Int.J.Curr.Microbiol.App.Sci (2018) *7*(4): 2801-2806

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 7 Number 04 (2018)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2018.704.318

Yield Components, Yield and Residual Fertility Status of the Soil after Rice as Influenced by Integrated Nitrogen Management

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Keywords

Integrated nitrogen, Yield and fertility levels

Article Info

Accepted:
23 March 2018
Available Online:
10 April 2018

A B S T R A C T

A field experiment was conducted at Agricultural College Farm, Bapatla, during *kharif* 2015-16 to find out the response of transplanted rice under three levels of inorganic nitrogen in combination with organic manures *viz*., poultry manure, FYM and neemcake at 75, 100 and 125 per cent RDN. The highest yield components and yield of rice was recorded with application of 50 per cent N applied as inorganic and remaining 50 per cent through poultry manure @ 125 per cent RDN comparable with 125 per cent and 100 per cent N through only chemical fertilizers. After harvest of the crop the highest soil N availability was obtained with 125 per cent N (50 per cent inorganic + 50 per cent FYM), the highest soil P availability with 125 per cent N (50 per cent inorganic + 50 per cent poultry manure) and the highest soil K availability was recorded with 125 per cent N (50 per cent inorganic + 50 per cent neemcake).

Introduction

Rice is one of the most important food grains produced and consumed all over the world. Global rice demand is expected to rise from 439 million tonnes in 2010 to 496 million tonnes in 2020 and further increase to 553 million tonnes in 2035 (FAO, 2013). This shows an overall increase of 26 per cent in the next 25 years, thus global rice yields must raise much faster. 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 2.98 t ha^{-1}, while the world average is 4.25 t ha^{-1} (IRRI, 2011). To meet the food requirement of the growing population, the rice production has to be enhanced with good management practices. Nitrogen (N) application is essential to realize the yield potential of high yielding varieties of rice.

Adding inorganic fertilizers is a good way of correcting the deficiency of nutritional elements, but they not only add to the cost of production but often are not available to meet the demands of farmers. Although the fertilizers are very effective in increasing yield, they may deteriorate the soil structure and pollute the groundwater. Integrated nitrogen supply concept involving both organic and inorganic sources based on their availability and cost effectiveness is well adopted and judicious combination of these

two sources has been found to mutually reinforce the efficiency of both the sources resulting in higher productivity and soil fertility. In the light of the above context this study was planned to find out the performance of rice under three inorganic nitrogen levels and combination with organic manures like FYM. Poultry manure and neemcake.

Materials and Methods

An experiment was conducted at Agricultural College Farm, Bapatla during *kharif* 2015-16 on clay soils, which was slightly alkaline in reaction, organic carbon and nitrogen were medium, available phosphorous and potassium were high. The experiment consisted of twelve treatments viz., 75 per cent recommended dose of nitrogen i.e. 90 kg ha^{-1} (T_1), 100 per cent recommended dose of nitrogen i.e. 120 kg ha^{-1} (T_2), 125 per cent recommended dose of nitrogen i.e. 150 kg ha^{-1} (T_3), 50 per cent N of T_1 through inorganic fertilizer + 50 per cent N of T_1 through FYM (T_4), 50 per cent N of T_1 through inorganic fertilizer + 50 per cent N of T_1 through poultry manure (T_5), 50 per cent N of T_1 through inorganic fertilizer + 50 per cent N of T_1 through neemcake (T_6), 50 per cent N of T_2 through inorganic fertilizer + 50 per cent N of T_2 through FYM (T_7), 50 per cent N of T_2 through inorganic fertilizer + 50 per cent N of T_2 through poultry manure (T_8), 50 per cent N of T_2 through inorganic fertilizer + 50 per cent N of T_2 through neemcake (T_9), 50 per cent N of T_3 through inorganic fertilizer + 50 per cent N of T_3 through FYM (T_{10}), 50 per cent N of T_3 through inorganic fertilizer + 50 per cent N of T_3 through poultry manure (T_{11}), 50 per cent N of T_3 through inorganic fertilizer + 50 per cent N of T_3 through neemcake (T_{12}).

The experiment was laid out in a Randomized block design and replicated thrice. Well decomposed farmyard manure with 0.5 per cent nitrogen, poultry manure with 1.5 per cent and neem cake with 1.8 per cent nitrogen were used as organic sources and they were applied as per the treatment combinations ten days before transplanting. The inorganic nitrogen was applied through urea as per treatments while recommended dose of phosphorous (60 kg P_2O_5 ha^{-1}) and potassium (40 kg K_2O ha^{-1}) were applied through single superphosphate and muriate of potash, respectively uniformly to all the treatments. Entire quantity of phosphorus and potassium and one third of the N were applied as basal at the time of transplanting. Remaining N was applied in two equal splits, one at active tillering stage and the other at panicle initiation stage. Thirty two days old seedlings were transplanted in experimental plots keeping two seedlings per hill by adopting a spacing of 20 cm x 15 cm. Recommended agronomic practices and plant protection measures were followed.

Results and Discussion

Yield components and yield

Yield components and yield were significantly influenced by different sources of nitrogen and presented in table 1. Among all treatments, significantly highest yield components *viz*., number of panicles m^{-2}, number of grains and filled grains $panicle^{-1}$ were recorded in the treatment T_{11} which was comparable with T_3 and T_2 followed by T_{12}. Similar results were also recorded in the grain yield and 1000 grain weight was not significantly influenced by the different nitrogen management treatments. The better performance of the poultry manure treated plot might be due to higher concentration of macro and micro nutrients and steady nutrient release compared to other organic manures. The enhanced and continuous supply of nutrients by the integrated application might have led to better tillering ability and conversion of total number of tillers to productive tillers increasing the number of panicles m^{-2}.

Table.1 Yield components and yield of rice as influenced by combined use of organics and inorganics in transplanted rice

Treatments	Total no. of panicles m^{-2}	Total number of grains $panicle^{-1}$	Number of filled grains $panicle^{-1}$	Test weight (g 1000 $grains^{-1}$)	Grain yield (kg ha^{-1})
T_1	214.0	136.0	121.6	14.8	3313
T_2	317.4	181.7	155.7	14.8	5530
T_3	321.0	182.1	156.8	15.0	5604
T_4	166.7	110.3	101.2	15.8	2641
T_5	170.0	115.3	104.6	15.6	2752
T_6	183.0	113.5	102.6	15.5	2835
T_7	207.0	132.7	121.5	15.3	3180
T_8	248.9	155.3	137.3	15.3	4126
T_9	247.3	154.8	137.6	14.8	4024
T_{10}	250.3	157.3	139.4	15.1	4196
T_{11}	321.7	183.3	157.8	15.0	5680
T_{12}	284.5	158.3	140.1	15.9	4870
SEm±	10.46	7.29	5.12	0.43	224.9
CD (0.05)	30.7	21.4	15.0	NS	660
CV (%)	7.4	8.5	7.0	5.0	10.0

Table.2 Available N, P_2O_5 and K_2O status (kg ha^{-1}) of soil after harvest of rice as influenced by combined use of organics and inorganics in transplanted rice

Treatments	Available nutrients		
	Nitrogen	Phosphorus	Potassium
T_1	200.7	32.7	350.4
T_2	218.3	31.5	347.2
T_3	249.7	30.3	345.3
T_4	190.0	33.0	352.8
T_5	185.4	42.0	383.5
T_6	182.7	41.1	421.7
T_7	237.3	35.4	405.0
T_8	220.6	53.4	391.6
T_9	221.6	33.5	396.6
T_{10}	312.4	28.9	423.7
T_{11}	248.0	64.5	467.1
T_{12}	280.9	45.8	509.0
SEm±	10.53	2.65	13.73
CD (0.05)	30.9	7.8	40.3
CV (%)	8.0	12.9	7.0

The effect of nitrogen on seed filling is assimilate accumulation which is also a primary function and in turn, facilitates higher N assimilation with adequate supply of photosynthates to grain (Kumar *et al.*, 2008).

The contribution of carbohydrates from photosynthetic activity for longer period might have resulted in efficient translocation of food material into grain there by increasing the number of filled grains $panicle^{-1}$.Such an increase in yield components and yield with poultry manure was also reported by Sangeetha *et al.*, (2010) and Ananda *et al.*, (2006). The lowest yield components and yield were recorded in treatments T_6, T_5 and T_4 might be due to lower dosage that lead to the less availability of nutrients.

Availability of nutrients

Among all the treatments T_{10} treatment recorded the maximum nitrogen availability (312.4 kg ha^{-1}) after harvest of the rice crop which might be due to decomposition of organic matter added through FYM by slow mineralization that lead to increased availability of nitrogen status of the soil.

Due to increase in microbial activity in the presence of organic matter, it released the available form of native, unavailable form of nutrients. Consequently, available nutrients status was enhanced Singh *et al.*, (2006) and Rajanna *et al.*, (2012) also reported similar results (Table 2).

The T_{11} treatment recorded maximum (64.5 kg ha^{-1}) available P after harvest of the rice crop and it was followed by T_8 and proved significantly superior to rest of the treatments. This might be due to poultry manure having highest phosphorous content (2.63 per cent) when compared other sources *viz*., FYM 0.25 per cent and neemcake 1.4 per cent (Reddy and Reddi, 2015). The increased available P content of soil might be due to release of CO_2 and organic acids during decomposition. This

helps in solubilizing the native soil P. The organic matter may also reduce the fixation of phosphate by providing protective cover on sesqueoxides and chelating cations like Ca^{2+} and Mg^{2+} (when applied along with inorganic fertilizer) which in turn enhanced the availability of P (Singh *et al.*, 2008). Lowest P availability was observed in the inorganic treatments *viz*., T_2 and T_3 which might be due to higher grain and straw yield of the crop, which in turn might have resulted in extraction of the most of soil nutrients.

The maximum potassium content in the treatment T_{12} might be due to the lesser yields recorded which would have led to lesser uptake of potassium even though it received 125 per cent RDN through organics and inorganics and when compared to T_{11}. The beneficial effect of neemcake on available potassium might be due to the reduction of potassium fixation, solubilisation and release due to the interaction of organic matter with clay besides the direct potassium addition to the potassium pool of soil.

The available nutrients in soil increased due to treatments incorporating either total or part of nutrients through organic sources as compared to inorganic sources. This may be due to the release of aliphatic and aromatic hydroxy acids, humates and lignins from organic manures which would release the nutrients into the soil (Aruna *et al.*, 2012).

It can be concluded that combined application of 50 per cent as inorganic and other 50 per cent as organic source *i.e*., poultry manure @ 125 per cent RDN (T_{11}) resulted in comparable yield with 125 RDN alone and was thus found to be the best combination for increasing the productivity of rice and also resulted in increased residual fertility levels of the soil compared to different sources *i.e.*, neemcake and FYM and alone application of inorganic fertilizers.

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How to cite this article:

Sowjanya, A. and Sree Rekha, M. 2018. Yield Components, Yield and Residual Fertility Status of the Soil after Rice as Influenced by Integrated Nitrogen Management. *Int.J.Curr.Microbiol.App.Sci.* 7(04): 2801-2806. doi: https://doi.org/10.20546/ijcmas.2018.704.318