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Effects Of Long Term Application Of Inorganic And Organic Fertilizers On Soil Fertility Status And Yield Of Rice

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ABSTRACT

Long Term Fertilizer Experiments were conducted since kharif, 2000 at Regional Agricultural Research Station, Jagtial, PJTSAU in rice – rice cropping system. The higher grain (74.28 q ha^{-1}) and straw (67.79 q ha^{-1}) yield of rice was registered due to the continuous application of 150% NPK followed by 100% NPK + FYM treatment (70. 52 q ha^{-1} and 63.85 kg ha^{-1} grain and straw yields respectively) and lowest in control treatment (40.86 kg ha^{-1} and 36.74 kg ha^{-1} grain and straw yields respectively). The use of organic manures with chemical fertilizers significantly increased the availability of N, P, K and S in soil over the sole application of chemical fertilizers. Application of 100 % NPK + FYM (T_8) and FYM (T_{10}) increased the available nitrogen status by 22.4 and 20.1percent as against control. The available phosphorus and available potassium were gradually depleted when compared to initial values in all the treatments but the magnitude of depletion was less in the treatments which received phosphorus and potassium respectively.

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INTRODUCTION

Continuous cultivation of rice after rice every year with fertilizer application resulted in build up of phosphorous in most of the soils of rice growing areas of Andhra Pradesh. Rice yield increase and economic benefit to farmers depends on soil fertility. Soil fertility depends on the status of soil nutrients such as total amount of N, P, K and other nutrients and their capacity to produce these nutrients in the form for easily available to the crop (available nutrients), toxic substances, soil erosion, being washed out and other ways of lost. It is opined that continuous use of chemical fertilizers under intensive cropping decreases crop yields due to deteoration of soil health and extra removal of nutrients by crops takes place with heavy fertilization. Mineral fertilizer input is the dominant factor of the overall nutrient balance, but their use is often imbalanced and their use efficiency remains below optimum levels. Managing the variability in soil nutrient supply resulting from intensive rice – rice cultivation is one of the major challenges to sustaining and increasing rice yields. Continuous cropping with cereal – cereal system needs balanced use of fertilizer for sustaining this system and nutrient dynamics on long term basis. Long term experiments provide valuable information on the impact of continuous fertilizer use on the fertility and productivity of the soil. Hence, the present experiment was undertaken to study the long term effects of continuous application of plant nutrients through chemical fertilizers and organic manure on soil nutrient status and grain yield rice.

MATERIAL AND METHODS

A field experiment was conducted during *karif,* 2016 at Regional Agricultural Research Station, Jagtial (India) on an ongoing long term (16 years) experiment which was initiated in *kharif,* 2000. The soil of the experimental site is a Typic Ustochrept. The soil was clay in texture, with a bulk density of 1.47 Mg m^{-3} and infiltration rate of 0.6 cm hr^{-1}, slightly saline in reaction (pH of 7.1) with a electrical conductivity of 0.47 dSm^{-1}, high in organic carbon content (0.79 %) and low in available N (107.6 kg ha^{-1}), medium in available P_2O_5 (44.2 kg ha^{-1}) and high in available K_2O (440 kg ha^{-1}). The experiment consisted of 12 treatments (Table 1) which were arranged in a randomised block design with four replications. The dimensions of the experimental plot are 12 m x 9 m. The soil samples were collected from each plot after

16 cropping cycles and analysed for available nitrogen by alkaline permanganate method (Subbiah and Asija, 1956) using Kelplus, available phosphorus by ascorbic acid method (Olsen *et al.,* 1954) using spectrophotometer, available potassium with neutral normal ammonium acetate method (Jackson, 1973) using Flame photometer and available sulphur by turbidimetry method (Chesnin and Yein, 1963) using spectrophotometer.

Table 1: Details of treatments and source of nutrient

Treatment No	Treatment	kg N-P_2O_5-K_2O ha^{-1}	
T_1	50%NPK	60-30-20	-
T_2	100%NPK	120-60-40	-
T_3	150%NPK	180-90-60	-
T_4	100% NPK +HW	120-60-40	Only hand weeding
T_5	100% NPK+ $ZnSO_4$	120-60-40	10 kg ha^{-1}(in *kharif*)
T_6	100% NP	120-60-0	-
T_7	100% N alone	120-0-0	-
T_8	100% NPK+FYM	120-60-40	10 t ha^{-1}(in each *kharif*)
T_9	100% NPK-S	120-60-40	P through DAP
T_{10}	FYM	-	10 t of FYM each in *kharif* and *rabi* per ha
T_{11}	Control	-	No fertilizers, No manures
T_{12}	Fallow	-	No crop, No fertilizers

RESULTS AND DISCUSSION

YIELD

The highest grain yield (Table 2) of 74.28 q ha^{-1} was obtained due to the continuous application of 150 % NPK (T_3) for 16 cropping cycles, which was statistically on par with 100 % NPK + FYM (70.52 q ha^{-1}), 100 % NPK + HW (69.34 q ha^{-1}) and 100 % NPK + Zn (69.27 q ha^{-1}). Later it was comparable with 100 % NPK treatment (68.94 q ha^{-1}). Among the treatments the lowest grain yield of 40.86 q ha^{-1} was recorded in control (T_{11}). Application of FYM @ 10 t ha^{-1} significantly increased the yield by 26.6 percent as against control. Continuous application of only 100 % N (T_7) every year resulted in reduced yields compared to 100 % NP (17.8 %) and 100 % NPK (21.2 %) emphasizing the need of balanced fertilization. The data pertaining to straw yield (Table 2) indicates that different treatments significantly influenced the straw yield. The straw yield ranged from 36.74 to 67.79 q ha^{-1}. Among the fertilizer treatments the highest straw yield of 67.79 q ha^{-1} was recorded due to the continuous application of 150 % NPK (T_3). The straw yield in T3 was comparable with 100 % NPK + FYM (63.85 q ha^{-1}), 100 % NPK + Zn (63.31 q ha^{-1}), 100 % NPK + HW (61.03 q ha^{-1}) and 100 % NPK (59.03 q ha^{-1}) treatments. The lowest straw yield of 36.74 q ha^{-1} was registered in control treatment. Application of FYM @ 10 t ha^{-1} (T_8) significantly increased the straw yield by 25.1 percent as against control. Application of 150 % NPK (T_3) increased the straw yield by 45.8, 21.8 and 12.9 percent as against control (T_{11}), 50 % NPK (T_1) and 100 % NPK (T_2) treatments.

Application of 150% NPK and 100% NPK +FYM treated plots recorded higher yields (grain and straw) as compared to all other treatments which could be due to higher nutrient uptake and improvement of soil environment (Krishna *et al.,* 2007 and Humne *et al.,* 2008) and FYM proved to be beneficial in enhancing crop productivity and soil fertility (Khambalkar *et al.,* 2012) due to the indirect effect resulting from reduced loss of organically supplied nutrients. Better supply of nutrients through incorporation of organic manures ascribed to congenial physical environment leading to better root activity and higher nutrient absorption, which results in higher yield (Thakur and Sawarkar 2009). Decomposition of organic manures is accompanied by the release of appreciable amount of plant nutrients which could contribute towards the higher yields (Laxminarayana and Patiram 2006).

Thakur *et al.,* (2011) also reported that in continuous cropping, application of FYM along with optimal dose of 100% NPK was beneficial for enhanced crop productivity and soil fertility. Humne *et al.,* (2008) opined that application of FYM increases nutrient uptake by improving the soil environment. Similar results were also reported by Verma *et al.,* (2012). Similar results were also reported by Santhy *et al.,* (1998), Selvi *et al., (*2005), Verma *et al.,* (2005) and Khambalkar *et al.,* (2012).

SOIL FERTILITY STATUS

The available nitrogen status of the soil (Table 3) increased over the initial value (107.6 kg ha^{-1}) in all the treatments, which was due to continuous cropping that resulted in addition of crop residues. It is well established fact that the crop utilises about 25 to 30 % of applied phosphorous and rest of it remains in the soil. Build up of available Phosphorus was observed in treatments where it was applied. The highest build up of P (43.0 kg ha^{-1}) was observed in 150%NPK followed by application of 100% NPK + FYM (42.9 kg ha^{-1}) while, depletion of P was observed in plots where it was not applied. Depletion was more under application of 100% N alone (16.5 kg ha^{-1}) from initial value (19.6 kg ha^{-1}) over control (17.6 kg ha^{-1}). Similar results have been reported by Kumar *et al.,* (2008) and Kumar *et al.,* (2012).

It is interesting to note that, even though the available phosphorous content in plots applied with 100% N alone treatment is still in medium (16.5 kg ha^{-1}) range, considerable yield increase was recorded with application of phosphorous along with nitrogen (Table 2). This indicated that the yield loss under application of nitrogen alone was mainly due to imbalanced nutrition. These results are in conformity with those of Subehia *et al.,* (2005).

The status of available potassium decreased in all the treatments from the initial value (364 kg ha^{-1}) and there were no considerable yield differences among the treatments with and without K application indicating no response to the applied K. Depletion of available K even in treatments consisting K application under continuous cropping was also reported by Katyal *et al.,* (2000) and Yaduvanshi and Swarup (2006). This decrease in available K was probably due to non-release of non-exchangeable K for utilisation of crop on one hand and higher uptake of K by the crop on the other hand.

CONCLUSIONS

From the foregoing discussion, it is clear that the accumulation of N, P, K and S, was more pronounced in due to long term application of fertilizers and manures. From the yield point it can be concluded that though a higher dose of 150% NPK is a better option, but for sustaining soil quality and crop productivity supplementing the inorganics with organics is the best strategy. This clearly indicated the complete supply of all the essential nutrients in sufficient amounts in balanced ratio during the crop growth period.

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Table 2: Effect of long term fertilizer and manure application on yield in 2016-Kharif

Treatment	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
T_1 - 50% NPK	62.24	52.99
T_2 - 100% NPK	68.94	59.03
T_3 - 150% NPK	74.28	67.79
T_4 - 100% NPK + HW	69.34	61.03
T_5 - 100% NPK + Zn	69.27	63.31
T_6 - 100% NP	66.08	60.52
T_7 - 100% N	54.32	51.97
T_8 - 100% NPK + FYM	70.52	63.85
T_9 - 100% NPK –S	66.35	56.74
T_{10} - FYM	55.66	49.06
T_{11}- Control	40.86	36.74
SE(m)	3.70	4.62
CD (0.05)	7.56	9.43
C.V.	8.25	11.54

Table 3: Effect of long term fertilizer and manure application on available nutrients in kharif-2016

Treatments	N (kg ha^{-1})	P_2O_5 (kg ha^{-1})	K_2O (kg ha^{-1})	S (kg ha^{-1})
T_1 - 50% NPK	186	29.4	315	23.35
T_2 - 100% NPK	204	30.9	322	25.8
T_3 - 150% NPK	211	43	353	28.93
T_4 - 100% NPK + HW	203	30.9	309	27.33
T_5 - 100% NPK + Zn	207	29.5	306	26.2
T_6 - 100% NP	196	25.9	271	25.39
T_7 - 100% N	205	16.5	263	20.33
T_8 - 100% NPK + FYM	219	42.9	325	31.13
T_9 - 100% NPK –S	209	29.9	298	19.22
T_{10} - FYM	214	38.7	314	27.23
T_{11}- Control	171	17.6	281	24.05
T_{12} - Fallow	181	25.4	294	25.53
S. Em.±	13.07	2.05	19.09	2.48
CD (0.05)	26.69	4.19	38.98	5.06
CV(%)	9.14	9.49	8.92	13.85

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