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Effect of INF and FYM on nutrients available (kg ha^{-1}) after medium land rice (*Oryza sativa L.*) harvest

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ABSTRACT

A pot culture experiment entitled **"Effect of INF and FYM on nutrients available (kg ha^{-1}) after medium land rice (*Oryza sativa* L.) harvest"** was conducted at Institute of Agricultural Sciences farm, Siksha 'O' Anusandhan University, Bhubaneswar Odisha. On sandy loam soil during kharif 2018-2019.The experiment consisted of eight treatments and the experiment was laid out in a Randomized Block Design with three replications. A comparison of soil fertility status after harvest of rice revealed that combined application of organic and inorganic fertilizer significantly increased the available N, P and available K. This indicates improvement in the fertility status of the soil due to an integrated nutrient management. The combined application of organic and inorganic fertilizers raised the total soil N from initially low (245kg ha^{-1}) concentration to the medium concentration. The combined application of FYM with inorganic fertilizer significantly increased the available soil P after crop harvest. Data revealed that available potassium content of the experiment was highest (225kg ha^{-1}) with application of 100% RDF + 5t FYM ha^{-1}(T_7) and lowest in control (105kg ha^{-1}) (T_1).

Keywords: Soil Fertility, Organic Fertilizer, Inorganic Fertilizer

1. INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most important cereal crops in the world. It is staple food of more than 70% of world population. At global level, rice is grown on an area of about 155.62 million ha^{-1} with production and productivity of 461 million tonnes and 4.09t ha^{-1}, respectively. As the global climate change continues, water shortage and drought have become an increasingly serious constraints limiting rice production worldwide (Guan *et al*., 2010). In India it is the most important staple food, contributing 45% to the total food grain production. Its demand in India is bound to increase with growing population, which is projected to be 1.301 and 1.378 billion by 2020 and 2030 respectively. India ranks first in respect of area (44.50 million ha), second in production with 102.75 million tonnes, only after China, but the productivity of rice is very low with 2.20 tones ha^{-1}. Odisha cultivates rice in 4.18 million ha with an annual production of 7.58 million tones and average yield of 1815 kg ha^{-1}.The state economy is directly linked with improvements in production and productivity of rice in the state (Das, 2012). Productivity of Odisha soil are mainly constrained by iron (Fe) and aluminum (Al) toxicity, phosphorus (P) deficiency, impaired biological activity, low base saturation and other acidity induced soil plant nutritional and fertility problems. Nitrogen (N) is one of the main factors affecting rice yield and low nitrogen recovery by the crop under such problematic soils call for a sustainable approach of managing nitrogen for increasing the yield as well as improving its use efficiency. The best remedy for soil fertility management is, therefore, a combination of both inorganic and organic fertilizers, where the inorganic fertilizer provides nutrients and the organic fertilizer mainly increases soil organic matter and improves soil structure and buffering capacity of the soil (Jobe, 2003). A major portion of nitrogen in rice soils occur in organic pool, though this is usually very low. Conclusive evidences indicate that in production of irrigated rice, improvement in organic carbon content of soil and initial soil nitrogen content and efficiency of applied nutrient are more important. Rice is a heavy nitrogen feeder, however, fertilizer N efficiency in rice is very low under tropical conditions where it rarely exceeds 50 per cent and usually ranges between 15 to 35 per cent (De Dutta, 1984). Dixit and Gupta (2000) have shown that yield of grain and straw of rice plant, their nutrient uptake, grain quality and soil properties can be altered greatly by using proper combination of organics with chemical fertilizers. Since the organic wastes (FYM, crop residues) are the source of primary, secondary and micronutrients to the plant growth and constant source of energy for heterotrophic microorganisms which help in increasing availability of nutrients, quality and quantity of crop produce, it can be hypothesized that the use of proper combination of these locally available organic wastes which are narrow in C: N ratio and safe to apply for agricultural purposes, is as critical as that for integrated use.

2. Materials and Methods

The pot culture experiment was conducted at Research farm, Campus-4, Institute of Agricultural Science, Siksha 'O' Anusandhan, Bhubaneswar, Odisha during 2018-2019. The experimental site lies at 85.7920°E longitude and 20.2588 °N latitude with an elevation of 50.6 meter above mean sea level. The experimental location experiences tropical climate with a maximum temperature ranged from 31.5 to 28.5 ˚C and a minimum temperature ranged from 18.7 to 13.0 ˚C. Besides, the experimental site received an average rainfall of 3.7 mm. The relative humidity varied from 48 to 38 percent. Soil collected and grounded and filled in pots (capacity 12kg) @ 10kg per pot. A well decomposed farmyard manure with 0.5 % nitrogen, 0.2% P and 0.4% K was used as organic source for nitrogen, phosphorus and potassium in the present study. Rice seedlings (Naveen variety) of 30 days old were transplanted keeping two seedlings per hill. Four hills were transplanted in each pot. A thin film of water was maintained at the time of transplanting for better establishment of the seedlings. From the fourth day onwards 2 to 3cm depth of water was maintained up to panicle initiation stage and frequently the water is drained out to create aeration and refolded to maintain 3-4 cm depth of water up to physiological maturity. After dough stage, water was completely drained out to facilitate easy harvesting. Weeds were removed from the plots by manual labour three weeks after transplanting and the plots were kept weed free.

(Fig-1. Experimental Field)

3. Results and Discussion

3.1. Available Primary Nutrients

A comparison of soil fertility status after harvest of rice revealed that combined application of organic and inorganic fertilizer significantly increased the available N, P and available K (Table-1). This indicates improvement in the fertility status of the soil due to an integrated nutrient management (Khan et al., 2010).

3.1.1. Available Nitrogen

The combined application of organic and inorganic fertilizers raised the total soil N from initially low (245 kg ha^{-1}) concentration to the medium concentration (Table-1). It is clear from table that available nitrogen differed significantly. Amongst all the treatments, integrated use of organic (FYM) and inorganic sources increased the available nitrogen content of soil significantly as compared to inorganic fertilizers and control. Use of inorganic fertilizers alone registered numerically more available nitrogen than control. Amongst integrated nutrients, T_7, T_5 and T_3 were found statistically significant with each other. Treatment T_7 (100% RDF + 5t FYM ha^{-1}) recorded highest available nitrogen (302 kg ha^{-1}) followed by T_5 (75% RDF + 5t FYM ha^{-1}) and was significantly higher than all treatments. Use of inorganic was found numerically inferior than the organic treatments. Integrated nutrient management practices registered significantly higher available nitrogen than inorganic practices and control. Better response of addition of organic manure in improving the nitrogen status of the soil can be ascribed to its slow decomposition producing humic and amino acids, which in turn increase the nutrient availability. Ramamurthy (2002) also reported that application of FYM improves the N status of the soil. The results were in consonance with the findings of Kumar and Singh 2010, Shilpashree *et al.* 2012, Zahoor Ahmad Bhat 2013, Kumar *et al.* 2018

3.1.2. Available Phosphorus

The combined application of FYM with inorganic fertilizer significantly increased the available soil P after crop harvest (Table-1). The highest available P (20.50 kg ha^{-1}) was obtained from the application of 5t FYM ha^{-1} in combination with 100% RDF inorganic fertilizers and the minimum was recorded in control (9 kg ha^{-1}). Amongst all the treatments, integrated use of organic and inorganic sources improves the available phosphorus content of soil. It was revealed from the results that lane application four levels of RDF where 100% RDF (20.5 kg ha^{-1}) was significant to 75 % (14.9 kg ha^{-1}) and 50% (11.43 kg ha^{-1}) RDF but remain at par with 150% RDF (18.5 kg ha^{-1}) in increasing available P in soil at harvest but the combination of the first three levels of RDF with 5 t FYM ha^{-1} recoded significantly higher available P between T_7 (100 % RDF + 5t FYM ha^{-1}) (20.50 kg ha^{-1}) and T_5(75%% RDF + 5t FYM ha^{-1}) (16.5 kg ha^{-1}) treatment, T_7 and T_3(50% RDF + 5t FYM ha^{-1}) (14.3 kg ha^{-1}) treatment. The increase in available P might be attributed to organic manure (FYM), which might have helped in releasing higher amount of P from the soil, Manure also helps in producing intermediate compounds that interact with phosphorus-fixing captions such as aluminium, iron, etc. thereby reducing P adsorption capacity. It might be due application of inorganic fertilizers along with organic increase the microbial activities which in turn resulted in more production of carbon dioxide. This carbon dioxide on dissolution in water form carbonic acid which has capacity to dissolve surface primary minerals and releases soluble fractions of phosphorus compounds. Similarly, Iyamuremye and Dick (1996) also suggested that organic manures are known to decrease P adsorption/fixation and enhance P availability in P-fixing soils. In agreement with this result, Tolanur and Badanur (2003) attributed the increased available P content of the soil due to release of organic acids during decomposition, which, in turn, helped in releasing P. Generally, the available P status of the soils in the controls was very low (9 kg ha^{-1}) (Tekalign, 1991), indicating that the low soil P was among the factors highly limiting the productivity of the soils in the study pots. Similar results were also reported by Tana and Woldesenbet 2017, Zahoor Ahmad Bhat 2013, Kumar *et al.* 2018.

3.1.3. Available Potassium

Data revealed that available potassium content (Table 1) of the experiment was highest (225 kg ha^{-1}) with application of 100% RDF + 5t FYM ha^{-1}(T_7) and lowest in control (105 kg ha^{-1}) (T_1). Application of inorganic nutrients at 50, 75, 100 and 150 % RDF alone increase the available potassium content in soil from control. The first three level were significant with each other but 100% RDF was at par with 150% RDF. The combination of the three levels with 5t FYM ha^{-1} increases significantly the available potassium content over their corresponding RDF doses. Treatment T_7 (100 % RDF + 5 t FYM ha^{-1}) recorded significantly higher available potassium over all the treatment. Available potassium build up was observed in all treatments other than control. It might be due addition of organic manure (FYM) which provide the continuous source of carbon for the decomposition of organic manure and Resulted more humus. The more quantity of humus have facilitated the solubilisation of native potassium and protected it from further adsorption (Das *et al*.1991). Kumar *et al.* 2018 also reported that the available K content of soil increased significantly with the application of organic manure and also with chemical fertilizers. The increase in K availability with the application of FYM might be due to the addition of K from the organic sources and also could be due to higher microbial activities in soil which increased the release of non-exchangeable or fixed-K forms into available forms. The beneficial effect of FYM 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. In line with this result, Singh et al. (2015) reported significant increase of the available potassium of soil with the addition of FYM. Among the nutrient management treatments, application of 100% RDF + FYM @ 5t ha^{-1} to rice recorded higher quantity of available soil NPK after crop harvest and improved physicochemical and biological properties of soil which enhanced the efficiency in utilization of native as well as applied nutrients at faster rate, that favoured better plant growth and improved the yield components of rice. This might be due to slow release of nutrients in FYM and also due to the chelating effect of FYM. Rathore *et al.*, (1995) also observed that residual soil fertility increased under FYM application, whereas, NPK alone made no impact on fertility build-up. The result corroborate the findings of Virdia *et al.*, (2010), Prakash *et al.*, (2010), Kumar *et al.*, (2012), Sepehya *et al.*, (2012),Das *et al.*, (2014) Pandey *et al.*, 2007 .

Table-1.Impact of inorganic nitrogenous fertilizers and farmyard manure on available nutrients (kg ha^{-1}) after harvest of rice

Treatment	N	P_2O_5	K_2O
T_1 Control	243	9	105
T_2 - 50% RDF	258	11.43	135
T_3 -50% RDF + FYM @5t/ ha^{-1}	266	14.3	161
T_4 -75% RDF	268	14.9	165
T_5 -75% RDF + FYM @ 5t/ ha^{-1}	292	16.5	202
T_6 -100% RDF	273	17.4	183
T_7-100% RDF + FYM @ 5t/ ha^{-1}	302	20.5	225
T_8 -150% RDF	277	18.5	196
Initial status	245	13.2	156
SEm±	2.21	0.46	4.62
CD (P=0.05)	6.70	1.39	14.03

4. Conclusion

The weather during the crop period did not exhibit any major fluctuations and was congenial for crop growth. Need based irrigation was given to avoid moisture stress. Significant increase in available N, P and K was observed with the application of FYM @ 5t $ha^{-1}$with 100% RDF. Addition of FYM with different levels of RDF increased available N, P and K in the soil also. The soil test results after rice harvest revealed significant increase in soil BD, porosity, OC, available N, available P, available K and grain and straw yield of rice when FYM 5t ha^{-1} was applied in combination with inorganic 100% RDF than the use of 100% RDF alone. Among the treatments, combined application of 5t ha^{-1} FYM with 75% RDF inorganic fertilizer was superior to 50% RDF + FYM 5t ha^{-1} but significantly inferior to 100% RDF + FYM 5t ha^{-1}. Hence, the use of FYM 5t ha^{-1} with 100% RDF was found to be appropriate to improve the physico-chemical properties of the soil and to increase the productivity of rice in the study as compared to the application of 100% RDF alone. Thus use of FYM and inorganic fertilizers should be included in integrated crop management for sustainable agriculture.

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