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Influence of soil test based integrated fertilization on growth, productivity and quality parameters of rice in Central India

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Abstract
Field experiment was conducted during *kharif* season of 2015-16 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, leaf area index and crop growth rate of rice at different days were obtained under T_6 and minimum in control. The integrated effect of the applied fertilizers significantly increased grain (5753 kg ha^{-1}) and straw (7573 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 total chlorophyll (2.47, 3.72, 2.90 and 2.55 mg g^{-1}) and total carotenoid (1.75, 1.99, 1.76 and 1.67 mg 100^{-1} g) in leaves were obtained under T_6 and minimum in control.

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

Introduction
Rice (*Oryza sativa* L.) is one of the most staple foods for more than 60% of word population and it contributes 45% to the total food grain production in India (Ram *et al*., 2013) [16]. In India, it occupies nearly 43.3 Mha area with production of 104.32 Mt and productivity of 2404 kg ha^{-1}. In Madhya Pradesh, it is grown in an area of 2.02 Mha with production of 3.58 Mt and productivity of 1768 kg ha^{-1} (Agriculture Statistics at a glance, 2016) [1].

Nitrogen, phosphorus and potassium are major essential plant nutrient and key input for increasing crop yield (Dastan *et al*., 2012) [5]. Mineral nutrition does play an important role in influencing the quality of crops and it is fact that the soil health deteriorates due to continuous use of chemical fertilizers (Savci, 2012) [20]. Imbalanced and continuous fertilization of N, P and K nutrients for intensive agriculture to meet the increasing food demand of world's huge population, subvert the soil ecology, disrupt environment, degrade soil fertility and consequently show harmful effects on human health along with contaminating ground water (Joshi *et al*., 2006) [7]. Continuous use of chemical fertilizer in the absence of adequate organic manures poses problems of toxicity, deterioration of physical properties of soil, poor aeration resulting in decreased productivity. The need of the day is sustaining agriculture without harming the delicate balance of soil ecology, soil fertility as well as unlocking the mystery of biota influencing plant growth by using chemical fertilization along with organic manure. The integrated nutrient management (INM) paves the way to overcome these problems, which involves conjunctive use of chemical fertilizers and organic manures to sustain crop production and soil health (Nanjappa *et al*., 2001) [14]. Therefore, integrated applications of alter sources of nutrients for sustaining the soil fertility and desired crop productivity is prime need of today's. Integrated nutrient management includes use of chemical fertilizers along with bulky manures which could help in mitigating these problems (Chaterjee *et al*., 2005) [3]. Farmyard manure is being used as a major source of organic manure and as good sources for use in integrated nutrient management practices in rice crop.

One of the reasons for lower production of rice is imbalanced fertilization of N, P and K nutrients.

Targeted yield approach (Ramamoorthy *et al.*, 1967) [17] has been found more effective to recommend the balanced fertilization considering the available nutrient status in soil and the crop need. The targeted yield approach is unique in providing fertilizer required for desired targeted yield as per the farmers' resource availability because this practices leads to balanced use of fertilizer for better crop yield with sustainable soil health, which is possible only through Soil Test Crop Response (STCR) approach.

Non-availability of fertilizers in time and their higher cost are the reasons for creating imbalance of nutrients in soil. Use of STCR-INM based fertilizer adjustment equations has been proved very useful for prescribing fertilizer doses to rice grown in rice-wheat sequence for achieve higher productivity and improving soil health (Singh *et al*., 2014) [24]. STCR-INM has been found to be quite promising not only in maintaining high productivity but also in providing greater stability in crop production (Patidar and Mali, 2004) [15]. Considering the above facts, the present study was undertaken with the objective to study the influence of soil test based integrated fertilization on growth, productivity and quality parameters of rice in Central India.

Materials and methods

Investigation on influence of soil test based integrated fertilization on growth, productivity and quality parameters of rice was carried out at the Research Field of Soil Science and Agricultural Chemistry, JNKVV, Jabalpur during k*harif* season of 2015-16 under the 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} (105:82:43 kg N, P_2O_5 and K_2O ha^{-1}); T_4: T.Y. 60 q ha^{-1} (147:117:64 kg N, P_2O_5 and K_2O ha^{-1}); T_5: T.Y. 50 q + FYM 5 t ha^{-1} (105:82:43 kg N, P_2O_5 and K_2O ha^{-1}) and T_6: T.Y. 60 q + FYM 5 t ha^{-1} (147:117:64 kg N, P_2O_5 and K_2O ha^{-1}) based soil test values and targeted yield of rice with four replications in randomized block design under optimum agronomic management practices.

The soil of the experimental field was medium black belonging to fine Montmorillonitic, hypothermic family of *Typic Haplustert* with pH 7.67, EC 0.29 dSm^{-1}, organic carbon 5.51 g kg^{-1} and available N, P and K were 239.5, 19.6 and 345.2 kg ha^{-1}, respectively. The sowing of seed of rice (cv. Kranti) was done at a spacing of 25 × 10 cm in 5 m x 5 m plot size. The calculated amount of Farm yard manure (FYM) as per the treatment was applied to soil and mixed thoroughly in well-prepared plots prior to sowing. As per the treatments specification all the doses of phosphorus (P_2O_5) as single super phosphate and potassium (K_2O) as muriate of potash and half dose of nitrogen as urea were applied at the time of sowing as basal dose and remaining half amount of nitrogen was top dressed in two equal split at 25 and 55 days after sowing (DAS).

The observations for growth attributing characters *viz*. plant height was recorded at different stages of crop (30, 60, 90 DAS and at harvest), leaf area index (LAI) and crop growth rate (CGR) were recorded at 30, 60 and 90 DAS respectively.

The LAI was determined plot wise at different stages of crop by using following formula as suggested by Watson (1952).

$$LAI = \frac{\text{Total leaf area } (m^2)}{\text{Land area } (m^2)}$$

The daily increment in biomass termed as crop growth rate (CGR) and was determined at different growth stages by using the formula as suggested by Watson (1952) and it is expressed in g m^{-2} day^{-1}.

$$CGR = \frac{W_2 - W_1}{p(t_2 - t_1)}$$

p = ground area (m^2)
W_1 = dry weight per unit area at t_1
W_2 = dry weight per unit area at t_2
t_1 = first sampling and
t_2 = second sampling

Quality parameters namely, total chlorophyll (mg g^{-1}) and total carotenoid (mg 100 g^{-1}) contents in rice leaves were determined at 30, 45, 60 and 75 DAS, respectively. Total chlorophyll content in fresh leaves was estimated by method described by Sadasivam and Manickam (1992) [18] and the total carotenoid contents in leave by method given by Thimmaiah (1999) [25]. Grain and straw yield were recorded after harvesting of net plot. Observations recorded in respect of all the parameters were analyzed by standard statistical packages (Gomez and Gomez, 1984) [6].

Results and discussion

It was found that plant height was significantly affected by integrated fertilization of NPK levels with and without FYM at different stages of crop growth except 30 DAS. Data (Table 1) clearly revealed that plant height increased gradually with the advancement in crop growth up to 90 DAS and highest rate of increase was between 30 to 60 DAS, while lowest during 60 to 90 DAS under all the treatments. Maximum plant height (55.87, 77.25 and 76.83 cm) was obtained due to treatment T_6 and minimum under control at 60 and 90 DAS and at harvest of the crop, respectively. The progressive increase in plant height might be due to the fact that the demand of NPK levels with FYM have been sufficient for formation of chlorophyll and nucleic acids which are responsible for growth and development. The findings are in accordance with the results reported by Samsul *et al.* (2012) [19], Khidrapure *et al.* (2015) [8] and Mahmud *et al.* (2016) [12].

Leaf area index (Table 2) was significantly improvement by NPK levels with and without FYM and increased successively with crop growth up to 60 DAS and thereafter it declined till 90 DAS due to leaf senescence. It was also found that significantly higher leaf area index (1.83, 4.39 and 3.75) was obtained under higher levels of nutrients applied (T_6) over rest of the treatments except T_3, T_4 and T_5 at 30 DAS, T_4 and T_5 at 60 DAS and T_4 at 90 DAS, respectively. However, the minimum leaf area index (1.53, 2.97 and 2.11) was obtained under control. It was in good agreements with those reported by Naing Oo *et al.* (2010) [13], Khidrapure *et al.* (2015) [8] and Vidya and Channappagouda (2015) [26]. Similarly, Barik *et al.* (2011) [2] have also reported that the incorporation of nutrients at lower and higher doses (20 kg N + 40 kg P_2O_5 + 20 kg K_2O ha^{-1} or 40 kg N + 60 kg P_2O_5 + 40 kg K_2O ha^{-1}) significantly improved the LAI at 30, 60 and 90 DAS. Kumar *et al.* (2005) [9] also found 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} significantly increased leaf area index.

Data presented in Table 2 clearly indicated that different treatments significantly altered the crop growth rate (CGR) at all the stages of crop growth. Increasing levels of NPK with and without FYM improved the crop growth rate gradually up to 30 DAS but it was rapid during 30 to 60 DAS and thereafter declined. At all the stages of crop growth significantly higher CGR (2.13, 14.29 and 12.85 g m^{-2} day^{-1}) was obtained under T_6 treatment as compared to control. It was might be due to optimal supply of nutrients through inorganic and organic sources which accelerated the crop growth rate.

As depicted in Figure 1, highest grain (5753 kg ha^{-1}) and straw (7573 $kgha^{-1}$) yields of rice were obtained under higher level of NPK along with FYM (T_6) treatment and minimum in control. The improvement in yield under higher level nutrients might be due to higher absorption of nutrients responsible for increased photosynthetic accumulation and high biomass production which resulted in greater yield. Similar findings were also reported by Kumar *et al.* (2014) [10], Mahmud *et al.* (2016) [12] and Senthilvalavan and Ravichandran (2016) [21]. Chesti *et al.* (2015) [4] 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.

Total chlorophyll content in rice leaves at various stages enhanced significantly with increasing levels of NPK with and without FYM (Table 3). In general, the content of total chlorophyll in leaves was higher at 45 DAS and thereafter declined at 60 and 75 DAS. It was also found that maximum contents of total chlorophyll (2.47, 3.72, 2.90 and 2.55 mg g^{-1}) in leaves was obtained under T_6 treatment which was significantly superior over rest of the treatments at different growth stages except T_5 at 30 DAS, which was statistically at par. However, the minimum chlorophyll content was recorded under control. The findings are in close conformity with those of Siavoshi and Shankar (2013) [22] and Khidrapure *et al.* (2015) [8]. Lakshmisha *et al.* (2012) [11] also observed that chlorophyll content in leaf is positively influenced by integration of inorganic fertilizers and organic manures.

Carotenoids are the important and accessory photosynthetic pigments and a non-enzymatic antioxidant in plants. Total carotenoid content in rice leaves differed significantly due to various treatments at different stages (Table 3). Carotenoids content in leaf increased between 30 DAS to 45 DAS and thereafter declined gradually up to 75 DAS. Maximum content of total carotenoid (1.75, 1.99, 1.76 and 1.67 mg 100^{-1} g) in leaves were recorded under T_6 and minimum in control. Similar findings have been reported by Lakshmisha *et al.* (2012) [11]. Increased carotenoieds might be due to production and synthesis of hormones and vitamins especially vitamin B_{12} with enhanced enzymatic activity in organic amended influencing the photosynthesis, formation of ATP, amino acids, carbohydrates, protein, nucleic acid synthesis and selective effect on enzyme activities.

Conclusion

Sustaining rice productivity and soil fertility is of prime importance in today's agricultural which may not be achieved without balanced application of inorganic organic sources of plant nutrients. Increasing cost of fertilizers input, diminishing nutrients use efficiency and marginalizing net returns are some more concerns that need to be address on priority. For harnessing potential yield of rice and improving soil health, recommendation of fertilizers and manures based on soil test values of nutrients will prove to be the best practice.

Table 1: Effect of soil test based integrated fertilization on plant height at different stages of rice.

Treatments	Plant height (cm)			
	30 DAS	**60 DAS**	**90 DAS**	**At harvest**
T_1: Control	28.71	43.65	53.13	51.67
T_2: GRD	29.87	49.15	65.87	64.91
T_3: T.Y. 50 q ha^{-1}	30.25	51.17	68.51	67.75
T_4: T.Y. 60 q ha^{-1}	31.13	54.71	73.45	72.87
T_5: T.Y. 50 q + FYM 5 t ha^{-1}	30.78	53.66	71.83	71.15
T_6: T.Y. 60 q + FYM 5 t ha^{-1}	31.45	55.87	77.25	76.83
S Em ±	0.93	1.45	1.91	1.87
CD *(p=0.05)*	NS	4.47	5.88	5.76

Table 2: Effect of soil test based integrated fertilization on leaf area index and crop growth rate at different growth stages of rice.

Treatments	Leaf area index			Crop growth rate (g m^{-2} day^{-1})		
	30 DAS	**60 DAS**	**90 DAS**	**30 DAS**	**60 DAS**	**90 DAS**
T_1: Control	1.53	1.55	10.61	8.13	2.97	2.11
T_2: GRD	1.67	1.77	12.95	10.87	3.79	2.97
T_3: T.Y. 50 q ha^{-1}	1.69	1.83	13.27	11.35	3.91	3.13
T_4: T.Y. 60 q ha^{-1}	1.77	1.95	13.83	12.17	4.20	3.49
T_5: T.Y. 50 q + FYM 5 t ha^{-1}	1.75	1.91	13.65	11.79	4.13	3.37
T_6: T.Y. 60 q + FYM 5 t ha^{-1}	1.83	2.13	14.29	12.85	4.39	3.75
S Em ±	0.05	0.07	0.45	0.42	0.11	0.09
CD *(p=0.05)*	0.15	0.22	1.39	1.30	0.34	0.28

Table 3: Effect of soil test based integrated fertilization on total chlorophyll and carotenoid content in rice leaves.

Treatments	Total chlorophyll content (mg g^{-1})				Total carotenoid content (mg 100^{-1} g)			
	30 DAS	**45 DAS**	**60 DAS**	**75 DAS**	**30 DAS**	**45 DAS**	**60 DAS**	**75 DAS**
T_1: Control	1.78	1.41	1.48	0.83	0.55	2.33	1.23	0.75
T_2: GRD	1.99	1.53	1.67	1.16	0.99	2.82	1.81	1.36
T_3: T.Y. 50 q ha^{-1}	2.10	1.60	1.75	1.37	1.25	2.96	2.01	1.59
T_4: T.Y. 60 q ha^{-1}	2.19	1.65	1.83	1.51	1.41	3.17	2.27	1.90
T_5: T.Y. 50 q + FYM 5 t ha^{-1}	2.31	1.69	1.91	1.68	1.56	3.35	2.48	2.11
T_6: T.Y. 60 q + FYM 5 t ha^{-1}	2.47	1.75	1.99	1.76	1.67	3.72	2.90	2.55
S Em ±	0.073	0.045	0.047	0.039	0.036	0.079	0.067	0.055
CD *(p=0.05)*	0.225	0.139	0.145	0.120	0.111	0.243	0.206	0.169

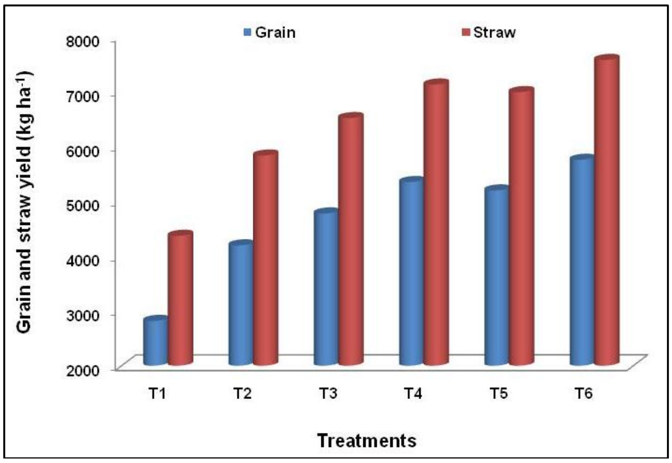

Fig 1: Grain and straw yields of rice as influenced by soil test based integrated fertilization.

References

1. Agricultural statistics at a glance. Department of Agriculture and Cooperation, Ministry of Agriculture, Govt. of India. 2016.
2. Barik K, Raj A, Saha RK Fulamli. Yield performance, economics and soil fertility through organic farming sources (vermicompost) of nitrogen as substitute to chemical fertilizers in wet season rice. Crop Research. 2011; 36(1-3):4-7.
3. Chaterjeet BP, Ghanti U Thapa, Tripathy P. Effect of organic nutrition in sprout broccoli (*Brassica oleracea* var. *italica* Plenck). Vegetable Science. 2005; 33(1):51-54.
4. Chesti MH, Kohli A, Mujtaba A, Sofi JA, Nazir Q, Tabasum Peer QJA *et al*. Effect of integrated application of inorganic and organic sources on soil properties, yield and nutrient uptake by rice (*Oryza sativa* L.) in Intermediate Zone of Jammu and Kashmir. Journal of the Indian Society of Soil Science. 2015; 63(1):88-92.
5. Dastan S, Siavoshi M, Zakavi D, Ghanbaria-Malidarreh A, Yadi R, Ghorbannia E Delavar *et al*. Application of nitrogen and silicon rates on morphological and chemical lodging related characteristics in rice (*Oryza sativa* L.) North of Iran. Journal of Agricultural Science. 2012; 4:6.
6. Gomez AA, Gomez KA. Statistical procedures for Agricultural Research. 2nd Edn. John Wiley and Sons, New York. 1984.
7. Joshi KK, Kumar V, Dubey RC, Maheshwari DK. Effect of chemical fertilizer adaptive variants, *Pseudomonas aeruginosa GRC2* and *Azotobacterchroococcum* AC1 on *Macrophomena phaseolina* causing charcoal rot of *Brassica juncea*. Korean J. Environ. Agric. 2006: 25:228-235.
8. Khidrapure Guppar DS, Maruti K, Tejagouda MB Shankrayya. Effect of integrated nutrient management on plant growth and seed yield in hybrid maize. The Bioscan. 2015; 10(1):369-371.
9. Kumar A, Gautam RC, Singh R, Rana KS. Growth, yield and economics of maize wheat cropping sequence as influenced by integrated nutrient management of New Delhi. Indian Journal of Agricultural Science. 2005; 75(1):709-711.
10. Kumar A, Meena RN, Yadav Lalji, Gilotyia YK. Effect of organic and inorganic sources of nutrient on yield, yield attributes and nutrient uptake of rice. The Bioscan. 2014; 9(2):595-597.
11. Lakshmisha G, Singh VP, Shivakumar BG, Arora A. Effect of organic and inorganic nutrients on physiological traits of soybean [*Glycine max* (L.) Merill]. Indian Journal of Plant Physiology. 2012; 17(1):52-56, 27.
12. Mahmud ATM, Shamsuddoha Md, Nazmul Haque. Effect of organic and inorganic fertilizer on the growth and yield of rice (*Oryza sativa* L.). Nat. Sci. 2016; 14(2):45-54.
13. Naing Oo A, Banterng P, Polthanee A, Trela-Ges V. The effect of different fertilizers management strategies on growth and yield of upland Black Glutinous rice and soil property. Asian Journal of Plant Sciences. 2010; 9:414-422.
14. Nanjappa HP, Ramchanrappa BK, Mallikarjuna BO. Effect of integrated nutrient management on yield and nutrient balance in maize. Indian J. Agron. 2001; 46(4):668-701.
15. Patidar M, Mali AI. Effect of farmyard manure, fertilizer level on growth, yield and quality of rice. Indian Journal of Agronomy. 2004; 19(1):117-20.
16. Ram US, Srivastava VK, Singh SK, Yadav MK, Sen A. Agronomic biofertilizer of rice with special reference to Zn and Fe nutrition. Int. J Curr. Microbial App. Sci. 2013; 2(11):384-387.
17. Ramamoorthy B, Narsimhan RL, Dines RS. Indian Farming 1967; 17(5):43.
18. Sadasivam S, Manickam A. In Biochemical Methods for Agricultural Sciences, Wiley Eastern Limited, New Delhi. 1992, 184-185.
19. Samsul H, Partha SP, Ashok S. Growth attributes, cob yield and economics of maize (*Zea maize* L.) cultivars as affected by integrated nutrient management under Terai Region of West Bengal. Indian Journal of Agricultural Research. 2012; 46(1):42-47.
20. Savci S. An agricultural pollutant: chemical fertilizer. International J. Environmental Science and Development. 2012; 3(1):77-80.
21. Senthilvalavan P, Ravichandran M. Residual effect of nutrient management practices on the yield NPK uptake and profitability of rice fallow black gram. Asian Journal of Science and Technology. 2016; 7(1):2305-2310.
22. Siavoshi Morteza, Shankar L Laware. Role of organic fertilizers on chlorophyll content in rice (*Oryza sativa* L.). Dama International. 2013; 2(3):2319-4731.
23. Singh RN, Singh Surendra, Kumar Binod. Effect of integrated nutrient management practices in rice in framer’s fields. J. Res. (BAU). 2005; 17:185-189.
24. Singh YV, Singh SK, Sharma PK, Singh P. Soil test based integrated fertilizer recommendation for wheat (*Triticum aestivum*) in an Inceptisol of Eastern Plain Zone of Uttar Pradesh. Journal of the Indian Society of Soil Science. 2014; 62(3):255-258.
25. Thimmaiah SK. Standard methods of biochemical analysis. Kalyani Publication, New Delhi. 1999.
26. Vidya V Choudhari, Channappagouda BB. Effect of organics on morpho-physiological traits and grain yield of maize (*Zea maize* L.). The Bioscan. 2015; 10(1):339-341.
27. Watson DJ. Physiological basis of varieties in yield. Advance Agronomy. 1952; 4:101-145.