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Soil Test Based Fertilizer's Recommendation on Yield, Soil Fertility Status and Economics of Rice Crop (*Oryza sativa L.*)

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ABSTARCT

Balance dose of fertilizers not only gives better yield of cereals but also provide better nutrition to the population. The present study was carried out at the Jewari village of Kaimur district during *kharif* season with the objective to find out soil test based fertilizer recommendation and farmers' practice fertilizer on growth, yield and yield attributes characters and soil fertility status. The maximum plant height was recorded with application of fertilizer on the basis of soil test (111.2 cm) followed by IPNI (International Plant Nutrition Institute) based fertilizer recommendation (109.5 cm) which was 7 and 5 per cent more over farmer's practice (FP). Highest net returns (Rs. 65924/-) and B: C ration (2.91) was obtained with the application of fertilizer on the basis of soil test.

Key Words: *Kharif* Rice, Di- Ammonium Phosphate, Muriate of Potash, Urea.

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most important cereals that hold the key towards food security of the world. In Bihar, rice is one of the important cereal crops next to wheat and maize on area basis. Imbalanced and discriminate use of chemical fertilizers has resulted in deterioration of soil health and rice production (Rajput *et al*, 2016). Extractive farming has depleted inherent nutrient reserves and negative nutrient budget has been created. Consequently, both rice yield and response to applied Imbalance fertilizers have declined. Soil testing is an important tool for the recommendation of the fertilizer doses for various crops. Soil test based fertilizer use is a must for sustainable agriculture (Rao and Srivastav, 2000). The fertilizer application by the farmers in the field without knowledge of soil fertility status and nutrient requirement of different crops usually leads to adverse effect on soil and crops by way of nutrient deficiency or toxicity due to inadequate use or over use of fertilizers. In this regard targeted yield approach has been found to be beneficial which recommends balanced fertilization considering available nutrient status in the soil and the crop needs. Rice crop needs seventeen essential nutrients. Most important among them are N, P, K, Fe, Mn, Zn, Cu and B. These nutrients are supplied to rice crop through the soil in the form of fertilizers and manures.

Fertilizer is one of the most important and expensive inputs in agriculture and the application of correct amount of fertilizer is primary prerequisite for farm profitability and environmental safety (Kimetu *et al,* 2004). In India, fertilizers are generally applied to crops on the basis of generalized state level fertilizer recommendations, though the nutrient requirement of crops vary from place to place even for the same crop, as the fertility is highly variable chemical property of the soils. Fertilization of crops based on generalized recommendation leads to under fertilization or imbalanced fertilization, results in lower productivity, profitability along with environmental pollution. Soil test based application of plant nutrient helps to understand higher comeback ratio and benefit: cost ratio as the nutrients are applied in proportion to the amount of the deficiency of a particular nutrient and the correction of the nutrients imbalance in soil helps to harness the synergistic effects of balanced fertilization (Choudhary *et al,*

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2019). It provides a scientific basis for balanced fertilization and balance between applied nutrients and soil available nutrients (Ramamoorthy and Velayutham, 2011). The nutrient management practices based on soil test basis to minimize the use of chemical fertilizers would be most effective in improving crop productivity and maintaining soil health. Therefore, the presently experiment was under taken to study soil test based fertilizer's recommendation on yield, soil fertility status and economics of rice crop (*Oryza sativa L.*).

MATERIALS AND METHODS

A field experiment was conducted during the *kharif* seasons of 2019-20 at Jewari villages of Kaimur district of Bihar. The area falls under humid, subtropical climate. The daily temperature of the experimental site during the year varies widely between minimum 17 ^{0}C and maximum 41 ^{0}C with an average rainfall (between May to November 2019) 166.17 mm. The maximum rainfall (344.50 mm) and raining days (15) was recorded in the month of July 2019. The experiment was laid out in randomized block design with 4 treatment *viz.,* farmer's Practice: imbalance dose of fertilizer (N: P_2O_5:K_2O:: 140:50:00 kg ha^{-1}), T1- RDF (N: P_2O_5:K_2O:: 100:60:40 kg/ha), T2- Fertilizer application on the basis of Soil test (N: P_2O_5:K_2O:: 118:47:51 kg/ha), T3- IPNI recommendation (N: P_2O_5:K_2O:: 150:57:30 kg/ha). Half dose of N and full dose of P_2O_5 and K_2O was applied basal. Remaining N was applied in 2 equal splits at 30 and 60 d after transplanting (DAT). Twenty five days old seedlings of rice were transplanted at a distance of 20 cm from row to row and 15 cm from plant to plant. The initial soil was alluvium with slightly alkaline (pH 7.85), electrical conductivity (0.125 dS m^{-1}), organic carbon (0.42%), available N (269 kg/ha), P (19 kg/ha) and K (197 kg/ha), S (8.25 mg / kg), B (0.32 mg/kg). Soil pH was determined in soil water suspension of 1:2.5:: Soil: Water, after stirring for 30 min using Systronic pH meter as described by Jackson, (1973). organic carbon (Walkley and Black 1934); available N (Subbiah and Asija 1956); NaHCO3 extractable-P (Olsen *et al*, 1954), ammonium acetate extractable K (Hanway and Heidel 1952) and 0.15% $CaCl_2$ extractable S by developing turbidity using $BaSO_4$ (Chesnin and Yien 1951) The soil samples were analyzed for available B by extracting with hot 0.02*M* CaCl2 (Aitken *et al*, 1987) as it does not alter the amount of B extracted and gives a clear and colourless extract. Boron content in the soil extract was determined by spectrophotometer using Azomethine-H (John *et al*, 1975). The data were subjected to standard analysis of variance (ANOVA) and treatment differences were tested following tests of least significant difference (LSD) at statistical significance level of P≤ 0.05 (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Yield and yield attributes

The maximum plant height was recorded with the application of fertilizer on the basis of soil test based (111.2 cm) followed by application of fertilizer on the basis of IPNI based technology (109.5 cm) and RDF (107.2 cm) which was 7, 5 and 3% significantly increased over FP (104.3 cm)

Table 1. Treatment details of the farmer's field experiment.

Treatment symbols	Year of experimentation
	2019-20
	Rice (MTU-7029)
FP	Farmer's Practice: Imbalance dose of fertilizer (N: P_2O_5:K_2O:: 140:50:00 kg ha^{-1})
T1	RDF (N: P_2O_5:K_2O:: 100:60:40 kg ha^{-1})
T2	Fertilizer application on the basis of Soil test (N: P_2O_5:K_2O:: 118:47:51 kg ha^{-1})
T3	IPNI recommendation (N: P_2O_5:K_2O:: 150:57:30 kg ha^{-1})

Table 2. Effect of soil test based fertilizers nutrition on growth and yield and economics of rice crop.

Technology Option	Plant height at harvest (cm)	No. of (tiller/m^2)	No. of (Penicles/ m^2)	Grains/ earhead	Test wt. (1000 grains in gram)	Yield (t/ha)
FP	104.3	373.7	338.3	303.7	14.92	4.65
T_1	107.2	405.8	338.2	305.1	16.22	6.30
T_2	111.2	412.5	413.0	309.5	19.98	7.16
T_3	109.5	409.8	393.0	307.0	16.83	6.80
CD (5%)	4.26	10.30	9.08	5.26	1.51	2.93
SEm ±	1.84	3.82	3.08	1.79	0.61	0.99

Statistically significant differences (P<0.05). For technology option details are Table 1.

(Table 2). Application of fertilizer on the basis of soil test (T2) was recorded maximum no. of tillers (412.5 m^2) and minimum in FP (373.7 m^2) in rice crop. Number of panicles was recorded maximum in T2 (413 m^2) followed by T3 (393 m^2) which was significantly increased by 22 and 16 per cent, respectively over FP (338.3m^2). The grains/ ear head increased significantly, minimum being in the FP and the maximum in T2, which was 2% higher over the FP (303.7 grains/ ear head). Results show that application of fertilizers on the basis of soil test (T2) 1,000-grain weight of rice increased 34 per cent, over FP (Farmer's Practice). Grain yield of rice increased significantly (Table 02), the maximum was in fertilizers application on the basis of soil test (T2) which yielded 5, 14, and 54 per cent higher than IPNI based application of fertilizer (T3), RDF (T1) and FP (Farmer's Practice) respectively (Table 4). Thus optimum yield 7.16 t/ha was found most economic treatment as compared to farmer practices and general recommendation. Similar results were also reported by Singh and Singh (2014) and Sharma and Singh (2014).

Soil fertility Status

Application of fertilizers on the basis of soil test and farmer's practice did not affect significantly soil pH (Table 3). The pH was varied from 7.50 to 7.68. Similar views were expressed by Singh *et al* (2016). However, a significant increase in electrical conductivity over the FP was observed with application of fertilizer application on the basis of soil test and IPNI based fertilizer application and RDF. Similar results were expressed by Thakur *et al* (2011). A significant increase in organic carbon content (Table 4) with the application of fertilizers on the basis of soil test (0.54%), IPNI based treatment (0.49%) and RDF (0.48%) as compared to FP (0.43%) was recorded. This may probably be due to the balanced dose of fertilizers. The organic carbon content of soil increased significantly and attained maximum value in treatment T2 at all farmer's plot. Similar results were expressed by Thakur *et al* (2011) and Singh *et al* (2016). The organic carbon content was low (<0.50%) in all the technology option except T2, FP, T1 and T3 was medium range (0.5 to 0.75%) soil samples (Table 3). High temperature and more tillage practice in the soil increases the rate of oxidation of organic matter resulting reduction of organic carbon content (Kumar *et al*, 2013). The available N content of soil was the highest in T2 (268 kg/ha). The increase in N content with T2 (287 kg/ha) followed by T3 (268 kg/ha) and T1 (246 kg/ha) was 25, 16 and

Table 3. Effect of soil test based fertilizers nutrition on soil fertility status of post harvest rice.

Tech. Option	Initial Status							
	pH	EC ($dS\ m^{-1}$)	OC (%)	N (kg/ha)	P (kg/ha)	K (kg/ha)	S (mg/kg)	B (mg/kg)
FP	7.85	0.125	0.42	269.5	19.45	197.2	8.25	0.32
Post Harvest Rice Soil								
FP	7.68	0.149	0.43	230	18.3	213.2	8.01	0.37
T1	7.65	0.173	0.48	246	21.6	220.8	8.16	0.40
T2	7.69	0.151	0.54	287	24.3	226.7	9.79	0.45
T3	7.50	0.162	0.49	268	21.8	224.2	8.96	0.41
CD (5%)	NS	0.019	0.048	9.87	1.939	NS	0.658	0.049
SEm ±	0.065	0.006	0.016	7.39	0.659	4.45	0.224	0.017

Statistically significant differences ($P<0.05$).

7 per cent, respectively, over the FP (230 kg/ha). The soil-available P increased by 33, 19 and 18 per cent for soil test based fertilizer application, IPNI based technology option and RDF, respectively over the FP. The lowest K content in soil was in the FP and the highest in fertilizers application on the basis of soil test. The K content in soil under soil test based fertilizer application, IPNI based technology option and RDF was 6, 5 and 3 per cent higher than the FP. In post harvest soil available N, P and K status was build up and maximum amount of available NPK were noted under soil test based fertilizer recommendation. Similarly, available P and available K were significantly higher in the application of fertilizer on the basis of soil test. This was mainly due to higher use of phosphoric and potassic fertilizers (Singh and Singh, 2017). The available S content in soil was maximum in fertilizer application on the basis of soil test followed by IPNI based technology and RDF, being 22, 12 and 2 per cent, higher than the FP (Farmer's Practice). Similar trend was recorded in boron content of post harvest soil of rice.

Economics

However, higher yields realized under the soil test based fertilizer recommendation based technology resulted in higher gross returns (Rs. 100324/ha) followed by IPNI based nutrient management (Rs. 94710/ha) then RDF (Rs. 88648/ha) (Table 4). Net returns was also found similar trend. Farmer's practice was found to be minimum net return (Rs. 35385/-ha) in comparison to the other approaches of fertilizer application. Application of fertilizer on the basis of soil test recorded highest (2.91) B: C ratio followed by IPNI based treatment (2.74) and RDF (2.73) and minimum B: C ratio was found in FP (2.19). The average benefit cost ratio of recommended practices on the basis of soil test was 2.91 and that of farmers practice was 2.19, this may be due to higher yields obtained under recommended practices compared to farmers practice. Similar result has been reported by Bhowate and Olambe (2017).

CONCLUSION

It can be concluded that fertilizer application on the basis of soil test increased crop production and sustain soil fertility. A significant increase in grain yield of rice over 100% RDF was recorded with application of fertilizer on the basis of soil test. It was found that fertilizer saved without compromising yield of rice by using balance dose of fertilizer on

Table 4. Effect of soil test based fertilizers nutrition on economics of rice.

Technology option	Cost of cultivation (Rs/ha)	Gross Return (Rs./ha)	Net Return (Rs./ha)	B:C Ratio
FP	29645	65030	35385	2.19
T1	32460	88648	56188	2.73
T2	34400	100324	65924	2.91
T3	34500	94710	60210	2.74
CD (5%)	-	--	-	-
SEm ±	-	-	-	-

Statistically significant differences (P<0.05).

the basis of soil test. However, application of RDF on the basis of soil test increase net return and B:C ratio followed by fertilizer application on IPNI based.

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