with 100 per cent recommended N and K alone. From this it is inferred that 50 per cent of the N and K can be substituted through green manuring. Lodging of white ponni was considerably reduced when 50 per cent of the recommended N and K were applied along with green manure. In green manuring with 50 per cent of the recommended N and K,

the nutrient use efficiencies were better. The positive nutrient balance was also obtained with green manuring. From this two years of study it is inferred that green manuring can be used as a tool to get sustained yield through nutrient use efficiencies and to maintain soil nutrient balance.

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