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Productive performance of rice as affected by G*lyricidia* leaf manuring in conjunction with fertilizer nitrogen

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ABSTRACT

Field experiments were conducted on sandy clay loam soils of Agricultural College Farm, Bapatla to study the influence of Glyricidia *Leaf Manuring (GLM) in conjunction with fertilizer nitrogen on productivity of rice during* wet *seasons of 2007-08 and 2008-09. The experiment was laid out in a Randomized Block Design with six treatments replicated for four times. The treatments consisted of three levels of fertilizer nitrogen applied alone and in conjunction with GLM @ 10 t ha^{-1} i.e,120 kg N ha^{-1} , 180 kg N ha^{-1}, 240 kg N ha^{-1} , 120 kg N ha^{-1} + GLM @ 10 t ha^{-1}, 180 kg N ha^{-1} + GLM @ 10 t ha^{-1}, 240 kg N ha^{-1} + GLM @ 10 t ha^{-1} .* Glyricidia *leaf manure was incorporated in the field seven days before rice transplanting in respective treatments during both the years of study. The experimental soil was slightly alkaline in reaction, low in organic carbon and available nitrogen, medium in available phosphorus and high in available potassium. Each unit increase in N level led to significant increase in growth characters, yield attributes, grain yield and straw yield of the crop. All the yield parameters such as productive tillers m^{-2}, number of filled grains panile^{-1} and test weight recorded were maximum with the treatment that received 240 kg N ha^{-1} + GLM @ 10 t ha^{-1} , however, it was on a par with that of 240 kg N ha^{-1} alone(M_3) or 180 kg N ha^{-1} + GLM @ 10 t ha^{-1} to those of the rest showing GLM incorporation showing an advantage of fertilizer nitrogen equivalent to 60 kg ha^{-1} in terms of rice productivity. Application of 240 kg N ha^{-1} + GLM @ 10 t ha^{-1} recorded higher grain yield (5672 and 5249 kg ha^{-1}, respectively, during first and second year) and straw yield (6674 and 6032 kg ha^{-1}, respectively, during first and second year), but these yields were on a par with those obtained with 180 kg N ha^{-1} + GLM @ 10 t ha^{-1} and 240 kg N ha^{-1} alone during both the years of the study. Overall, the study indicated clear advantage of* Glyricidia *Leaf Manuring in enhancing productivity of rice in conjunction with fertilizer nitrogen to a tune of replacement of fertilizer nitrogen 60 kg ha^{-1}.*

Key words: *rice, glyricidia, leaf manure, fertilizer, nitrogen*

Rice occupies a pivotal place in Indian agriculture and it is the staple food for more than 60 % of Indian population and it accounts for 43 % of total food grain production and 46% of total cereal production. In India, it is grown in an area of 39.47 m.ha with an annual production of 87.83 million tones and productivity of 3217 kg ha^{-1} (Ministry of Agriculture, Government of India, 2011-12). At the current rate of population growth in India, it is estimated that the demand for food grains by 2020 will be around 340 million tones (Abdul Kalam, 2010). The scope for meeting such demand is only through increasing productivity of food grain crops. Among several management practices that affect crop productivity, fertilizer application, especially nitrogen, is of paramount importance for its role in growth and development of the crop. Continuous use of inorganic sources of N leads to decline or stagnation in productivity due to limitation of one or more nutrients. On the other hand, use of organic nutrient sources alone, though improve soil health, seldom found to meet the crop nutrient requirement completely. In this context, combined use of cost effective inorganic fertilizers and organic manures is essential for economic viability and environmental safety. Keeping this in view, the present

investigation was undertaken to study the response of rice to different nitrogen levels alone and in conjunction with glyricidia leaf manure.

MATERIALS AND METHODS

Field experiments were conducted at Agricultural College Farm, Bapatla of Acharya N.G. Ranga Agricultural University, Andhra Pradesh, India during wet seasons of 2007-08 and 2008-09. The experimental soil was sandy clay loam, having pH of 7.8, EC of 0.3 dS m^{-1}, organic carbon 0.3%, available N, P_2O_5 and K_2O was 144 kg ha^{-1}, 34 kg ha^{-1} and 591 kg ha^{-1}, respectively. The experiment was laid out in randomized block design with six treatments *viz* ,120 kg N ha^{-1} , 180 kg N ha^{-1}, 240 kg N ha^{-1} , 120 kg N ha^{-1} + GLM @ 10 t ha^{-1}, 180 kg N ha^{-1} + GLM @ 10 t ha^{-1}, 240 kg N ha^{-1} + GLM @ 10 t ha^{-1} and replicated for four times. Green leaf manure through *Glyricidia* was incorporated seven days before rice transplanting as per the treatments, during both the years of study. The weekly mean maximum temperature ranged from 29.2 ^{0}C to 33.7 ^{0}C and 27.5 ^{0}C to 34.9 ^{0}C during 2007 and 2008, respectively. The mean minimum temperatures for the corresponding period ranged from 18.1 ^{0}C to 26.0 ^{0}C and 14.1 ^{0}C to 26.0 ^{0}C, respectively, while the average maximum and minimum temperatures during the same period were 31.3 ^{0}C and 22.0 ^{0}C during 2007, and 31.7 ^{0}C and 22.4 ^{0}C during 2008, respectively. A total rainfall of 484.5 mm and 358.6 mm was received during 2007 and 2008, respectively. A super fine rice cultivar BPT-5204 (Samba Mashuri) was selected for the study. A common dose of 60 kg P_2O_5 and 40 kg K_2O ha^{-1} was applied in the last puddle through single super phosphate and muriate of potash, respectively, by taking the plot size into consideration. Nitrogen was applied as per the treatments in three equal splits as 1/3 at planting, 1/3 at active tillering and 1/3 at panicle initiation stage. The seedlings of 28 day-old were transplanted in all the plots @ 2-3 seedlings $hill^{-1}$ at a spacing of 20 cm x15 cm. To maintain uniform population across the treatments, gap-filling was done on the seventh day after planting by taking seedlings from the nursery left out for the purpose. All other recommended agronomic and plant protection measures were adopted to raise the crop. Observations on growth parameters, yield (grain and straw) and nutrient uptake by the crop was recorded.

RESULTS AND DISCUSSION

Incorporation of G*lyricidia* leaf manuring in conjunction with fertilizer nitrogen significantly influenced the crop growth characters (plant height, number of tillers m^{-2} and dry matter accumulation), grain and straw yield, and nutrient uptake (N, P, K and Zn and Fe) by the crop during both the years of study.

The plant height measured at different growth stages was increased significantly with increase in N level from 120 to 240 kg ha^{-1}, and when G*lyricidia* leaf manure was applied along with N levels, plant height response was significant upto 180 kg N ha^{-1} only (Table 1). Maintenance of continuous higher availability of N due to good blend of GLM and fertilizer N might have helped the plants to grow taller by increased cell

Table 1. Influence of *glyricidia* leaf manure (GLM) in conjunction with fertilizer nitrogen on growth characters of rice

Treatment (N kg ha^{-1})	Plant height(cm)		No. of tillers m^{-2} at maturity		Dry matter accumulation at 60 DAT(kg ha^{-1})		Dry matter accumulation at maturity(kg ha^{-1})	
	2007	2008	2007	2008	2007	2008	2007	2008
120	75.2	72.5	353.2	316.5	3080	2992	7569	7324
180	84.2	78.6	426.2	387.6	3548	3427	9625	9285
240	89.3	83.2	462.3	436.3	3964	3704	11712	10623
120 + GLM	84.3	81.6	398.7	363.8	3456	3324	8923	8387
180 + GLM	89.7	85.7	484.3	447.1	3962	3728	11897	11245
240 + GLM	93.2	86.2	490.4	470.4	4257	3976	12398	11352
SEm $\pm$	1.4	1.1	9.8	12.5	99	92	236	337
CD (P<0.05)	4.3	3.2	29.6	37.7	297	276	710	1016
CV (%)	3.4	2.6	4.6	6.7	5.2	5.1	4.3	6.5

GLM applied @ 10 t ha^{-1}

division and enlargement (Yoshida and Oritani, 1974 and Beringer, 1980). Of all the treatments included in the study, application of 120 kg N ha^{-1} alone recorded significantly the least plant height. Number of tillers recorded m^{-2} increased significantly with the increase in level of N application from 120 kg ha^{-1} to 240 kg ha^{-1}, but that increase was significant upto 180 kg ha^{-1} only when 10 t GLM ha^{-1} was added together. The influence of GLM was not seen on the tiller production beyond 180 kg N ha^{-1} application. Increase in plant height and tiller density by the incorporation of green leaf manure in addition to fertilizer N was reported by Mathew *et al*. (1994), Rao *et al*. (2004) and Indrani *et al*. (2008).

Dry matter accumulation also followed the similar trend of plant height and tiller number m^{-2} at every growth stage, irrespective of the year of study, as it is the product of these two parameters. As was noticed with plant height and number of tillers, dry matter accumulation was also the highest with 240 kg N ha^{-1} plus GLM, but it was on a par with that of application of 240 kg N ha^{-1} alone or 180 kg N ha^{-1} plus GLM, showing the benefit of GLM to a tune of 60 kg N ha^{-1} in increasing dry matter accumulation by the crop. Increased N availability at higher level of N might have been responsible for profuse tillering and plant height and hence higher dry matter accumulation. Such increased dry matter accumulation with increasing N application together with green leaf manure was reported by Hiremath and Patel (1996), Stalin *et al*. (1999), and Rao *et al*. (2004).

Yield attributes (Table 2) such as productive tillers m^{-2}, number of filled grains $panicle^{-1}$ and 1000-grain weight were significantly influenced by the N levels and GLM given to rice, during both the years of the study.

All the yield attributes increased significantly with increase in level of N application from 120 kg ha^{-1} to 240 kg ha^{-1} alone, but when these levels of N application were combined with GLM the increase in all the yield attributes was significant upto 180 kg N ha^{-1} only, irrespective of the year of the study, showing N contribution from GLM.

Number of productive tillers m^{-2} across different N levels alone or together with GLM ranged from 318.7 to 425.8 during the first year and from 308.8 to 417.8 during the second year of the study, the lowest was with 120 kg N ha^{-1} alone and the highest was with 240 kg N ha^{-1} together with GLM. The highest productive tiller number recorded with 240 kg N ha^{-1} plus GLM @ 10 t ha^{-1}, however, was on a par with that of 240 kg N ha^{-1} alone or 180 kg N ha^{-1} plus GLM.

Number of filled grains $panicle^{-1}$ followed the trend of productive tillers m^{-2} and total number of grains $panicle^{-1}$. Number of filled grains $panicle^{-1}$ increased with each increment in N level which might be due to higher availability of N at panicle initiation and grain development stage resulting in increased number of filled grains $panicle^{-1}$. The contribution of carbohydrates from photosynthetic activity for longer period might have resulted in efficient translocation of food material into the sink (grain) thereby increased the number of filled grains $panicle^{-1}$. The number of filled grains $panicle^{-1}$ were the maximum (143.3 and 138.2 during 2007 and 2008, respectively) with 240 kg N ha^{-1} over

Table 2. Influence of g*lyricidia* leaf manure in conjunction with fertilizer nitrogen on yield attributes and yield of rice

Treatment (kg N ha^{-1})	No. of effective tillers m^{-2}		No. of grains $panicle^{-1}$		Test weight (g)		Grain yield (kg ha^{-1})		Straw yield (kg ha^{-1})	
	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
120	318.7	308.8	122.9	120.5	13.9	13.5	3285	3156	4176	3958
180	363.8	358.8	135.2	132.3	15.5	15.2	4268	4123	5243	4962
240	401.9	397.6	158.6	147.6	16.8	16.3	5253	4872	6215	5693
120 + GLM	352.4	347.8	131.4	127.9	15.4	15.1	3821	3657	4756	4625
180 + GLM	422.1	415.3	162.7	149.5	17.1	16.5	5437	5083	6423	5944
240 + GLM	425.8	417.8	165.4	152.7	17.3	16.6	5672	5249	6674	6032
SEm +	12.2	11.7	2.4	1.8	0.2	0.2	165	161	168	118
CD (P<0.05)	32.8	35.2	7.3	5.4	0.7	0.6	492	485	506	357
CV (%)	6.8	6.3	3.5	2.6	2.9	2.3	6.1	6.0	5.1	3.7

180 and 120 kg N ha^{-1}. These results are in compliance with Singh *et al.* (2006), Srivastava *et al*. (2006) and Pandey *et al.* (2008).

There was a progressive increase in grain and straw yields with each increment in N level from 120 to 240 kg ha^{-1}, during both the years of study, however, when these levels of N application were combined with GLM the increase in grain yield was significant upto 180 kg N ha^{-1} only. The highest grain yield was recorded with 240 kg N ha^{-1} plus GLM (5672 kg ha^{-1} and 5249 kg ha^{-1} during 2007 and 2008, respectively), however, it was on a par with that of 240 kg N ha^{-1} alone or 180 kg N ha^{-1} plus GLM. The lowest was with 120 kg N ha^{-1} alone (3285 kg ha^{-1} and 3156 kg ha^{-1} during 2007 and 2008, respectively). Application of N @ 240 kg ha^{-1} + GLM @ 10 t ha^{-1} also recorded maximum straw yields (6674 and 6032 kg ha^{-1} during 2007 and 2008, respectively) compared to the rest of the treatments during both the years of the study. All the yield components, *viz*., number of productive tillers m^{-2}, number of filled grains panicle^{-1} and 1000-grain weight, were the highest and contributed for higher grain yield in this treatment. The increase in yield with increase in N application might be due to the fact that it is a substrate for the synthesis of organic nitrogen compounds which are constituents of protoplasm and chloroplasts resulting in increased photosynthetic activity for a longer period. These results are in compliance with Srivastava *et al*. (2006), Pandey *et al*. (2008) and Alpna and Kumar (2010).

The uptake of major nutrients (N, P and K) and micro nutrients (Zn and Fe) was significantly influenced by different N levels and glyricidia leaf manuring. during both the years of the study (Table 3). The uptake was increased with increase in N levels upto 240 kg ha^{-1}.

Across the treatments, application of 240 kg N ha^{-1} with GLM @ 10 t ha^{-1} resulted in significantly higher NPK uptake (162.2, 22.7, 201.7 kg ha^{-1} and 145.2, 15.3, 157.2 kg ha^{-1} during 2007 and 2008, respectively) compared to that of 120 kg N ha^{-1} with or without GLM and 180 kg N ha^{-1} application alone, but it was on a par with 240 kg N ha^{-1} applied alone or 180 kg N ha^{-1} applied together with GLM during both the years of study. Irrespective of the year of the study, the lowest NPK uptake (97.2, 9.2, 125.5 kg ha^{-1} and 81.4, 8.1, 100.2 kg ha^{-1} during 2007 and 2008, respectively) was noticed with 120 kg N ha^{-1} applied alone over the rest of the treatments. The uptake being the product of nutrient content and dry matter accumulation, the increase in nutrient uptake by the crop at higher dose of N in addition to GLM incorporation might be due to increased availability of nutrients and higher grain and straw yields. Comparable findings were reported by Bhattacharya *et al.* (1992); Devasenamma *et al.* (1999); Sudhakar *et al.* (2003); and Sujathamma and Reddy (2004).

Overall, the field studies conducted for two consecutive years clearly indicated the benefit of glyricidia leaf manuring in enhancing the productivity of rice in conjunction with fertilizer nitrogen to a tune of 60 kg ha^{-1}, and application of 180 kg N ha^{-1} along with 10 t ha^{-1} of GLM to rice recorded higher growth parameters, yield attributes and grain yield, straw yield and nutrient uptake by the crop.

Table 3. Influence of *glyricidia* leaf manure in conjunction with fertilizer nitrogen on nutrient uptake (kg ha $^{-1}$) of rice

Treatment (kg N ha^{-1})	N uptake		P uptake		K uptake		Zn uptake		Fe uptake	
	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
120	97.2	81.4	9.2	8.1	125.5	100.2	0.13	0.12	0.15	0.15
180	129.2	121.7	12.7	10.7	157.2	135.9	0.19	0.15	0.20	0.21
240	153.2	137.7	14.9	14.3	182.5	146.8	0.22	0.17	0.23	0.23
120 + GLM	119.3	113.4	11.3	9.7	153.2	126.3	0.18	0.14	0.19	0.22
180 + GLM	157.4	143.5	17.8	15.1	191.6	152.2	0.23	0.18	0.24	0.24
240 + GLM	162.2	145.2	22.7	15.3	201.7	157.2	0.23	0.18	0.25	0.24
SEm+	3.8	3.1	1.0	0.4	7.8	3.8	0.003	0.004	0.006	0.003
CD (P<0.05)	11.6	9.2	3.0	1.1	23.4	11.6	0.01	0.01	0.02	0.01
CV (%)	5.4	4.7	14.0	5.9	8.9	5.5	4.7	4.5	5.4	3.3

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