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Performance of rice under the different nutrient management practices at clay loam soil of district-Balod (C.G.)

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Abstract
An experiment was conducted at the farmer's field of Dallirajhara, District-Balod (C.G.) in the kharif season of 2021 to assess the performance of rice crop under different nutrient management practices at clay loam soil. The experiment consisting seven different nutrients management practices and laid out in randomized block design. The results of experiment revealed that the soil test based STCR dose applied for 60 q ha^{-1} yield of rice successfully achieved the target under the acceptable limit of 10% ± deviation. Due to balanced fertilization for a targeted yield, STCR based treatment recorded significantly superior grain yield (57.40 q ha^{-1}) over 100 percent RDF (48.90 q ha^{-1}) and showed significant effect on plant height, numbers of effective tillers, panicle length and number of grains per panicle of rice. STCR recorded maximum 17.4% higher grain yield as compared to RDF. Integrated nutrient management practices with 75% RDF + Vermi-compost @ 5 t ha^{-1} and 75% RDF + Super-compost @ 5 t ha^{-1} were respectively yielded 53.37 and 51.90 q ha^{-1} grains and found at par with STCR dose. Application of Vermicompost and super-compost successfully saved the 25% of chemical fertilizer and produced at par yield over the RDF. Addition of zinc @ 5 kg ha^{-1} with 100% RDF was not significantly affected the growth and yield of rice due to the sufficient level of zinc in the soil. Among all the treatments, control was recorded significantly lowest grain yield (27.97 q ha^{-1}). Test weight of grains was not significantly affected by various treatments. The benefit and cost ratio was also found highest (1.71) in the STCR.

Keywords: Growth parameters, yield attributes, yield, STCR, INM, benefit and cost ratio

Introduction
Rice (*Oryza sativa* L.) is the most valuable and extensively cultivated food crop of the world. Over 2 billion people in Asia alone derive 80% of their energy needs from the rice (Chaudhari *et al* 2018) [9]. Total food grain production of India was 308.65 million tones among which the production of Rice was 122.27 million tons **(**Govt. of India, 2020-21). Paddy is the major crop of Chhattisgarh state. Chhattisgarh state has an ideal weather condition for growing of rice. In the year 2019-20, the total production of rice in the state was 8.56 million tones with an area about 42.66 lakh hectares. Productivity of rice in the state was about 20.06 q ha^{-1} (Agriculture statistics, 2020) which is quite low as compare to national average productivity 27.13 q ha^{-1} (GOI, Agricultural statistics at a glance, 2021) [1]. Adopting of soil test based balanced fertilization and integrated nutrient management using different organic manures may be useful for improving the yield of rice as well as improve the soil health. Balanced fertilization using targeted yield equation is also found the best technology for soil test-based fertilizer recommendation. Targeted yield technology or STCR based fertilizer recommendation is an approach, in which the complete focus takes into account of crop needs and nutrients present in the soil (Ramamoorthy *et al.* 1967) [18]. The INMs helps to restore and sustain soil fertility and crop productivity. Balanced nutrition to the crops leads to better plant growth and yield. It may also help to check the emerging deficiency of nutrients other than NPK. It brings economy and efficiency in fertilizer use and favorably affects the physical, chemical and biological environment of soil. On the above background, an experiment was taken adopting various nutrient management practices on rice with aim to find out the best suitable nutrient practices for the rice growing farmers of the region.

Materials and Methods
The experiment was conducted on farmer's field at village- Darratola of block-Dallirajhara, District- Balod (C.G.). The location of the village was N-20°35'475" and E-081°02'331". The soil of the experimental field was clay loam.

The field was situated near the iron ore mines area and affected by sludge which comes through the spillage water. The characteristics of the experimental soil were slightly acidic in reaction (pH 5.6), low in organic carbon (0.41%) and available nitrogen (206.5 kg ha^{-1}), medium in available phosphorus (14.5 kg ha^{-1}) and available potassium (210.4 kg ha^{-1}). Micronutrients status of the soil was higher in iron (27.3 ppm), zinc (1.24 ppm), copper (3.62 ppm) and manganese (23.3 ppm). Appropriate methods were adopting for analysis of the soil. The experiment was laid out in randomized block design with three replications. The experiment consisted different nutrients management practices in seven treatments. These treatments were: T1- control (no fertilizer), T2- farmer practice @ 80:40:20 kg ha^{-1} N, P_2O_5 and K_2O, T3- 100% RDF @ 100:60:40 kg ha^{-1} N, P_2O_5, and K_2O, T4- 100% RDF + Zn @ 5 kg ha^{-1}, T5- Soil test based STCR dose for 60 q ha^{-1} yield (132:58:82 kg ha^{-1} N, P_2O_5, and K_2O), T6- 75% RDF + Vermicompost @ 5 t ha^{-1} and T7- 75% RDF + Super compost @ 5 t ha^{-1}.

The fertilizer prescriptions equation used for the STCR for 60 q ha^{-1} yield were FN = 4.05 × TY – 0.57 SN – 0.78 ON, FP = 1.46 × TY – 3.09 SP – 0.31 OP and FK = 1.61 × TY – 0.10 SK – 0.14 OK. As per the treatments, all amounts of phosphorous, potassium and zinc were applied basal. The nitrogen was applied in split doses at transplanting, at tillering and panicle initiation stages. Fertilizers i.e., urea, di-ammonium phosphate, muriate of potash and zinc sulphate were used for the supply of nutrients. Observations from each plot were taken for the study of growth and yield attributes of rice. Final grain and straw yields were recorded from each plot and converted in q ha^{-1}. Statistical analysis was done for determining the standard error of mean (S. Em ±) and the value of CD (Critical Difference) at 5% level of significance.

Results and Discussion

Effect of nutrients management on growth parameters of rice

The highest plant height (131.93 cm) and maximum number of effective tillers (8.20) were recorded in the treatment of soil test based STCR dose for 60 q ha^{-1} yield. The INM based treatments, 75% RDF + Vermi-compost @ 5 t ha^{-1} and 75% RDF + Super-compost @ 5 t ha^{-1} were recorded at par plant height (129.60 and 129.27 cm) and number of effective tillers (7.93 and 7.57) with STCR. These treatments were observed significantly superior over the rest of the treatments (control, farmer practice and 100% RDF). Application of high amount of nutrients but in a balanced manner were recorded significant plant height and number of effective tillers over the general recommended dose of nutrients. Macronutrients plays an important role in the growth of plants, especially nitrogen was main component for cell elongation and vegetative growth. Sathiya *et al.* (2009) [21], Sahu *et al.* (2015) [19] and Singh *et al.* (2015) [24] were found similar results on growth parameters of rice when used STCR based nutrient management. Combined use of inorganic fertilizers with organic manures in rice resulted better plant height and number of tillers were also reported by Apon *et al.* (2018) [5] and Arenjungla *et al.* (2021) [6]. Application of zinc @ 5 kg ha^{-1} with 100% RDF was recorded at par plant height (124.40 cm) and number of effective tillers (6.80) as compared to 100% RDF and showed no significant effect on growth parameters of rice. It was may be due the sufficient level of zinc in the soil (1.24 ppm). Similar results were also reported by Pal *et al.* (2008) [16] and Mondal *et al.* (2020) [15]. Among all the treatments, significantly lowest plant height (115.33 cm) and number of effective tillers (3.83) were recorded in the control.

Effect of nutrients management on yield attributes of rice

The highest panicle length (28.77 cm) and number of grains (177.60) were recorded in STCR which was found at par with 75% RDF + Vermi-compost @ 5 t ha^{-1} and 75% RDF + Super-compost @ 5 t ha^{-1} and significantly superior over the RDF, farmer practice and control. Soil test based balanced fertilization and integrated nutrient management was showed best results. Increase in panicle length with increasing dose of nutrients was also reported by Salman *et al* (2012) [20]. Increasing number of grains $panicle^{-1}$ might be due to adequate supply of photo-synthates from the source to the sink (grain) was also reported by Sathiya *et al* (2009) [21]. Yosef *et al* (2012) [28], Singh *et al.* (2018) [25] Deytarafder *et al.* (2016) [10] and Hasanuzzaman *et al.* (2010) [12] also found similar results of integrated nutrient management and reported positive effect of integration of organic manure with chemical fertilizer on the yield attributes of rice. Application of zinc @ 5 kg ha^{-1} with 100% RDF recorded 25.37 cm panicle length and 62.13 numbers of grains per panicle and showed no significant effect on the yield attributed. Jana *et al* (2020) [15] and Pal *et al.* (2008) were also reported the similar results of application of zinc. Among all the treatments, the test weight was ranged from 24.53 to 25.43 gm and observed at par with each other. As the test weight is a genetic character of the specific variety of the crop, the test weight of rice was not significantly affected by the different doses of fertilizer applications. Similar results were also reported by Jana *et al* (2020) [15] and Sonboir *et al* (2020) [26].

Effect of nutrients management on yields of rice

Among all the treatments, the significant highest grain (57.40 q ha^{-1}) and straw yield (65.89 q ha^{-1}) were found in the treatments of STCR. It recorded 17.38% higher grain yield in comparison with treatment of 100% RDF (48.90 q ha^{-1}). The results showed that the target yield in the soil test based STCR treatment was successfully achieved under acceptable limit of 10% ± deviation. Many scientists applied the soil test based STCR dose of fertilizer in the rice and successfully achieved the targeted yield. Chaubey *et al*. (2015) [8], Singh *et al.* (2015) [24], Sellamuthu *et al.* (2016) [22] and Rajput *et al.* (2016) [17] also reported the similar results. INM based treatments - 75% RDF + Vermi-compost @ 5 t ha^{-1} and 75% RDF + Super-compost @ 5 t ha^{-1} were respectively recorded 53.37 and 51.90 q ha^{-1} grain yield and observed at par with 100% RDF. The result showed that integrated application of Vermicompost and super-compost @ 5 t ha^{-1} with chemical fertilizer successfully saved 25% of the chemical fertilizer. Increase in the yield with increasing dose of fertilizers were also reported by Pal *et al.* (2008), Sathiya *et al.* (2009) [21], Salman *et al.* (2012) [20], and Yesuf *et al.* (2014) [27]. Application of zinc @ 5 kg ha^{-1} with 100% RDF was not found significant and recorded 49.37 q ha^{-1} grain and 55.98 q ha^{-1} straw yield which were recorded at par with 100% RDF. It was may be due the sufficient level of zinc in the soil (1.24 ppm). Similar results of no effect of zinc on yield of rice were also reported by Pal *et al.* (2008) [16], Kumar *et al.* (2018) [14], Chatterjee *et al.* (2020) [7] and Mondal *et al.* (2020) [15]. Application of RDF observed significantly superior over the treatments of farmers practice and control. Among all the treatments, significantly lowest yields (27.97 q ha^{-1} grains and

33.23 q ha^{-1} straws) were recorded in the control where no fertilizer was applied.

Benefit Cost ratio (B: C ratio)

Benefit cost ratio expressed in terms of net return on Rs per Rs invest on operational cost of cultivation. The highest B: C ratio was recorded in STCR (1.71). Chaubey *et al.* (2015) [24] also reported that substantially higher B: C ratio with STCR. The lowest B: C ratio (0.25 and 0.56), were found in INM based treatments, this was because the cost incurred in INM based treatments were much higher than control. The similar results were also reported by Kumari *et al.* (2013).

Table 1: Effect of nutrient management practices on growth parameters, yield attributes and yields of rice

Treatment	Treatment details	Plant height (cm)	Effective tillers hill^{-1} (no.)	Panicle length (cm)	Grains/ panicle (no.)	Test weight (gm)	Grain yield (q ha^{-1})	Percent change over 100% RDF	Straw yield (q ha^{-1})	B:C ratio (Rs/Rs)
T1	Control (0:0:0 kg ha^{-1})	115.33 c	3.83 e	19.00 e	127.67 e	24.53	27.97 d	-42.81	33.23 d	0.58
T2	Farmer Practice (80:40:20 kg ha^{-1})	118.40 c	5.13 d	21.73 d	135.33 d	24.73	44.80 c	-8.38	47.96 c	1.28
T3	100% RDF (100:60:40 kg ha^{-1})	123.43 b	6.60 c	24.47 c	158.00 c	24.77	48.90 bc	0.00	54.29 bc	1.39
T4	100% RDF + Zn @ 5 kg ha^{-1}	124.40 b	6.80 bc	25.37 bc	162.13 c	25.27	49.37 bc	0.95	55.98 b	1.41
T5	STCR 60 q ha^{-1} (132:58:82 kg ha^{-1})	131.93 a	8.20 a	28.77 a	177.60 a	25.43	57.40 a	17.38	65.89 a	1.71
T6	75% RDF + Vermi-compost @ 5 t ha^{-1}	129.60 a	7.93 ab	27.37 a	174.60 ab	25.40	53.37 ab	9.13	63.82 a	0.25
T7	75% RDF + Super-compost @ 5 t ha^{-1}	129.27 a	7.57 abc	26.93 ab	171.00 b	25.33	51.90 ab	6.13	62.99 a	0.56
CD (P= 0.05)		3.35	1.20	1.98	6.00	NS	5.66	-	6.62	-
SEm ±		1.09	0.39	0.64	1.95	0.225	1.84	-	2.15	-

*Total NPK applied in T6 @ 120:70:70 kg ha^{-1} and T7 @ 105:60:55 kg ha^{-1}

Conclusion

The present investigation concluded that the overall performance of rice crop under the different nutrients management practices were found positive. Among all the treatments, the soil test based balanced fertilization (STCR) was found best with highest grain yield and maximum benefit cost ratio. The INM based treatments (Vermicompost and super-compost) were also produced at par grain yield with STCR. The benefit cost ratio of INM based treatments were estimated minimum because of high cost of manure. If the farmers will make the manure in his farm, then the cost will be minimized and the benefit may be increased.

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