Growth and Yield Attributes of Rice as Influenced by N Fertilizer and Differential Incorporation of Sunnhemp Green Manure*

T. L. Neelima* and V. B. Bhanu Murthy

Department of Agronomy, College of Agriculture, Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad – 30, Andhra Pradesh, India.

Abstract

A study on "Rice as influenced by N fertilizer and differential incorporation of Sunnhemp as green manure" was taken up at the College farm, College of Agriculture, Rajendranagar, Hyderabad. The total biomass produced by the Sunnhemp was 35 t/ha (29.3 t/ha of shoot and 6.7 t/ha of root portion). The nitrogen contribution by shoot was 94 kg/ha and root 22 kg/ha. Maximum dry matter of the rice crop was obtained due to incorporation of total plant (1306 g/m) and shoot (1264 g/m^2) of sunnhemp and application of 180 kg N/ha (1233 g/m). Productive tiller number increased by about 30 – 33 per cent due to green manuring with succulent shoots (shoot or total) when compared with control or root incorporation. The panicle length, total and filled grain number per panicle was not significantly influenced by green manuring practices. The yield of rice was significantly higher due to shoot or total incorporation. Soil nitrogen balance was positive with incorporation of total plant or shoot of sunnhemp and 180 kg N ha^{-1}.

Rice is a staple food crop of Asia including India. Intensive rice system has degraded the partial productivity of N fertilizer due to decline in N supplying capacity of intensively cultivated wetland soils due to less organic matter. Green manures are agro biologically viable and ecologically sound alternatives, which serve dual purpose of increasing crop productivity as well as improving long term soil fertility in sustainable crop production (Singh *et al.* 1991). Sunhemp, a fibre crop is widely popular due to its use as green manure and fodder. It is most suitable green manure crop for rice, sugarcane and horticultural crops. *Insitu* cultivation of Sunhemp produced about 12 t/ha of fresh or green matter which on incorporation enhanced the rice yield by 0.5 t/ha compared to the rice yield of 5.1 t/ha without green manure (Balasubramanian and Palaniappan, 1990). Direct GM application to soil has been reported to increase the soil organic matter, available N and other nutrients in the plow layer. Keeping this in view, an attempt was made to know the effect on N fertilizer and differential incorporation of sunhemp green manure on performance of rice and nutrient budgeting in soil.

Materials and Methods

A field experiment was conducted during Kharif season of 2004 – 05 at College farm, College of Agriculture, Rajendranagar, Hyderabad. The soil of the experimental field was sandy loam in texture, with pH 7.2, organic carbon 0.31% and available N, P_2O_5 and K_2O as 207, 23 and 258 kg/ha respectively. The total rainfall received during Pre Kharif or summer (22nd May 2004 to 22nd July 2004) and Kharif (29th July to 24th November 2004) was 206 mm in 10 rainy days and 395 mm in 24 rainy days. The experiment was replicated thrice with 16 treatmental combinations comprising four differential incorporation of sunhemp green manure {green manuring total (GM-T), root (GM-R), shoot (GM-S) and no green manure (GM-C)} and four nitrogen levels (N_0, N_{60}, N_{120} and N_{180} kg N/ha). Sunhemp was grown during the last week of May in the plots earmarked for total and root incorporation. After 60 days, the shoot portion of Sunhemp from the plots of root incorporation was cut, shifted, uniformly spread and incorporated in the plot marked for shoot incorporation. Then each plot was flooded with water and puddled with rotavator. Six days after incorporation, the main

* *Corresponding author : t_l_neelima@yahoo.co.in*

plots were divided into subplots. The recommended dose of 60 kg each of P_2O_5 and K_2O/ha was uniformly applied in all the treatments. Rice crop was established by transplanting 27 days old seedlings in last week of July. Nitrogen was applied as per the treatments. LAI was worked out as per the method suggested by Watson (1952). Nitrogen content in the plant sample was determined by micro kjeldahl's method (Jackson, 1973). Nitrogen uptake by rice was determined by multiplying their respective chemical concentration with dry matter and yield. Nitrogen budgeting in the soil was calculated by using the following formula.

Expected balance = Total N applied – N removal by plant

Net gain/loss = Post harvest soil N – Initial soil N.

Results and Discussion

Sunnhemp: Sunnhemp crop, attained a mean height of 113.7 cm with the total biomass production of sunhemp (shoot and root) 35 t/ha. Of the total biomass, nearly 83 per cent was from shoot portion, remaining was contributed by below ground growth. The nitrogen content in the shoot was 1.6 per cent and in the root, it was 1.5 per cent. Consequently, Nitrogen accumulation by shoot portion of sunhemp was 94 kg/ha, while it was only 22 kg/ha by root. Ladha *et al.* (1998) reported that above ground portions of legumes contributed 81 to 162 kg N/ha as against 13 – 37 kg N/ha by below ground growth.

Rice: Growth Characters: A perusal of data in Table 1 revealed that differential incorporation of sunhemp green manure and N levels exerted significant effect on growth and yield attributed of rice viz., plant height, tiller, LAI and dry matter production. Rice plants grew significantly taller producing higher biomass production due to GM-T (total incorporation of Sunhemp) and GM-S (shoot incorporation of sunhemp). However, GM-T was significantly superior to rest of the treatments in case of LAI.

Growth attributes of rice viz., plant height, LAI and drymatter production significantly increased with graded levels of N registering significantly higher values at 180 kg N/ha. Adequate nitrogen supply always increased the amount of protoplasm and chlorophyll which are key factors for increasing photosynthetic leaf area, which inturn might have enhanced drymatter production of rice (Kwo & Chen, 1980).

Yield attributes and Yield: The data presented in Table 1 revealed that yield attributes, yield and HI of rice were significantly influenced by various treatments barring panicle length, no of grains panicle^{-1} due to green manure incorporation and graded levels of N and HI due to green manure incorporation. The yield attributes ie., productive tillers number and test weight were highest with complete plant (GM-T) or shoot (GM-S) incorporation of sunhemp green manure compared to control (GM-C) or root (GM-R) incorporation. Productive tiller number increased by about 30 – 33 per cent due to green manuring with succulent shoots (shoot or total). Purushotham *et al.* (1990) earlier reported the beneficial effect of green manuring on this yield attribute. Rice crop reached 50 per cent flowering stage earlier by 6-7 days due to GM-T or GM-S as compared to that of GM-R and GM-C. Rice crop produced grain yield of 3273 kg/ha without green manure incorporation (GM-C). It increased by 8.9 per cent due to sunhemp root incorporation (3564 kg/ha) and 27.7 per cent due to shoot incorporation (GM-S) (4179 kg/ha) and 28.75 per cent due to GM-T (4214 kg/ha). The treatment GM-T (total incorporation sunhemp) has significantly out yielded all other treatments (GM-S, GM-R and GM-C) in respect of grain yield of rice. It was mainly due to significantly more number of productive tiller/plant considerably more number of grains/panicle, length of panicle, and test weight (Table 1). The straw yield followed the same trend set by grain yield of rice.

Highly significant differences in yield attributing characters were observed due to nitrogen application. The yield attributes i.e., productive

Table 1. Yield attributed, yield, HI and Agronomic efficiency of rice as influenced by N fertilizer and Sunnhemp green manuring.

Treatments	Plant height (cm)	LAI	Drymat-ter (gm^{-2})	No. of tillers m^{-2}		Length of panicle (cm)	Days to 50% flowering	No. of grains per panicle		1000 grain weight (g)	Grain yield ($kg\ ha^{-1}$)	AE (kg grain kg^{-1} N applied)
				Total	Produc-tive			Total	Filled			
Green manure												
GM-T	8.0	6.17	1306	503	409	18.8	70.9	197	173	14.3	4214	7.0
GM-R	73.8	4.20	935	373	307	18.2	77.3	184	145	14.1	3564	7.4
GM-S	78.1	4.50	1264	480	399	18.6	71.9	196	167	14.3	4179	6.9
GM-C	71.5	3.40	812	360	294	17.5	78.1	181	139	13.9	3273	10.3
SEm±	1.7	0.29	55	-	24	0.6	0.5	13	13	0.08	254	-
CD(p=0.05)	4.3	0.73	134	-	57	NS	1.3	NS	NS	0.2	623	-
Nitrogen levels												
N_0	72.9	3.43	929	362	281	17.5	76.8	180	131	13.7	3125	0
N_{60}	75.0	4.24	1022	416	337	18.1	75.9	187	144	14.0	3610	9.0
N_{120}	76.7	4.92	1134	453	382	18.3	73.2	195	166	14.3	4067	7.8
N_{180}	78.8	5.67	1233	484	409	19.3	72.4	199	180	14.6	4373	6.9
SEm±	0.8	0.11	23	-	10	0.5	0.4	14	13	0.06	92	-
CD (0.05)	1.6	0.22	47	-	21	NS	0.8	NS	NS	01	190	-

Agronomic efficiency (kg grain per kg N applied)

tiller number and test weight markedly increased with increasing nitrogen levels upto 180 kg N/ha (Table 1). The Nitrogen levels failed to show any significant effect on panicle length, total and filled grains per panicle and more test weight leading to higher grain yield (Table 1). The response of rice crop in terms of grain yield went on increasing with graded levels of N registering highest value at 180 kg N/ha. It was higher by 7.25, 21.1 and 39.9 per cent over N_{120}, N_{60}, N_0. Usually it is recommended to apply 120 kg N/ha for this agro climatic zone. However, the significant response upto 180 kg N/ ha in the current experiment might be due to sandy loam nature of soil having low N status (207 kg N/ ha). Further more N might have been lost by deep percolation losses as the experimental site was of sandy loam in texture. This result was in comfirmity with that of Dey and Jain (2003) and Singh *et al.* (2006). The trend set by straw yield HI was same as that of grain yield of rice. The significantly higher straw yield in rice with GM-T or GM-S might be due to better growth attributes.

Interaction effect of N levels and sunhemp green manuring on grain yield of rice was found to be significant (Table 2). Without nitrogen or with 60 kg N/ha incorporation of complete plant of sunhemp or incorporation of its shoot portion improved the grain yields significantly compared to no green manuring. But when 120 kg N/ha or 180 kg N/ha was applied, the differences due to green manuring practices were nullified and were not significant statistically. The requirement of nitrogen with each of the green manuring practices appeared to be distinctly different. With shoot or total incorporation, 60 kg N/ha appeared to be enough as the grain yields with this dose were comparable with those under 180 kg N/ha. When root portion alone was incorporated the nitrogen requirement appeared to be 120 kg N/ha. And without any green manuring, grain yield increased with each increase in N level up to 180 kg N/ha. The response of straw yield and harvest index to N was similar to that of grain yield of rice. Production efficiency is an indicator of yield produced per ha per day. It was found to be highest due to GM-T and N180.

Nitrogen balance in soil: N budgeting in soils is very important to understand the effect of application of N through organic (green manure incorporation) and inorganic sources. Nitrogen uptake by grain and straw as well as total uptake by rice plant increased with increasing nitrogen level up to 180 kg N/ha (Table 3). Increase in nitrogen uptake by rice crop was associated with corresponding increase in grain and straw yield. The uptake of Nitrogen due to shoot incorporation was 115.4 kg/ha and with total incorporation it was more or less similar (117.5 kg N/ha). With root incorporation total nitrogen uptake increased marginally by 7 kg/ha compared to control (81.8 kg N/ha). Nitrogen uptake by the crop also increased with the application of 180 kg N/ha.

In the current experiment the soil nitrogen balance was positive with incorporation of total plant (16 kg N/ha) or shoot (11 kg N/ha) of sunnhemp green manure and also with the application of 120 (1 kg N/ha) and 180 kg N/ha (19 kg N/ha).

Conclusion

Application of N either through organic or inorganic sources is important in order to maintain the soil fertility. However, green manures being socially acceptable, economically viable and environmentally sustainable sources of nutrient application help in improving and maintaining sustainability of soil and crop productivity. So, green manures are to be supplemented with inorganic N sources.

References

Balasubramanian, P. and Palaniappan, S.P. 1990. Studies on effect of green manuring and N application in rice - moong cropping system. *Indian Journal of Agronomy* 35: 297-298.

Dey, P. and. Jain, J.M. 2003. Yield and nitrogen uptake of residual wheat in rice wheat cropping system as influenced by green manures. *The Andhra Agricultural Journal* 50: 1-5.

Table 2: Interaction effect of sunnhemp green manure and N levels on grain yield of rice (kg/ha)

	GM-T	GM-R	GM-S	GM-C	Mean
N_0	3645	2868	3625	2563	3125
N_{60}	4221	3220	4201	3019	3610
N_{120}	4393	3916	4347	3613	4067
N_{180}	4598	4252	4544	4098	4373
Mean	4214	3564	4179	3273	
		CD at 5%			
		N at GM	380		
		GM at N	1055		

Table 3: Nitrogen budgeting in soil

Treatments	N applied to rice (kg ha $^{-1}$)	Total available N(kg ha^{-1})	Plant removal (Kg ha^{-1})	Expected balance (kg ha^{-1})	Post harvest available soil N (kg ha^{-1})	Soil net gain/loss
Green manuring						
GM-T	116	323	117.5	205.5	223	+16
GM-R	22	229	88.9	140.1	201	-6
GM-S	94	301	115.4	185.6	217	+11
GM-C	-	207	81.8	125.2	187	-20
Nitrogen levels						
N0	0	267	82.5	124.5	145	-62
N60	60		94.9	172.1	168	-39
N120	120	327	109.8	217.2	208	+1
N180	180	387	117.3	269.7	226	+19

Initial soil N = 207.

Jackson, M.L. 1973. Soil chemical analysis. Printice Hall of India Private Limited, New Delhi.

Kwo, N.C and Chen, C. 1980. Response of agronomic characters, seed yield, oil content and fatty acid composition of rape seed to N, P_2O_5 and K_2O fertilizer treatment. *Journal of Agricultural association, Chin.* 112:23-25.

Ladha, J.K., Watnabe, I. and Saono. 1988. Nitrogen fixation by leguminous green manure and practices for its establishment in tropical lowland rice. Proceedings of the Symposium on Sustainable Agriculture: Green Manure in Rice Farming, 25-29, May 1997. International Rice Research Institute, Phillippines pp 165-183.

Purushotham, S., Jayaram, S. and Sudhakar, P. 1990. Effect of *Leucaena* and *Parthenium* as green manure on rice. *Mysore Journal of Agricultural Sciences* 24:429-432.

Singh, Y., Singh, B. and. Khind, C.S. 1991. Efficient management of leguminous green manures in wetland rice. *Advances in Agronomy* 45:135-189.

Watson, D.J. 1952. The physiological basis of variation in yield. *Advances in Agronomy* 6:103-109.

Yogeshwar singh and C.S. Singh. 2006. Effect of nitrogen and silicon levels on growth, yield and nutrient uptake of rice. *Oryza* 43:220-223.