

Original Research Article

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Assessment of Nutrient Use Efficiency in Long Term Fertilization on Rice Productivity under Vertisol

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ABSTRACT

This study was conducted in the year 2017-2018 in IGKV farm Raipur, Chhattisgarh to evaluate the long term impact of integrated nutrient management on productivity of Rice. For this study we calculated the different nutrient use efficiency viz. agronomic efficiency, recovery efficiency. The experiment was conducted with ten Treatments in RBD design with four replication. The result showed that the agronomic efficiency, recovery efficiency and factor productivity index were significantly higher with the 50 % NPK + Green manuring treatment over all other treatments. While lowest values of above efficiency were recorded with 100% N fertilizer was applied. Physiologic efficiency was recorded highest in 50% NPK treatment whereas it was at par with 50%NPK+BGA, 100%NPK+Zinc and 100%NPK+FYM treatment.

Keywords

IGKV farm,
integrated nutrient,
RBD

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Introduction

Rice (*Oryza sativa* L.) and wheat (*Triticum aestivum* L.) crops are major staple foods, contributing a key portion of digestible energy and protein in human intake and occupying a premium position among all food communities. The rice-wheat cropping system (RWCS) is one of the most prominent cropping systems prevailing on the India. Rice is the principal food grain crop of the Chhattisgarh state and occupies about

66% of the total cropped area followed by pulses, oilseed and horticulture occupies 17%, 5%, 2% respectively.

Long term Fertilizer experiments are the best tool to assess the influence the continuous application of fertilizers, organic manures used alone or combined on sustainability and soil fertility. To achieve the higher yield of rice, inorganic fertilizers were used with little or no addition of organic manure. Even though the inorganic fertilizers were resulted

in higher crop yield, over reliance on them associated with declined soil properties and degraded soils by specially organic matter, soil biota and in turn decreased yield in subsequent period. This have also caused environmental hazards such as ground and surface water pollution by nitrate leaching that may deteriorate human and animal health (Piment *et al.*, 1996). Majority of small and marginal farmers do not have financial resources to purchase sufficient fertilizers to replace soil nutrients removed through crop harvests. As a result, soil fertility has declined, and yields of staple food crops are typically low (Sanchez *et al.*, 1997). So to reduce the amount of chemical fertilizers applied the field without resulting in its deficiency will be the main challenge in fertilizer management in the field.

One of the possible options to reduce their use could be recycling of locally available organic wastes, viz. crop residue, green manure and farmyard manure (FYM), which can be a valuable and inexpensive source of plant nutrients. Positive effects of organic wastes on soil structure, aggregate stability and water-holding capacity have been well documented (Odlare *et al.*, 2008 and Wells *et al.*, 2000). Use of fertilizer, organic inputs and improved germplasm combined with the knowledge on how to adapt these practices to local conditions, aiming at maximizing agronomic use efficiency of the applied nutrients and improving crop productivity (Vanlauwe *et al.*, 2010). We have use farm yard manure (FYM), green manure (GM), blue green algae (BGA) etc. as nutrient sources for Rice.

To find out the most efficient combination of nutrient sources we calculated nutrient use efficiency (NUE like agronomic efficiency, physiological efficiency, recovery efficiency). This observation helped us to find out the amount of dry matter production per unit of nutrient applied or absorbed.

Materials and Methods

Thus field experiment was conducted Research Farm, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh. Soil was *Vertisol* in experimental site. Treatment we took for study were T₁ - Control, T₂ -50% of the recommended optimum NPK dose, T₃ - 100% of the recommended optimum NPK dose, T₄ - 150% of the recommended optimum NPK dose, T₅ - 100% of the recommended optimum NPK + ZnSO₄ @10 kg ha⁻¹ in *kharif* crop only, T₆ - 100% NP of recommended optimum N and P dose, T₇ - 100% N of recommended optimum N dose, T₈ -100% NPK + FYM (5 t ha⁻¹ in *kharif* crop only), T₉ - 50%NPK + BGA (10 kg ha⁻¹ dry culture in *kharif* crop only), T₁₀ - 50% NPK + GM (sown in site and mixed in soil in *kharif* season only). Different efficiencies were calculated with the help of following formulas:

Agronomic efficiency (AE)

It refers to the additional produce obtained in kg grain kg⁻¹ of nutrient applied.

$$AE = \frac{[\text{Grain yield (kg) with N}] - [\text{Grain yield (kg) with no N}]}{\text{Applied N (Kg)}}$$

Physiological efficiency(PE)

$$PE = \frac{\text{Grain yield in N treated plot (kg) - Grain yield in control plot (kg)}}{\text{Total N uptake in treated plot (kg) - Total N uptake in control plot (kg)}}$$

Recovery efficiency or apparent nitrogen recovery (ANR)

Recovery efficiency of nitrogen explains how much N applied was recovered and taken up by the crop calculated by using the following:

$$\text{RE or ANR} = \frac{U_N - U_0}{N}$$

Where,

U_N =N uptake in N applied plot, kg ha⁻¹,

U_0 =N uptake in control plot, kg ha⁻¹,

N =Rate of N, kg ha⁻¹

Factor productivity index (FPI)

The factor productivity index of N explained the yield produced for each kg of N applied and it included to the indigenous Soil N and fertilizer N was added. It was calculated by using the formula given by Cassman *et al.*, 1996 as follows

$$\text{FPI} = \frac{\text{Grain yield (kg ha}^{-1}\text{)}}{\text{N rate (kg ha}^{-1}\text{)}}$$

Results and Discussion

Agronomic efficiency

The agronomic efficiency (AE), that tells about the additional yield produced for each kg of N applied over the control. The effect of continuous application of organic and inorganic fertilizers on agronomy efficiency was found significant (Figure 1 and Table.1).

The AE of rice ranged from 12 to 58.20 %. Highest agronomy efficiency was recorded in 50% NPK+GM (58.20%). This was followed by 50% NPK (46.40%) and the lowest agronomy efficiency was recorded in control (T₁).The findings have been also corroborated with the results of Witt *et.al* (1999).

Table.1 Effect of long term fertilization and manuring on agronomy efficiency, physiological efficiency, recovery efficiency and factor productivity efficiency in rice (kg ha⁻¹)

Treatments	Agronomic efficiency	Physiological efficiency	Recovery efficiency	Factor productivity index
T1-control	-	-	-	-
T2 -50% NPK	46.40	62.54	0.76	82.00
T3 -100% NPK	30.45	48.26	0.63	48.25
T4 -150% NPK	24.17	41.49	0.59	36.03
T5 -100% +Zn	29.30	56.21	0.52	47.10
T6 -100%NP	29.75	51.56	0.58	47.55
T7 -100% N	12.00	47.00	0.24	29.80
T8 -100% NPK +FYM	36.10	49.21	0.74	39.45
T9 -50% NPK +BGA	43.30	61.49	0.70	78.90
T10 50% NPK + GM	58.20	47.07	1.24	93.80
SEm±	3.99	3.45	0.05	3.72
CD(P= 0.05)	11.95	13.21	0.17	11.17

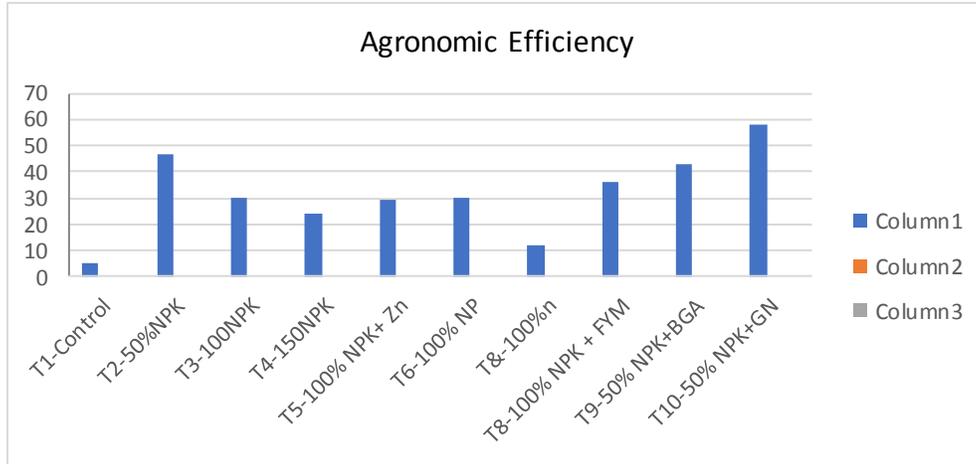


Fig.1 Effect of long term fertilization and manuring on agronomic efficiency

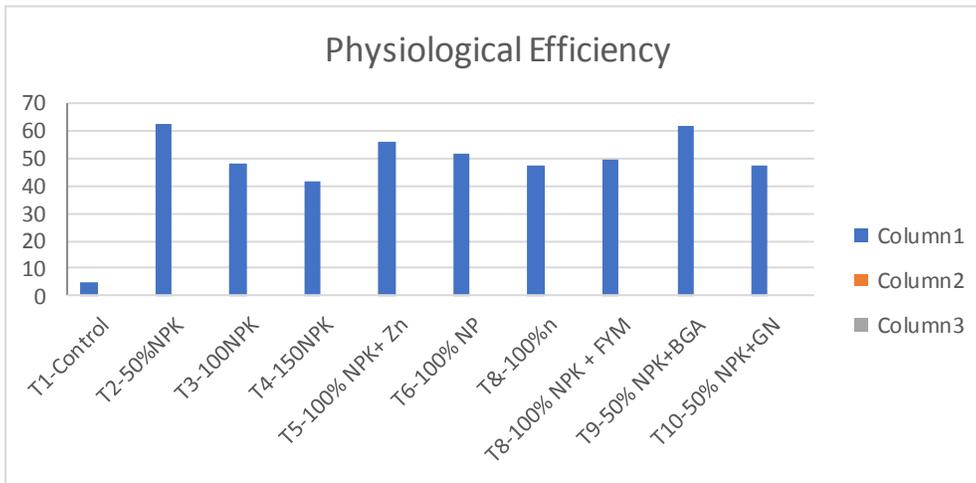


Fig.2 Effect of long term fertilization and manuring on physiological efficiency

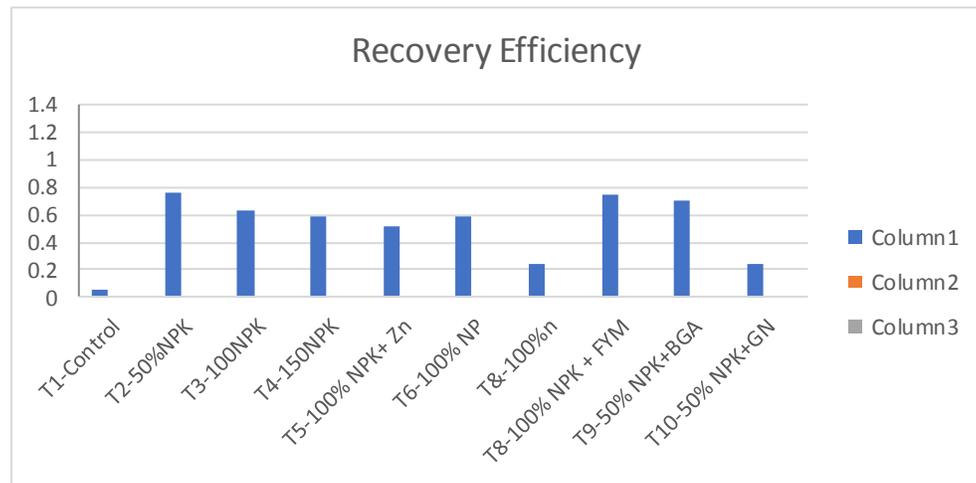


Fig.3 Effect of long term fertilization and manuring on Recovery Efficiency

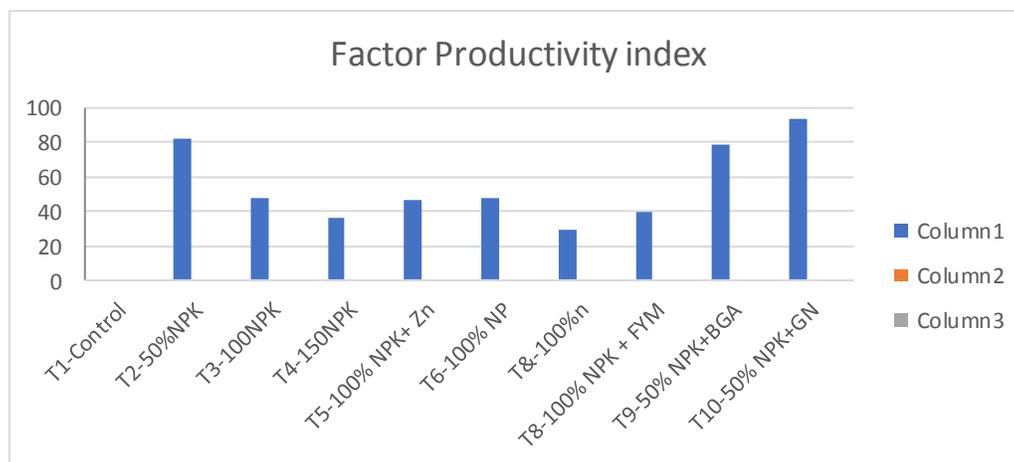


Fig.4 Effect of long term fertilization and manuring on factor productivity index

Physiological efficiency

The effect of continuous application of organic and inorganic fertilizers on physiological efficiency was found significant (Figure 2 and Table.1). Highest physiological efficiency was recorded from T₂ (50% NPK). The physiological efficiency of rice was ranged from 47.00 to 62.54. Lowest of this trait was recorded from T₁. This may be due to lower dose of nutrient responses more as compare to higher dose might be linear response of nutrient in lower level as compared to higher doses which are generally gives curvilinear response. The findings have been also corroborated with the results of Surekha *et al.*, (2008).

Recovery efficiency

The effect of continuous application of organic and inorganic fertilizers on recovery efficiency of N was found significant (Figure 3 and Table.1). The recovery efficiency was significantly higher with 50% NPK + GM treatment over other treatment. The Treatment T₁₀ (50% NPK+ GM) recorded higher recovery efficiency (1.24) followed by 50% NPK (0.76) and lowest in 100% N treatment (0.24). Similar findings also reported by Roul *et al.*, (2006).

Factor productivity index

Significant effect of The effect application of long term organic and inorganic fertilizers on Factor productivity index was noticed (Figure 4 and Table.1). 50% NPK+ GM treatment recorded significantly higher Factor productivity index (93.8) followed by 50% NPK (82.0) and lowest in 100% N treatment (29.8). The Factor productivity index of rice was also influenced significantly due to different treatments and the total uptake ranged from 29.8 to 93.8. Similar result corroborated by Surekha *et al.*, (2008).

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