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On Farm Assessment of INM Techniques on Soil Health and Yield of Rice in Sahibganj, Jharkhand

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ABSTRACT

On-farm trial was conducted to assess the Integrated Nutrient Management (INM) techniques on yield of rice and soil health after harvest during 2018-19 and 2019-20 at ten locations. The result of three treatments viz. Farmer's Practice, Technology Option 1 and Technology Option 2 indicated that TO1 and TO2 significantly increased the yield and yield attributing characters over farmer's practice (FP). Significantly high yield of rice grain (41.2 q per ha) was recorded with INM techniques. The data on available N, P and K status of soil after harvest of rice crop was significantly higher under TO2 as compared to FP. Highest net-return (Rs. 44,214 per ha) with B:C ratio of 2.44 was reported under TO2. INM techniques also resulted in lowest technology gap (8.78 q per ha) and technology index (17.56%) over other treatments which suggests it's feasibility at farmer's field.

INTRODUCTION

Rice (*Oryza sativa* L.) is a major cereal rich in nutrients, vitamins and minerals. It is an excellent source of complex carbohydrates, contribute key portion of digestible energy and protein in human intake and occupying a premium position among all food commodities It is a staple food for more than half of the world's population. In India, rice occupied an area of 43.37 million ha and contributed 115.60 million tonnes grain with productivity of 2.67 t per ha during 2018-19. Rice is highly energy intensive crop and responsible for serious environmental and sustainable implications due to rapid ground water depletion, soil health degradation, reduced carbon sustainability due to open field rice residue burning and emission of green-house gases (Singh et al., 2020). Long-term experiments conducted in India also indicated that continuous use of chemical fertilizers resulted in decrease in rice productivity as well as deterioration in soil health (Singh et al., 1999). Integrated nutrient management help to achieve efficient use of chemical fertilizers integrated with organic source of nutrients (Mahajan et al., 2008). INM is developed with an understanding of the interactions among crops, soils and climate which advocates the integration of inorganic and organic sources of nutrients. This approach is based on the maintenance of plant nutrition supply to attain the certain level of crop production by enhancing the benefits from all potential sources of plant nutrition in a cohesive manner (Mahajan and Sharma, 2005). The key component of INM is to reach the most effective and homogeneous combination that could lead to good management and be an effective target of the fertilizers, sufficient and balanced use of their quantity and quality (Yadav and Kumar, 2000). INM integrates traditional and recent practices of nutrient management into an environmentally sound and cost-effective ideal farming system that uses remunerations from all probable sources of nutrients viz. organic, inorganic and biological in a carful, effective and combined way. It optimizes the balance between input sources and outputs with the goal of coordinating the nutritional demand of the crop and its discharge in its surroundings (Sharma et al., 2019).

Rice is a main crop of Sahibganj district cultivated in about 45,000 ha during *kharif* season, which is 49 per cent of the net sown area. The average productivity of rice in the district is lower

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than the state and national average. The average NPK consumption in district is also lower than the state and national average. The low yield of rice in the district might be due to unscientific and imbalanced use of plant nutrients. Hence, an on-farm trial (OFT) was designed and conducted during 2018-19 and 2019-20 to assess the INM techniques on grain yield of rice, yield attributing characters and chemical properties of soil after harvest of crop.

METODOLOGY

The trial was conducted at ten locations. There were three treatments viz. (i) Farmer's Practice (FP): Application of nitrogen and phosphorus @ 60-25 kg NP per ha, (ii) Technology Option 1 (TO1): Application of 100 per cent recommended dose of fertilizers (RDF) i.e., 80-60-40 kg NPK per ha and (iii) Technology Option 2 (TO2): Application of 75 per cent RDF + Vermicompost @ 20 q per ha + Blue Green Algae @ 10 kg per ha + Azospirillum @ 2 kg per ha. The experimental design was randomized block design (RBD) considering each location (farmer) as one block (replication). Rice variety Sahbhagi dhan was taken as test crop. Standard agronomic procedures were followed during the trial. Observations on growth parameter were taken from five randomly selected plants. The pH and EC of soils were measured in 1:2.5 (Soil: Water) suspension with the help of glass electrode digital pH meter and conductivity bridge as described by Jackson (1973). Organic carbon was estimated by chromic acid wet digestion method given by Walkley and Black (1934). Available nitrogen was estimated by distilling soil with alkaline potassium permanganate and determining the ammonia liberated as per method suggested by Subbiah and Asija (1956). For available P estimation soil was extracted with Bray P_1 extractant (0.03N NH_4F in 0.025N HCl solution) and was determined (Bray and Kurtz, 1945) as described by Jackson (1973) on double beam spectrophotometer. Available potassium was determined by flame photometer after extraction of soil with neutral normal ammonium acetate (Hanway and Heidal, 1952) in soil to solution ratio 1:5 (w/v).

The economics was assessed through mean total cost of cash inputs in rice cultivation, mean gross returns, mean net returns and the benefit-cost ratio (B:C ratio) based on the data collected at farmer's field during personal interviews of the participating farmers. The minimum support price declared by GOI for the year 2019-20 (Rs. 1815 per q) was considered as selling price of rice. Data recorded during 2018-19 and 2019-20 were pooled and analysed as per the standard statistical method suggested by Steel and Torrie (1960). The extension gap, technology gap and technology index were calculated using following equation as suggested by Yadav, *et al.* (2004). The potential yield of rice variety Sahbhagi dhan is 50 to 55 q per ha. In the present study potential yield was considered as 50 q per ha.

Extension Gap = Yield under Particular Practice – Farmer's Practice Yield

Technology Gap = Potential Yield – Yield under Farmer' s Practice

$$\text{Technology Index} = \frac{\text{Potential Yield - Yield under Particular Practice}}{\text{Potential Yield}} \times 100$$

RESULTS AND DISCUSSION

Yield, yield attributing characters and soil health

Result presented in Table 1 indicates that application of chemical fertilizer as per state recommendation alone (TO1) or integration of chemical fertilizers with organic manures and bio-fertilizer (TO2) significantly increased the grain yield of rice as well as yield attributing characters as compared to Farmer's Practice, except test weight of 1000 grains where no significant influence of the treatments was noticed. The significantly higher number of effective tillers per square meter (245), number of grains per spike (136) and grain yield of rice (41.22 q/ha) was recorded with application of NPK @ 75% RDF along with vermicompost @ 20 q/ha, blue green algae @ 10 kg/ha and Azospirillum @ 2 kg/ha (Technology Option 2). Increase in yield with 100 per cent recommended dose of fertilizer over farmer's practice may be due to the supply of plant nutrients in proper quantity and proportion. Studies suggested that application of recommended dose of inorganic fertilizers is more important than being neglected in order to maintain the economic yield, particularly in low fertile soil (Roy et al., 2001). However beneficial effect of integration of inorganic, organic and biological sources of plant nutrients on grain yield as well as yield attributing characters might be due to the increased nutrient uptake and beneficial impact of organic manures on physical, chemical and biological properties of soil. The results are in accordance with Yadav and Kumar (2000), Kumar et al., (2008) and Saha et al., (2020).

Pooled data analysis presented in Table 2 indicates that soil pH and electrical conductivity were not significantly influenced by the application of inorganic source of plant nutrients or integration of organic and inorganic sources during both the year of trial. However, integration of organic and inorganic sources of plant nutrients significantly increased the organic carbon content of soil after harvest of rice and the extent was 21.7 per cent as compared to FP. Application of vermicompost and blue green algae might have contributed in organic carbon content in the soil after harvest of rice.

It was found that Technology Option 1 and 2 significantly increased the available N, P_2O_5 and K_2O status of soil after harvest of rice (Table 2). Significantly higher available N (341.2 kg/ha) and P_2O_5 (20.24 kg/ha) was recorded under Technology Option 2, however in case of available K_2O the observed difference was non-

Table 1. Grain yield (q/ha) and yield attributing characters of transplanted rice as affected by INM techniques

Treatments	No. of effective tillers per m^2	No. of grains per spike	Test weight of 1000 grains (g)	Grain yield (q ha^{-1})
FP	213.6	114.4	21.46	30.17
TO1	235.6	125.7	21.70	36.39
TO2	244.8	136.0	21.75	41.22
SEm±	2.68	1.65	0.11	0.55
CD at 5%	7.97	4.90	NS	1.65
CV %	3.67	4.16	1.58	4.88

Table 2. Soil chemical status after harvest of rice

Treatments	pH	EC (dSm^{-1})	OC (%)	Av. N ($kg\ ha^{-1}$)	Av P_2O_5 ($kg\ ha^{-1}$)	Av. K_2O ($kg\ ha^{-1}$)
FP	5.89	0.694	0.866	308.61	17.27	226.35
TO1	5.97	0.691	0.886	325.15	18.79	245.03
TO2	6.09	0.688	1.054	341.23	20.24	246.42
SEm±	0.12	0.015	0.018	4.70	0.44	3.31
CD at 5%	NS	NS	0.055	13.96	1.31	9.83
CV %	6.39	6.834	6.205	4.57	7.41	4.37

Table 3. Economics analysis of rice under different treatments

Treatments	Cost of cultivation ($Rs.\ ha^{-1}$)	Gross return ($Rs.\ ha^{-1}$)	Net return ($Rs.\ ha^{-1}$)	B:C ratio
FP	30100	54749	24649	1.82
TO1	31750	66048	34298	2.08
TO2	30600	74814	44214	2.44
SEm±	-	762	762	0.02
CD at 5%	-	2264	2264	0.07
CV %	-	4.75	12.12	4.65

significant among both technological options. Addition of inorganic fertilizers along with organic manures helped in mineralization which resulted and rapid conversion of plant nutrients in available form. Favourable effect of integration of different sources of plant nutrients on available N, P and K content in soil after harvest was also observed by Saha and Jha (2006); Kumar et al., (2018) and Baishya et al., (2015).

Economics and gap analysis

Data presented in Table 3 indicates that TO1 and TO2 significantly increased the gross return, net return and benefit-cost ratio of rice over FP during two years of trial. Technology Option 2 resulted in significantly highest gross return (Rs. 74,814 per ha), net return (Rs. 44,214 per ha) and B:C ratio (2.44). This might be due to reduced use of chemical fertilizers by 25 per cent at same time increased yield by the integration of different sources of plant nutrients.

The extension gap recorded under TO1 and TO2 were 6.22 and 11.05 q per ha, respectively which emphasises the need to educate the farmers through various means for adoption of recommended practices as well as INM techniques in rice cultivation (Table 4). The highest technology gap was recorded under FP (19.83 q per ha) however, lowest technology gap was recorded under TO2 i.e., INM techniques (8.78 q per ha). The highest technology gap recorded under farmer's practice is in accordance with Jha et al. (2020). The lowest technology gap under INM techniques reflects the suitability of INM techniques for rice cultivation over current farmer's practices and recommended dose of fertilizer application. Similar observation under technology index was found and lowest value was recorded under TO2 (17.56%). The observation recorded under technology index showed the feasibility of INM techniques at farmer's field. Lower technology index and technology gap was observed under recommended practices over farmer's practice in mustard was reported by Kalita et al., (2019) and Jha et al., (2021).

Table 4. Gap analysis under INM techniques in rice

Treatments	Extension gap ($q\ ha^{-1}$)	Technology gap ($q\ ha^{-1}$)	Technology index (%)
FP	-	19.83	39.66
TO1	6.22	13.61	27.22
TO2	11.05	8.78	17.56

CONCLUSION

On the basis of present trial conducted during the year 2018-19 and 2019-20 it can be concluded that INM techniques (Application of NPK @ 75% RDF along with Vermicompost @ 20 q/ha, Blue Green Algae @ 10 kg/ha and Azospirillum @ 2 kg/ha) had significant influence on yield and yield attributing characters of rice and recorded highest values of these parameters as compared to farmer's practice and recommended dose of fertilizers. Highest net return along with B:C ratio of 2.44 was also recorded under INM techniques. Comparatively lower technology gap (8.78 q per ha) and lower technology index (17.56%) observed under INM techniques suggests it's feasibility at farmer's field. Hence, INM techniques (Integration of inorganic and organic sources of plant nutrients) may be advantageous in case of rice cultivation in Sahibganj district of Jharkhand.

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