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Influence of integrated nutrient application based on STCR approach on growth and yield of rice in central India

Meenal Thapar, AK Upadhyay and Rishikesh Tiwari

Abstract
Field experiment was conducted during kharif season of 2016-17 at the Research Field of Soil Science and Agricultural Chemistry, JNKVV, Jabalpur to evaluate the influence of soil test based integrated fertilization on growth, productivity and quality of rice. Experiment was laid out in permanent plot with six treatments based on soil test values and targeted yield of rice which were replicated four times in RBD. Experimental soil was medium black having neutral pH, normal EC, low OC and available nitrogen, while medium available phosphorus and potassium. Maximum plant height, Number of tillers plant^{-1}, harvest index of rice at different days was obtained under T6 and minimum in control. The integrated effect of the applied fertilizers significantly increased grain (5725 kg ha^{-1}) and straw (7623 kg ha^{-1}) yields in T6 and deviated by - 4.12% from higher targeted yield. Minimum grain and straw yields of 2817 and 4367 kg ha^{-1} were registered under control. Highest contents of in leaves were obtained under T6 and minimum in control.

Keywords: Rice, soil test based integrated fertilization, targeted yield, growth, yield

Introduction
Rice (*Oryza sativa* L.) cultivation is the most important agricultural operation in the country, not only in terms of food security but also as an assurance to livelihood. It is the stable food crops of more than half of the world's population, which fulfills 43 percent of calories requirement of more than 70 percent of the Indian population in their daily diet. To meet the demands of increasing population and to maintain self-sufficiency, the present production level needs to be increased up to 125 million tones by the year 2020 (Sridevi *et al.*, 2011) [19]. Rice stands second in the world after wheat in area and consumes 90% of world rice. At global level, rice is grown on an area of about 161.1 mha with production and productivity of 481.04 mt and 4.10 t ha$^{-1,}$ respectively. India ranks first in respect of area, it occupies an about 43.95 million ha with production of 106.60 mt, only after China, but the productivity of rice is very low only 2.42 tonnes ha-^{1,} which is low as compared to other agriculturally advanced countries of the world. In Madhya Pradesh, rice is cultivated over an area of 2.02 million ha with total production of 2.78 mt and average productivity of 1.44 t ha^{-1} during (Agricultural Statistics, 2017) [1].

Therefore, the need of the day is to sustain agriculture without harming the delicate balance of soil ecology, soil fertility as well as unlocking the mystery of biota influencing plant growth by integration of fertilizers and organic manure (Nanjappa *et al.*, 2001 and Chaterjee *et al.*, 2005) [18, 21]. In recent past concept of soil test based nutrient management approach has been found most effective to develop recommendations for potential productivity of crops and maintaining soil health (Ramamoorthy *et al.*, 1967) [11]. Use of STCR-INM based fertilizer adjustment equations has been could be very useful for prescribing fertilizer doses to rice grown in rice-wheat sequence to achieve desired productivity and improving soil health (Singh *et al.*, 2014) [13]. In light of above facts, present investigation was carried out with the objective to study the performance of rice under soil test based integrated nutrient management in a Black soil of Madhya Pradesh.

Material and Methods
Field experiment was conducted at the Research Field of Soil Science and Agricultural Chemistry, JNKVV, Jabalpur with rice variety 'Kranti' during *kharif* season of 2016 under STCR approach in on-going research programme of AICRP on STCR. The experiment was laid out in permanent plot with six treatments comprised of T_1: control; T_2: GRD (120:60:40 kg N,

P_2O_5 and K_2O ha^{-1}); T_3: T.Y. 50 q ha^{-1}; T_4: T.Y. 60 q ha^{-1}; T_5: T.Y. 50 q + FYM 5 t ha^{-1} and T_6: T.Y. 60 q + FYM 5 t ha^{-1} based on soil test values and targeted yield of rice with four replications in randomized block design following optimum agronomic management practices. The soil of the experimental site was Vertisol belongs to Kheri series of fine montmorillonitic hyperthermic family of T*ypic Haplusterts* and popularly known as medium deep black soil with pH 7.37, EC 0.321 $dSm^{-1,}$ organic carbon 5.41 g kg^{-1} and available N, P, K were 217.83, 21.45 and 311.57 kg ha-1 respectively. The sowing of rice seed was done at a spacing of 25*10 cm in 5*5 m plot size. The organic manure (FYM), available locally in plenty was utilized as per treatment were applied in well prepared plots one month before sowing. The NPK fertilizers were supplied through urea, single super phosphate and muriate of potash. Full doses of phosphorus, potassium and half dose of nitrogen as per treatment were applied as basal. The remaining half amount of nitrogen was top-dressed in two split doses at 30 DAS and 55 DAS. Crop management practices were performed as per the standard recommendation for this region. The observations on growth attributing character (plant height number of tillers $plant^{-1}$) were recorded at different days (30, 60, 90) after sowing and at harvest.

Results and Discussion

The data revealed that plant height increased gradually with the advancement in crop growth up to 90 DAS, while the rate of increase was maximum between 30 to 60 DAS and it was minimum during 60 to 90 DAS under all the treatments. Significantly increased with maximum plant height (60.23, 77.81 and 77.57 cm) were recorded in treatment T_6 where highest NPK levels integration with FYM (157:125:70 kg N: P_2O_5:K_2O + 5 t FYM ha^{-1}) over rest of the treatments except T_4 and T_5 at 60, 90 DAS and at harvest. However, the minimum values (28.93, 45.11, 52.27 and 51.45 cm) were recorded under without NPK was applied (control) at all the crop growth stages. The progressive increase in plant height might be due to the fact that the demand of NPK levels with FYM have been sufficient for the formation of nucleic acids which are responsible for growth and development. The findings are in accordance with the results reported by Khidrapure *et al.* (2015) [20] and Mahmud *et al.* (2016) [8, 9]. Earlier, Kumar *et al.* (2005) [17] reported that application of 120 kg N + 26.2 kg P_2O_5 + 33.2 kg K_2O ha^{-1} along with 10 t FYM ha^{-1} recorded significantly higher plant height over rest of treatment combinations.

Application of NPK nutrients integrated with and without FYM based on soil test values significantly influenced the number of tillers $plant^{-1}$ at different stages of crop growth of rice (30, 60, 90 DAS and at harvest). Data revealed that tillers production $plant^{-1}$ was increased with increasing levels of NPK but decreased gradually at harvest of crop (Table 2). The results clearly indicated that application of 147:117:64 kg N: P_2O_5: K_2O along with 5 t FYM ha^{-1} (T_6) was produced significantly higher number of tillers $plant^{-1}$ (2.95, 7.91, 8.93 and 8.79) compared to control. However, it was statistically at par with T_3, T_4 and T_5 at 30, 60 and 90 DAS and T_4 and T_5 at harvest, respectively. The minimum number of tillers $plant^{-1}$ was associated with control (T_1) at all the stages of crop growth. The progressive increase in number of tillers with NPK and FYM might be due to the fact that soil conditions with more availability and uptake of nutrients, water and growth promoting substances to promote more tillers. The findings are in accordance with the results reported by Naing Oo *et al*. (2010) [10] and Mahmud *et al*. (2016) [8, 9]. Similarly, Azad and Lehria (2001) [3] have also reported that application of FYM @ 10 t ha^{-1} in conjunction with different fertilizer levels exhibited a significant increase in effective tillers of rice compared to fertilizer alone.

An examination of the data revealed that each increment of NPK levels caused significant variation in grain and straw yields of rice. Maximum grain (5371 kg ha^{-1}) and straw (7235 kg ha^{-1}) yields of rice were obtained under higher level of NPK nutrients along with FYM (T_6) over rest of the treatments excluding T_1, T_2 and T_3 whereas, minimum grain (2781 kg ha^{-1}) and straw (4295 kg ha^{-1}) yields were registered under control (Figure 1). Higher targeted yield of 60 q + 5 t FYM ha^{-1} (T_6) could not be achieved and deviated by ± 4.12 % negatively, whereas the targeted yield of 50 q + 5 t FYM ha^{-1} (T_5) was obtained comfortably. Similar findings were reported by Kumar *et al*. (2014) [7], Mahmud *et al*. (2016) [8, 9] and Senthilvalavan Further, Chesti *et al.* (2015) also found significantly higher grain yield of 5.36 t ha^{-1} with the application of 100% NPK + 10 t FYM ha^{-1} as compared to the grain yield of 4.96 t ha^{-1} with the 100% NPK alone. The improvement in yield under higher level of nutrients might be due to higher absorption of nutrients responsible for increased photosynthetic accumulation and high biomass production which resulted in greater yield. It could be attributed to the increased vegetative growth possibly as a result of effective utilization of nutrients absorbed through extensive root system and prolific shoot development as a result of improved nourishment through N fertilization. Better crop due to synergistic effect all these factors helped in increasing photosynthetic rate and more photosynthates mobilization, which in term perhaps increased the movement of photosynthates from source to sink. Thus, finally resulted in increasing the yield and yield component.

Conclusion

The findings of the present investigation concluded that soil test based application of inorganic fertilizers alone or in integration with manure found significantly superior over general recommended doses of fertilizers in rice crop. But integrated use of inorganic and organic sources of nutrients was found best for different targeted yield of rice.

Table 1: Influence of soil test based integrated nutrient management on plant height in rice

Treatments	Plant height (cm)			
	30 DAS	60 DAS	90 DAS	At harvest
T_1: Control	28.93	45.11	52.27	51.45
T_2: GRD (120:60:40 kg N:P_2O_5:$K_2O$$ha^{-1}$)	29.31	52.35	66.45	65.89
T_3: T.Y. 50 q ha^{-1} (115:90:49 kg N:P_2O_5:K_2O ha^{-1})	29.85	54.47	69.33	68.83
T_4: T.Y. 60 q ha^{-1} (157:125:70 kg N:P_2O_5:K_2O ha^{-1})	30.67	58.33	74.41	73.99
T_5: T.Y. 50 q + 5 t FYM ha^{-1} (115:90:49 kg N:P_2O_5:K_2O ha^{-1})	30.39	56.76	72.67	72.23
T_6: T.Y. 60 q + 5 t FYM ha^{-1} (157:125:70 kg N:P_2O_5:K_2O ha^{-1})	31.17	60.23	77.81	77.57
SE m ±	1.07	1.75	2.11	1.99
CD *(p=0.05)*	NS	5.37	6.53	6.13

Table 2: Influence of soil test based integrated nutrient management on number of tillers in rice

Treatments	Number of tillers plant^{-1}			
	30 DAS	60 DAS	90 DAS	At harvest
T_1: Control	1.93	4.21	4.69	4.25
T_2: GRD (120:60:40 kg $N:P_2O_5:K_2O$ ha^{-1})	2.47	6.97	7.67	7.33
T_3: T.Y. 50 q ha^{-1} (105:82:43 kg $N:P_2O_5:K_2O$ ha^{-1})	2.63	7.35	8.15	7.87
T_4: T.Y. 60 q ha^{-1} (147:117:64 kg $N:P_2O_5:K_2O$ ha^{-1})	2.85	7.78	8.73	8.51
T_5: T.Y. 50 q + 5 t FYM ha^{-1} (105:82:43 kg $N:P_2O_5:K_2O$ ha^{-1})	2.77	7.55	8.41	8.16
T_6: T.Y. 60 q + 5 t FYM ha^{-1} (147:117:64 kg $N:P_2O_5:K_2O$ ha^{-1})	2.95	7.91	8.93	8.79
SE m ±	0.11	0.24	0.28	0.25
CD *(p=0.05)*	0.33	0.73	0.85	0.77

Table 3: Influence of STCR based nutrients application on yield and harvest index of rice

Treatments	Yield (kg ha^{-1})		Harvest Index (%)
	Grain	Straw	
T_1: Control	2781	4295	39.30
T_2: GRD (120:60:40 kg $N:P_2O_5:K_2O$ha^{-1})	4237	5859	41.97
T_3: T.Y. 50 q ha^{-1} (105:82:43 kg $N:P_2O_5:K_2O$ ha^{-1})	4819	6587	42.25
T_4: T.Y. 60 q ha^{-1} (147:117:64 kg $N:P_2O_5:K_2O$ ha^{-1})	5371	7235	42.61
T_5: T.Y. 50 q + 5 t FYM ha^{-1} (105:82:43 kg $N:P_2O_5:K_2O$ ha^{-1})	5213	7051	42.51
T_6: T.Y. 60 q + 5 t FYM ha^{-1} (147:117:64 kg $N:P_2O_5:K_2O$ ha^{-1})	5725	7623	42.89
SE m ±	219	313	1.77
CD *(p=0.05)*	675	963	NS

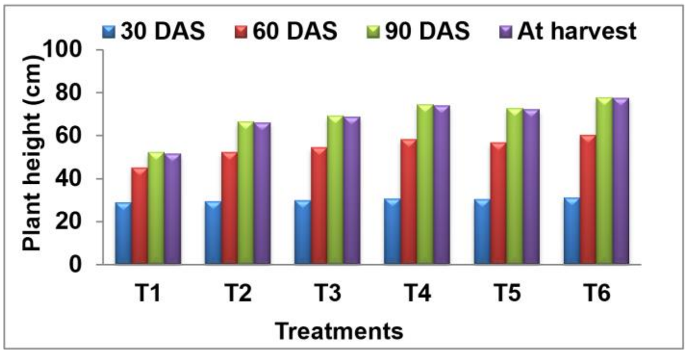

Fig 1: Influence of soil test based integrated nutrient management on plant height in rice

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