Residual effect of Integrated Nutrient Management practices on growth and yield of rice fallow blackgram (*Vigna mugno* L.)

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Abstract

Field investigations were carried out in rice - blackgram relay cropping system at the Experimental farm, Department of Agronomy, Annamalai University, Annamalainagar, which represents the tail end area of Cauvery Deltaic Zone of Tamil Nadu, India, to study the residual effect of integrated nutrient management practices on growth and yield of rice fallow blackgram. The experiments were laid out in randomized block design with three replications. The treatments were imposed to rice crop. The treatments comprised of integrated application of 75% recommended dose of N through fertilizer and 25% N through various organic manures (FYM, cow dung based vermicompost, cow dung and water hyacinth based vermicompost, enriched poultry manure compost, enriched coirpith compost, green manures and green leaf manures) with recommended dose of P and K were evaluated with farmers' practice and absolute control under. The residual effect of integrated nutrient management practices on growth, yield attributes, yield of fallow blackgram was recorded. Among the different combinations, residual effect of 75 % RDN through fertilizer + 25 % N through vermicompost (75 % Cd + 25 % Wh) had strikingly impressive effect on growth, yield attributes, seed yield and haulm yield of blackgram. NPK uptake by the crop was also increased in this treatment. This treatment was statistically on par with the application of 75 % RDN through fertilizer + 25 % N through vermicompost (100 % Cd) to rice.

Keywords: INM, RDF, FYM, *Azospirillum*, $ZnSO_4$, NPK uptake, sunflower.

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 it is the second largest producer (131 million tonnes) of rice next to China (197 million tonnes). The rice productivity in India is 3.37 t ha^{-1} while the world average is 4.25 t ha^{-1}. At the current population growth rate (1.5 %), the rice requirement of India by the year 2025 would be around 125 million tonnes (Kumar *et al.*, 2009). To meet the food requirement of the growing population, India has to increase its rice productivity by three per cent per annum (Gulab Singh Yadav *et al.*, 2009). In Tamil Nadu, it is cultivated in an area of 17.89 lakh hectares with the production and productivity of 50.40 lakh tonnes and 2.82 t ha^{-1}, respectively (Anonymous, 2010).

There is ample scope to fit short duration pulse crop *viz*., blackgram to a considerable extent in the rice fallows of Tamil Nadu. The beneficial effects of including a pulse crop in rice based cropping system have been well documented (Chinnusamy *et al.,* 1997). The existing system of fertilizer management in cropping system is based on the nutrient requirement of individual crop ignoring the carry over effect of manure or fertilizer applied to the preceding crop. Residual effect of nutrients may be more pronounced for organic sources of nutrients applied to the preceding crop, benefiting the succeeding crop to a greater extent (Hegde, 1998) and the system productivity becomes sustainable through integrated use of organic and inorganic sources of nutrients (Ramesh, 2008).

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. Recent response studies indicated the use of more than 150 kg nitrogen ha^{-1} than to the older ones of around 120 - 150 kg nitrogen ha^{-1}. 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 prerequisite for a sustainable agriculture is the balanced supply of plant nutrients. This can be achieved through integrated nutrient management approach, which involves the use of high value organic manures such as vermicompost along with inorganic nutrients for increasing the crop yield. The importance ascribed to sustainability at present is an appropriate attempt to promote organic manures, which can sustain soil health through improvement in physical, chemical and biological properties (Santhy *et al.*, 2001). Farm yard manure (FYM) is the most commonly used organic manure. It supplies macro and micronutrients apart from improving physical conditions of the soil (Sengar *et al.,* 2000). The bulkiness as well as non-availability of organic manures limit their use and necessitate evolving viable alternatives. In the recent years, vermicompost has been identified as one of the major gears to convert the biodegradable organic material into resourceful manure. It is rich in available nitrogen, phosphorus, potassium, calcium, vitamins, natural phytoregulators and microflora in balanced form that help in re-establishment of the natural fertility of the soil (Banik and Ranjita Bejbaruah, 2004).

Water hyacinth, an aquatic and most problematic weed can be effectively utilized for the production of vermicompost (Sudhakar, 2000) when mixed with cow dung upto 25 per cent on dry weight basis (Renuka *et al.,* 2007). The resulted water hyacinth based vermicompost has an optimistic effect on the formation of the micro aggregates of the soil and cation exchange capacity which reflected on rice growth and yield (Shanjida Khan and Sarwar, 2002).

Poultry manure contains considerable amount of plant nutrients which has to be used as manure after composting. Enrichment of poultry wastes with phosphatic fertilizers and biofertilizers can increase its nutrient content and availability. Disposal of agro industrial wastes are a major problem and dumping it in the vicinity of industrial areas initiate environmental hazards. Recycling of industrial wastes is one way of disposal mechanism and another way of resource management. One among the industrial wastes is coirpith from coir industries. It has a greater potential in supplying higher quantity of nitrogen, phosphorus and potassium besides secondary and micronutrients and can be used as best organic manure (Reghuvaran and Ravindranath, 2012).

Use of green manures, a rich source of nitrogen helps to keep soil quality and fertility enhancement as a whole meeting a part of nutrient need of crops. The pre-season green manuring and its in-situ incorporation had improved growth and productivity of succeeding cereals, particularly rice.

Materials and Methods

Field experiments were conducted at the Experimental Farm, Department of Agronomy, Annamalai University, Annamalainagar to ascertain the residual effect of integrated nutrient management practices on growth, yield and nutrient uptake of fallow blckgram. The experimental site is situated at 11°24' N latitude and 79°44' E longitude with an altitude of +5.79 m above mean sea level in the southern part of India and 15 km away from the Bay of Bengal coast. The weather at Annamalainagar is moderately warm with hot summer months. The initial analysis of the experimental soil revealed that heavy clay with neutral in reaction, with low soluble, low in available N, medium in available P_2O_5 and high in available K_2O.

The experiments were laid out in randomized block design with three replications. The treatment schedule comprised of T_1 - Control (No manures and fertilizer application), T_2 – 100 % Recommended dose of fertilizer N (RDN), T_3 - 100 % RDN + FYM @ 12.5 t ha^{-1}, T_4 - 75 % RDN + 25 % N through vermicompost (100 % cow dung – Cd), T_5 – 75 % RDN + 25 % N through vermicompost (75 % cow dung - Cd + 25 % water hyacinth - Wh), T_6 - 75 % RDN + 25 % N through enriched poultry manure compost, T_7 - 75 % RDN + 25 % N through enriched coirpith compost, T_8 - 75 % RDN + 25 % N through *Sesbania aculeata*, T_9 - 75 % RDN + 25 % N through *Crotalaria juncea*, T_{10} - 75 % RDN + 25 % N through *Gliricidia sepium*, T_{11} - 75 % RDN + 25 % N through *Pongamia glabra*.

The organic manures *viz.*, FYM, vermicompost, enriched poultry manure compost, enriched coirpith compost, green manures and green leaf manures and inorganic fertilizers *viz.*, urea, super phosphate and muriate of potash were used in the experiments. Green manure *in situ* with *Sesbania aculeata* and *Crotalaria juncea* as well as green leaf manures *Gliricidia sepium* and *Pongamia glabra* were incorporated one week before transplanting of rice in the respective treatments. Recommended agronomic management practices were followed as per the guidelines given by the Department of Agriculture, Government of Tamil Nadu. The growth attributes *viz.*, plant height, leaf area index (LAI), dry matter production (DMP), and yield attributes *viz.*, number of pods plant^{-1}, number of seeds pod^{-1}, seed yield and haulm yield were recorded. NPK nutrients uptake by the crop were also recorded.

Result and Discussion

Growth attributes

The residual effects of the integrated nutrient management practices enhanced the growth attributes of rice fallow blackgram and these were superior to absolute control during the period of experimentations (Table 1).

Among the integrated nutrient management practices, the residual effect of 75 % RDN through fertilizer + 25 % N through vermicompost (75 % Cd + 25 % Wh) applied to rice (T_5) recorded higher growth attributes (plant height, LAI and DMP) of blackgram and it was comparable with the application of 75 % RDN + 25 % N through vermicompost (100 % Cd) to rice (T_4). This could be due to synergistic and cumulative carry over effect of water hyacinth based vermicompost in supplying considerable amount of micronutrients besides major nutrients, beneficial growth promoting substances that might have helped in enhancing the growth characters of rice fallow blackgram grown as residual crop. Moreover, the application of water hyacinth based vermicompost and other organic manures and also improvement in soil physical and biological properties, which led to better availability of nutrients to the succeeding crop leading to better growth of blackgram. The results are in agreement with those of Rajarathinam (2002) and Prakash *et al*. (2008).

Yield attributes

Striking improvement in yield attributes (number of pods plant^{-1} and number of seeds pod^{-1}) of blackgram was observed in the plots which received integrated nutrient management practices than recommended NPK fertilizer alone and absolute control. The residual effect of 75 % RDN through fertilizer + 25 % N through vermicompost (75 % Cd + 25 % Wh) applied to rice (T_5) exhibited higher yield attributes and it was statistically comparable with 75 % RDN through fertilizer + 25 % N through vermicompost (100 % Cd) imposed to rice (T_4). The efficient utilization of mineralized N from the vermicompost and fertilizer N would have increased the availability of N throughout the growth period and thereby increased the assimilation of photosynthates which inturn better source and sink relationship led to higher yield attributes of rice fallow blackgram. Similar findings of enhancing the yield attributes in the fallow crops due to the residual effect of organic manures and inorganic fertilizer N applied to previous rice crop was reported by Britto and Girija (2006) and Stalin (2008).

Seed and haulm yield

In rice fallow blackgram, the yield (seed and haulm) registered by residual effect of integrated nutrient management treatments were higher than 100 % recommended dose of fertilizer N (T_2) and absolute control (T_1) (Table 2). The spectacular yield improvement was observed due to application of 75 % RDN through fertilizer + 25 % N through vermicompost (75 % Cd + 25 % Wh) (T_5) to rice and recorded higher seed yield of

602 kg ha^{-1} which was 69.6 per cent higher than that obtained in the absolute control (T_1). This was statistically on par with 75 % RDN through fertilizer + 25 % N through vermicompost (100 % Cd) (T_4) applied to rice. The efficient utilization of mineralized N from the water hyacinth vermicompost and fertilizer N would have increased the availability of N throughout the growth period and thereby increased the growth, yield attributes and yield of residual blackgram. Similar findings of enhancing the yield and yield attributes due to the residual effect of organics and inorganics applied to previous rice crop was reported by Subramani *et al.* (2008).

Nutrient uptake

Among the residual effect of INM treatments, application of 75 % RDN through fertilizer + 25 N through vermicompost (75 % Cd + 25 % Wh) applied to rice (T_5) recorded higher uptake of NPK over absolute control (T_1). The increased NPK uptake noticed in the treatment could be attributed to the increased availability of NPK in the soil as a result of conjunctive application of organic and inorganic fertilizer to the rice crop and the favourable influence of organics in amending the soil conditions. These results were concurred with the report of Kaleeswari *et al.* (2012) who observed an increase in the residual NPK and their uptake by the succeeding crops.

Conclusion

In the light of economic analysis it may be inferred that combined application of either 75 % RDN through fertilizer + 25 % N through vermicompost (75 % Cd + 25 % Wh) or 75 % RDN through fertilizer + 25 % of N through vermicompost (100 % Cd) imposed to rice under rice – blackgram relay cropping system increased the growth, yield attributes and yield of fallow blackgram. This may be an eco-friendly, economically viable and biologically active system that can be advocated to the farmers of Cauvery Deltaic Zone of Tamil Nadu.

Table 1. Residual effect of integrated nutrient management practices on plant height (cm), leaf area index (LAI), dry matter production (DMP), number of pods plant^{-1}, number of seeds pod^{-1} of fallow blackgram

Treatments	**Plant height (cm)**	**Leaf area index**	**Dry matter production (kg ha^{-1})**	**Number of pods plant^{-1}**	**Number of seeds pod^{-1}**
T_1 – Absolute control (No manures and fertilizer application)	37.1	2.06	1654	4.86	4.85
T_2 – 100 % Recommended dose of fertilizer N (RDN)	38.6	2.21	1853	5.58	5.06
T_3 – 100 % RDN + FYM @ 12.5 t ha^{-1}	41.8	2.49	2141	7.28	5.47
T_4 – 75 % RDN + 25 % N through VC (100 % Cd)	45.0	2.75	2433	9.05	5.85
T_5 – 75 % RDN + 25 % N through VC (75 % Cd + 25 % Wh)	45.6	2.80	2495	9.24	5.88
T_6 – 75 % RDN + 25 % N through EPMC	43.7	2.63	2308	8.30	5.69
T_7 – 75 % RDN + 25 % N through ECC	42.3	2.52	2178	7.56	5.54
T_8 – 75 % RDN + 25 % N through *Sesbania aculeata*	42.1	2.52	2156	7.42	5.52
T_9 – 75 % RDN + 25 % N through *Crotalaria juncea*	42.0	2.51	2147	7.34	5.50
T_{10} – 75 % RDN + 25 % N through *Gliricidia sepium*	40.1	2.33	1981	6.24	5.26
T_{11} – 75 % RDN + 25 % N through *Pongamia glabra*	40.4	2.37	2016	6.56	5.29
S.Ed	0.623	0.048	58.50	0.293	0.058
CD (P = 0.05)	1.250	0.096	119.60	0.586	0.116

*VC – Vermicompost; Cd – Cow dung; Wh – Water hyacinth; EPMC – Enriched poultry manure compost; ECC – Enriched coirpith compost

Table 2. Residual effect of integrated nutrient management practices on seed yield and haulm yield and NPK nutrient uptake of fallow blackgram

Treatments	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Nutrient uptake (kg ha^{-1})		
			N	P	K
T_1 – Absolute control (No manures and fertilizer application)	355	1312	28.1	9.9	29.8
T_2 – 100 % Recommended dose of fertilizer N (RDN)	402	1465	31.5	11.1	33.4
T_3 – 100 % RDN + FYM @ 12.5 t ha^{-1}	497	1755	36.4	12.8	38.5
T_4 – 75 % RDN + 25 % N through VC (100 % Cd)	581	2025	41.4	14.6	43.8
T_5 – 75 % RDN + 25 % N through VC (75 % Cd + 25 % Wh)	602	2057	42.4	15.0	44.9
T_6 – 75 % RDN + 25 % N through EPMC	548	1917	39.2	13.8	41.5
T_7 – 75 % RDN + 25 % N through ECC	515	1806	37.0	13.1	39.2
T_8 – 75 % RDN + 25 % N through *Sesbania aculeata*	508	1782	36.7	12.9	38.8
T_9 – 75 % RDN + 25 % N through *Crotalaria juncea*	501	1770	36.5	12.9	38.6
T_{10} – 75 % RDN + 25 % N through *Gliricidia sepium*	453	1605	33.7	11.9	35.7
T_{11} – 75 % RDN + 25 % N through *Pongamia glabra*	465	1645	34.3	12.1	36.3
S.Ed	13.4	58.3	0.98	0.33	1.02
CD (P = 0.05)	27.2	106.7	1.96	0.67	2.03

*VC – Vermicompost; Cd – Cow dung; Wh – Water hyacinth; EPMC – Enriched poultry manure compost; ECC – Enriched coirpith compost

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