Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; SP2: 381-383

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Influence of nutrient management practices on nutrient uptake and productivity of transplanted rice

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Abstract
Field experiment was conducted at the Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalainagar to study the influence of nutrient management practices on transplanted rice for its nutrient uptake and productivity. The experiment was laid out in randomized block design. The treatment schedule consist of nine treatments *viz.*, T_1 - Absolute control, T_2 - Recommended dose of fertilizer (120:38:38 kgs of N, P_2O_5 and K_2O ha^{-1}, T_3 - 75% RDN through fertilizer + FYM @ 12.5 t ha^{-1}, T_4 - 75% RDN through fertilizer + 25% N through *Sesbania rostrata*, T_5 - 75% RDN through fertilizer + 25% N through *Azadirachta indica*, T_6 - 75% RDN through fertilizer + *Azospirillum brasilense* soil application @ 2 kg ha^{-1}, T_7 - 75% RDN through fertilizer + FYM @ 12.5 t ha^{-1} + *Azospirillum brasilense* soil application @ 2 kg ha^{-1}, T_8 - 75% RDN through fertilizer + 25% N through *Sesbania rostrata* + *Azospirillum brasilense* soil application @ 2 kg ha^{-1}, T_9 - 75% RDN through fertilizer + 25% N through *Azadirachta indica* + *Azospirillum brasilense* soil application @ 2 kg ha^{-1}. Dry matter production, NPK uptake and yield components *viz.* number of productive tillers m^{-2}, grain yield and stalk yield were recorded and economics were also calculated. Among the treatments, the treatment T_8 - 75% RDN through fertilizer + 25% N through *Sesbania rostrata* + *Azospirillum brasilense* soil application @ 2 kg ha^{-1} imposed to rice recorded higher values in dry matter production, yield attributes, yield, economics and NPK uptake without affecting the soil fertility.

Keywords: INM, FYM, *Sesbania rostrata, Azospirillum brasilense, Azadirachta indica*

Introduction

Rice is the most important staple food for more than half of the world's population, including regions with high population density and rapid growth. Among the rice growing countries, India has the largest area (44 million hectares) and the second largest producer of rice next to China. The rice productivity in India is 3.37 t ha^{-1} and the world average is 4.25 t ha^{-1}. The rice requirement of India by the year 2025 would be around 195 million tonnes (Kumar *et al.*, 2009) [8] with the current population growth rate of 1.5%. India has to increase its rice productivity by three per cent per annum to meet the food requirement of growing population (Gulab Singh Yadav *et al.*, 2009) [4]. In Tamil Nadu, it is cultivated in an area of 17.89 lakh heactares with the production and productivity of 50.40 lakh tones and 2.82 t ha^{-1}, respectively. Rice often surprises us with its phenomenal adjustments to environment perhaps that is the reason why it has become one of the world's prime food crops.

From the stand point of profitability, the crop is heading towards a crisis despite of general increase in price over the past five years in many commodities, since the price is not considered to be remunerative. Highly intensified chemical agriculture with repetitive application of fertilizers, insecticides, fungicides and herbicides leads to decline in soil fertility and turn down in productivity. Though synthetic fertilizers have contributed more for enhancing agricultural production, their widespread use for longer period have contributed equally or more negatively in erosion of soil fertility and decline in productivity level (IRCN, 2001) [5], environmental pollution with adverse effects on human health, biotic and ecosystem (IRRI, 2003) [6].

Among the nutrient inputs, nitrogen ranks first to maximize output in agriculture (Sharma, 1995) [11]. Nitrogen is the key to any fertilizer management programme and it is the mean by which yield potential of modern rice genotypes can be achieved. The low N recovery, increased pollution and enhanced cost of production resulted in renewed interest in organic manuring to partially substitute the fertilizer N and to achieve sustainable productivity. The importance ascribed to sustainability at present is an attempt to promote organic manures, which can sustain soil health through improvement in physical, chemical and biological properties (Santhy *et al.*, 2001) [9]. Farm yard manure is the most commonly used organic manure.

It supplies macro and micronutrient apart from improving physical condition of the soil (Sengar *et al.*, 2000) [10].

Green manures are the rich source of nitrogen which helps to keep soil quality and fertility enhancement as a whole meeting a part of nutrient need of crops. Biofertilizers helps in mobilizing plant nutrients through their biological activity. Hence, the present investigation was planned to develop a remunerative, productive and sustainable integrated nutrient management practice in rice crop.

Materials and methods

Field experiment was conducted at the Experimental farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalainagar. The experimental field is situated at 11° 24' N latitude and 79° 44' E longitude at an altitude of 5.79 m above mean sea level. The climate of Annamalainagar is moderately warm with hot summer months. The weekly maximum temperature ranged from 26.8 to 36.9°C with a mean of 32.7°C. The weekly minimum temperature ranged from 23.1 to 27.3°C with a mean of 25.2°C. The soil is low in available nitrogen, medium in available phosphorus and high in available potassium.

The experiment was laid out in randomized block design with three replications. The treatments consists of T_1 - Absolute control, T_2 - Recommended dose of fertilizer (120:38:38 kgs of N, P_2O_5 and K_2O ha^{-1}, T_3 - 75% RDN through fertilizer + FYM @ 12.5 t ha^{-1}, T_4 - 75% RDN through fertilizer + 25% N through *Sesbania rostrata*, T_5 - 75% RDN through fertilizer + 25% N through *Azadirachta indica*, T_6 - 75% RDN through fertilizer + *Azospirillum brasilense* soil application @ 2 kg ha^{-1}, T_7 - 75% RDN through fertilizer + FYM @ 12.5 t ha^{-1} + *Azospirillum brasilense* soil application @ 2 kg ha^{-1}, T_8 - 75% RDN through fertilizer + 25% N through *Sesbania rostrata* + *Azospirillum brasilense* soil application @ 2 kg ha^{-1}, T_9 - 75% RDN through fertilizer + 25% N through *Azadirachta indica* + *Azospirillum brasilense* soil application @ 2 kg ha^{-1}. The inorganic nutrients NPK were supplied in the form of urea, single super phosphate and muriate of potash, respectively. Farm yard manure, *Sesbania rostrata*, *Azadirachta indica* and *Azospirillum brasilense* were applied according to the treatment. Recommended seed rate of 60 kg ha^{-1} was adopted. Twenty five days old seedlings were transplanted @ 2 seedlings $hill^{-1}$. A spacing of 12.5 cm x 10 cm were adopted to accommodate a plant population of 80 m^{-2}.

Biometric observation *viz*., dry matter production at harvest stage, plant nutrient uptake, yield components *viz.* number of productive tillers m^{-2}, grain yield and stalk yield were recorded. Net return and return $rupee^{-1}$ invested also calculated. The data presented was subjected to statistical analysis following the methods suggested by Gomez and Gomez (1991) [3] and wherever the treatment differences were found significant, critical differences were worked out at five per cent probability level. Treatment differences having not significant results at five per cent probability level were denoted as NS.

Results and Discussion

The data pertaining to the dry matter production at harvest stage and NPK uptake were given in table 1. The results of the experiments showed that significant variation on dry matter production and NPK uptake were recorded under different treatments. Among the treatments, application of 75% RDN through fertilizer + 25% N through *Sesbania rostrata* + *Azospirillum brasilense* soil application @ 2 kg ha^{-1} (T_8) recorded higher dry matter production (12473 kg ha^{-1}) at harvesting stage, higher values of N uptake (107.68 kg ha^{-1}), P uptake (19.84 kg ha^{-1}) and K uptake (70.63 kg ha^{-1}) at harvest stage. Substituting chemical nitrogen with organic source was realized up to 25 per cent with *Sesbania rostrata* in obtaining a similar response as that of 100 per cent N as urea. Nitrogen mineralized during decomposition of *Sesbania rostrata* could have resulted in increased contribution of nitrogen to the crop. Better nutrient availability through the integration of chemical fertilizers with *Sesbania rostrata* resulted in higher dry matter production. The results are in line with the findings of Balasubramanian (2012) [1]. Furthermore, inoculation of *Azospirillum brasilense* had improved higher nitrogenous activity and nutrient uptake (Wani, 1990) [12].

Yield attribute like number of productive tillers m^{-2}, grain yield and straw yield were also registered significant variation by the nutrient management practices (Table 2). Among the treatments, 75% RDN through fertilizer + 25% N through *Sesbania rostrata* + *Azospirillum brasilense* @ 2 kg ha^{-1} as soil application (T_8) recorded significantly higher values on number of productive tillers m^{-2} (419), grain yield (6154 kg ha^{-1}) and straw yield (6963 kg ha^{-1}). This might be due to higher deliberation of macro and micro nutrients in the *Sesbania rostrata* which has endorsed to higher rate of N mineralization as a result of high cation exchange capacity, slow and steady release of N could make the soil more productive, thus improved the number of productive tillers m^{-2}. The sustained release of N from organic manure, particularly from *Sesbania rostrata* supplemented with N fertilizer might have satisfied the nutritional need of the plant as opined by Jagadish Kumar and Yadav (2008) [7]. Inoculation with *Azospirillum brasilense* to rice increased the dry weight of straw and grain. This is in accordance with the findings of Bashir Ahmed *et al*. (2013) [2]. The treatment absolute control (T_1) registered lower values of growth and yield components and yield.

Higher crop yield resulted in better economic parameters like net return and return $rupee^{-1}$ invested. Among the treatments, application of 75% RDN through fertilizer + 25% N through *Sesbania rostrata* + *Azospirillum brasilense* @ 2 kg ha^{-1} as soil application (T_8) recorded higher net income of Rs. 55021 ha^{-1} and return per rupee invested of Rs. 3.13. Increased profitability in this treatment could be attributed to higher economic yield by the crop as a result of favourable physiological conditions offered by them.

Conclusion

Based on the result of the experiment it was concluded that application of 75% RDN through fertilizer + 25% N through *Sesbania rostrata* + *Azospirillum brasilense* @ 2 kg ha^{-1} as soil application (T_8) imposed to transplanted rice recorded higher values in most of the parameters like dry matter production, plant nutrient uptake, yield components *viz.* number of productive tillers m^{-2}, grain yield and stalk yield and economics without affecting the soil fertility and thereby supporting the crop production.

Table 1: Influence of nutrient management practices on dry matter production and nutrient uptake of transplanted rice

Treatments	DMP at harvest (kg ha^{-1})	Nutrient uptake (kg ha^{-1})		
		N	P	K
T_1 - Absolute control	7763	78.27	8.55	55.71
T_2 - Recommended dose of fertilizer (120:38:38 kgs of N, P_2O_5 and K_2O ha^{-1})	8625	87.79	11.03	58.57
T_3 - 75% RDN + FYM @ 12.5 t ha^{-1}	9831	93.55	13.77	62.04
T_4 - 75% RDN + 25% N through *Sesbania rostrata*	10561	98.59	15.56	64.99
T_5 - 75% RDN + 25% N through *Azadirachta indica*	10175	96.12	14.32	63.45
T_6 - 75% RDN + *Azospirillum brasilense* soil application @ 2 kg ha^{-1}	8965	90.41	11.93	59.86
T_7 - 75% RDN + FYM @ 12.5 t ha^{-1} + *Azospirillum brasilense* soil application @ 2 kg ha^{-1}	11353	102.07	17.20	67.02
T_8 -75% RDN + 25% N through *Sesbania rostrata* + *Azospirillum brasilense* soil application @ 2 kg ha^{-1}	12473	107.68	19.84	70.63
T_9 - 75% RDN + 25% N through *Azadirachta indica* + *Azospirillum brasilense* soil application @ 2 kg ha^{-1}	11711	104.43	18.32	68.66
S. Ed	198.90	1.42	0.62	0.88
CD (p=0.05)	415.64	2.97	1.29	1.84

Table 2: Influence of nutrient management practices on number of productive tillers, grain yield, straw yield and economics of transplanted rice

Treatments	Number of productive tillers m^{-2}	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Net income (Rs. ha^{-1})	Return rupee^{-1} invested
T_1 - Absolute control	290	2966	5447	16989	1.71
T_2 - Recommended dose of fertilizer (120:38:38 kgs of N, P_2O_5 and K_2O ha^{-1})	325	3635	5795	22361	1.83
T_3 - 75% RDN + FYM @ 12.5 t ha^{-1}	355	4389	6199	26227	1.80
T_4 - 75% RDN + 25% N through *Sesbania rostrata*	369	4680	6260	36725	2043
T_5 - 75% RDN + 25% N through *Azadirachta indica*	361	4522	6249	35165	2.39
T_6 - 75% RDN + *Azospirillum brasilense* soil application @ 2 kg ha^{-1}	335	3852	5869	26851	2.06
T_7 - 75% RDN + FYM @ 12.5 t ha^{-1} + *Azospirillum brasilense* soil application @ 2 kg ha^{-1}	389	5249	6572	36816	2.12
T_8 -75% RDN + 25% N through *Sesbania rostrata* + *Azospirillum brasilense* soil application @ 2 kg ha^{-1}	419	6154	6963	55021	3.13
T_9 - 75% RDN + 25% N through *Azadirachta indica* + *Azospirillum brasilense* soil application @ 2 kg ha^{-1}	397	5443	6597	46468	2.83
S. Ed	6.52	126.51	102.15	-	-
CD (p=0.05)	13.62	264.40	208.30	-	-

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