

# Effect of continuous use of inorganic fertilizers and manure on growth and yield attributes of rice in rice-wheat cropping system on a Mollisol

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## ABSTRACT

Field experiment was conducted with rice during 2002 in a long term fertilizer experiment which was being carried out since 1971 to study the crop productivity after intensive cropping under various fertilizer and manural treatments on *Mollisol*. The rotation was rice-wheat and treatments included various combination of N,P ,K ,Zn and FYM .The results obtained indicates that the application of 100% dose of NPK fertilizers + FYM @ 15 t ha<sup>-1</sup> produced maximum grain and straw yield and nutrients uptake by rice. Relatively higher uptake of N, P and K by grain and straw was found in 150% NPK in comparison to 100% N + Zn, 100% NP + Zn and 100% NPK but grain and straw yields were lower than above treatments which shows severe deficiency of zinc due to continuous use of heavy fertilization. Yield attributes show that the application of recommended dose of N, P and K with manure @15 t/ha helped in sustaining the yield of rice over the years.

**Key words :** Long Term Fertilizer Experiment, Rice, FYM

## INTRODUCTION

Rice (*Oryza sativa* L.) and wheat (*Triticum aestivum*) is a major cropping sequence in Indo-Gangetic plain of north India. The productivity of rice is declining over the years and several constraints have also been identified for lower productivity (Nambiar and Abrol 1989).Yadav *et. al* (2000) reported that rice-wheat system is more stable under integrated nutrient management system compared with chemical fertilizers practice. Therefore ,use of chemical fertilizers alone may not keep pace with time in maintenance of soil health for sustaining productivity .Growing concern about the sustainability of rice based cropping system coupled with increasing prices of chemical fertilizers has led to renewed interest in organic manuring. It has been established that continuous use of chemical fertilizers under intensive cropping system decreases crop yields due to degradation in soil health and nutrient removal by crops with heavy fertilization. Nutrients imbalance in soil with chemical fertilization is also a cause of excess removal of other nutrients from the soil (Bharadwaj *et al.*, 1994). As a result of such cropping, Zn is becoming important limiting factor in rice cultivation under continuous use of chemical fertilizers. Therefore, long-term field experiment can be used for precise monitoring of changes in soil fertility and soil productivity, this helps in solving complex problems related to soil fertility management. Therefore, the present study was undertaken to find out the effect of continuous use

of organic and inorganic fertilizers on the performance of rice in rice-wheat cropping system on a *Mollisol*.

## MATERIALS AND METHODS

The present study was carried out during 2002 with rice in an All India Coordinated Research Project on long term fertilizer experiment which was started since 1971 with rice-wheat cropping sequence at Crop Research Centre, G.B. Pant University of Agriculture and Technology, Pantnagar. Soil being silty clay loam had 7.3 pH, 1.48% organic carbon, 392.0 Kg N ha<sup>-1</sup>, 18.0 Kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>, 125.0 Kg K<sub>2</sub>O ha<sup>-1</sup> and 20.0 cmol (P<sup>+</sup>) Kg<sup>-1</sup> at the time of experiment initiation. For the above studies, seven treatments namely; T<sub>1</sub> control (no fertilizer and manure), T<sub>2</sub> 50% NPK, T<sub>3</sub> 100% NPK, T<sub>4</sub> 150% NPK, T<sub>5</sub> 100% NP + Zn, T<sub>6</sub> 100% N + Zn and T<sub>7</sub> 100% NPK + FYM were selected among total 12 treatments of long term fertilizer experiment. In this experiment, one month old seedling of rice (Var. Pant Dhan-4) was transplanted at the spacing of 15 × 20 cm after puddling of the field. The amount of fertilizers was calculated as per treatments on the basis of recommended dose of NPK @ 120:26:37 Kg ha<sup>-1</sup>. Half N and full P and K fertilizers were supplied through urea, single super phosphate and muriate of potash and applied as basal before transplanting of rice. Remaining half of N was applied into two equal splits; at tillering and flowering. Zinc sulphate was applied @ 50 Kg ha<sup>-1</sup> in alternate of approximately four years on soil test basis (soil test value is below critical level of Zn) and FYM is being applied @ 15.0 t ha<sup>-1</sup> to every *Rabi* crops

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once in a year. Yield data were recorded after crop harvest and grain and straw samples were collected from each selected plots. The grain and straw samples were analyzed for their nutrients composition.

## RESULTS AND DISCUSSION

Plant height, number of shoots, number of panicles, panicle length, number of spike lets and 1000-grains weight varied from 96.6 to 111.0 cm, 102 to 152.4, 99 to 140, 26.9 to 29.7 cm, 88 to 118 and 28.0 to 31.0 g, respectively, with various fertilizers and manure treatment (Table 1). Maximum plant height, number of shoots, number of panicles, panicle length, number of spikelets

and 1000-grains weight were recorded under 100% NPK + FYM treatment. Addition of FYM with NPK fertilizers improves physical conditions of soil and maintains organic matter status that increases the crop growth and as reported by Baruah *et al.* (1999) and Yadav *et al.* (2000). However, application of 100% NP + Zn resulted lower yield attributing characters as compared to 150% NPK and higher yield attributes were recorded as compared to 100% NPK and 100% N + Zn treatments except number of spikelets which was higher with 100% NP + Zn as compared to 100% NPK and 100% N + Zn treatments (Table 1). The addition of zinc in combination of N and P improves the plant growth and yield contributing

Table 1 : Effect of inorganic and organic fertilizer application on yield attributes of rice in a long term fertilizer experiment on a Mollisol

Treatments	Plant height (cm)	No. of shoots (m <sup>-2</sup> )	No. of panicles (m <sup>-2</sup> )	Panicle length (cm)	Spikelets (filled panicles <sup>-1</sup> )	Grain weight (1000-grains) (g)
T <sub>1</sub> 50% NPK	102.00	126.00	127.00	28.2/0	99.00	28.40
T <sub>2</sub> 100% NPK	106.00	138.00	132.00	28.40	106.00	29.00
T <sub>3</sub> 150% NPK	110.00	145.50	130.00	28.60	104.00	29.30
T <sub>4</sub> 100% NP	105.00	129.00	128.00	28.30	108.00	29.00
T <sub>5</sub> 100% N	104.00	128.00	126.00	28.00	101.00	28.40
T <sub>6</sub> 100% N + FYM	111.00	152.40	140.00	29.70	118.00	31.00
T <sub>7</sub> Control	96.60	102.00	99.00	26.90	88.00	28.00
SEM	5.94	4.00	5.00	2.46	7.22	2.83
CD (P=0.05)	8.30	12.40	15.40	*	22.20	*
CV	9.80	5.30	6.90	15.00///	12.10	16.80

\*Non-significant

Fig. 1 : Effect of phosphorous application on grain and straw yield of rice

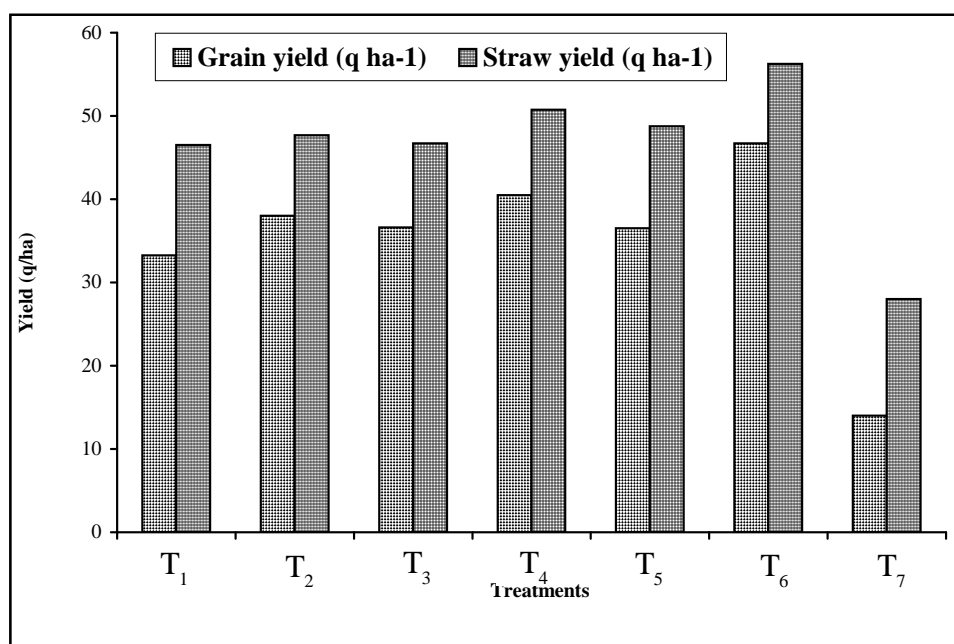
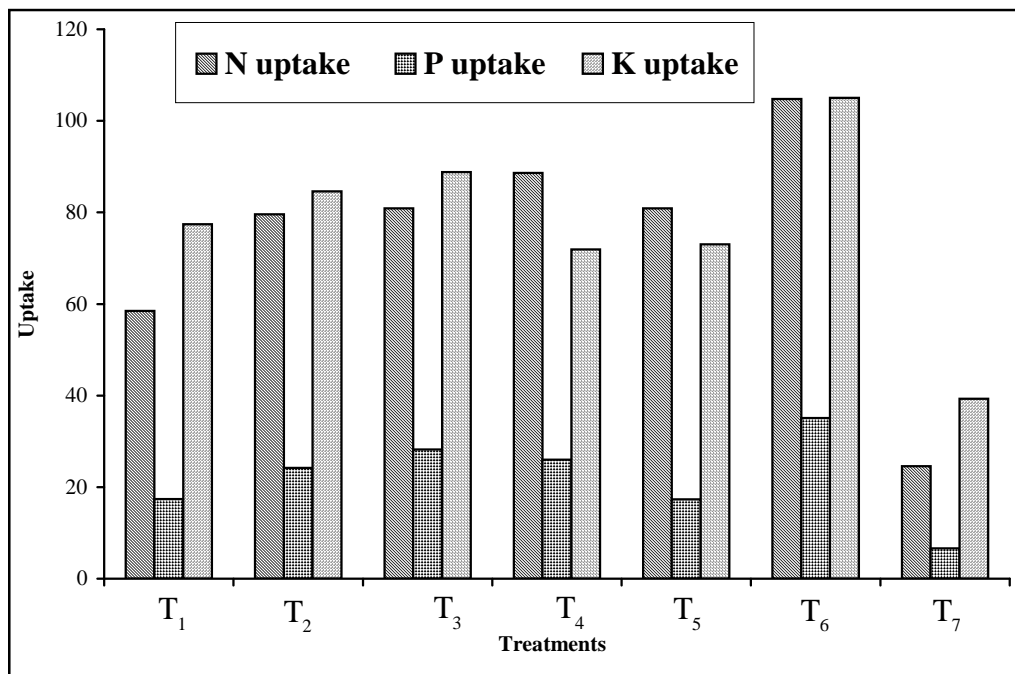


Fig. 2 : Effect of phosphorous application on NPK uptake by rice (grain and straw)



characters. Similar findings are reported by Nand Ram (1995) and Ghosh and Singh (1998).

Significantly higher grain and straw yields were found with all fertilizers and manure treatments as compared to control. Maximum grain (46.7 qha<sup>-1</sup>) and straw (56.2qha<sup>-1</sup>) yields of rice were recorded by 100% NPK + FYM treatment and which was followed by 100% NP + Zn treatment (Fig 1). The addition of FYM with optimal dose of NPK fertilizers improves physical condition of soil and supplies micro and macro nutrients as reported by Kumar and Yadav (1993), Bhardwaj *et al.* (1994) and Ghosh and Singh (1998). Whereas, application of 100 and 150% NPK without zinc produced significantly lower grain and straw yields in comparison to 100% NPK + FYM. This might be due to continuous heavy ft induces severe Zn deficiency in soil that damaged the crop. Similar findings had been reported by Nad and Goswami (1984) and Muthuswami *et al.* (1990). Application of 100% NP + Zn resulted relatively higher grain and straw yields than 50% NPK + Zn, 100% N + Zn, 100% NPK and 150% NPK. The increase in grain and straw might be attributed to the zinc addition with N and P fertilizers on potassium rich *Mollisol*. These finding had been confirmed by Nand Ram (1995) and Yadav (1998).

Combined application of NPK + FYM led to significant increase in N, P and K uptake as compared to all other treatments except 100% NP + Zn and 50% NPK (Fig2). Farm yard manure application has beneficial effect on nutrients availability in soil that increases the uptake of nutrients by rice crop as reported by Saha *et al.* (2000)

and Yadav *et al.* (2000). Addition of P with 100% N + Zn resulted statistically at par N and P uptake but significantly lower K uptake in grain as compared to 150% NPK. Phosphorus application increases N, P and K uptake by increase in efficiency of crops for utilizing the nutrients. Significantly lower N, P and K uptake were observed with 50% NPK + Zn and control as compared to 100% NPK, 150% NPK, 100% NP + Zn and 100% NPK + FYM but significantly higher N, P and K uptake were found with 50% NPK + Zn as compared to control (Fig 2). It may concluded from the above results that organic manure application @ 15.0 t ha<sup>-1</sup> in combination with optimal dose (100%) of NPK fertilizers produced maximum yields and nutrients uptake by rice and 100% phosphorus application with nitrogen and zinc shows superiority over optimal and super optimal dose (100 and 150%) of NPK fertilizers without zinc in rice grown on a *Mollisol*. Highest yields and sustainability in yield could be achieved only by the balanced use of organic and inorganic fertilizers. Application of organic and inorganic fertilizer dose with manure was successful in maintaining high level of rice productivity.

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