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STCR-based nutrient management practices for enhancing soil health, crop growth and yield of rice

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Abstract
A field experiment was conducted during *kharif* season of 2021 at Krishi Vigyan Kendra, Kondagaon (C.G.). The experiment was laid out in Randomized block design (RBD) and consisted of seven treatments and three replications. The application of fertilizer was based on soil test crop response (STCR) with/without FYM. The analysis revealed that the fertilization of STCR approach with FYM recorded maximum growth and yield parameters *i.e.* plant height, number of tillers, dry matter accumulation, crop growth rate (CGR) and leaf area index (LAI) with respect to RDF and control. It can be concluded that fertilization with STCR approach provided precise dose of fertilizer application rather than other treatments. STCR approach also sustains the soil fertility.

Keywords: RBD, soil test crop response, growth and yield parameters, FYM

1. Introduction

Rice (*Oryza sativa* L.) is the essential cereal crop in all over the world and is the primary food of over half the world's population. Rice is known as a "Global grain" because of its basic role as a staple food. Rice is third highest producing crop worldwide after Sugarcane and Maize (FAOSTAT, 2017) [5]. India is the 2nd largest producer of rice after China. In India, rice is grown in 43.78 million ha with production level of 118.43 million tons and the productivity is about 2705 kg ha^{-1} (Agriculture Statistics at a glance, 2020) [1] whereas, In Chhattisgarh, rice is grown in 3.67 million ha and production is 6.50 million tons and productivity is about 1773 kg ha^{-1} (Agriculture Statistics at a glance, 2020) [1]. Around 60% of Indians use rice as their primary diet, which also determines the nation's food security. However, poor, unbalanced, improper, or excessive nutrient utilization in agricultural systems is major factor in the country's low crop yields, particularly in Chhattisgarh. There are large gaps between crop yield potential and farmers' yield. Fertilizer being the most crucial input for increasing crop production in the shortest possible time plays a vital role to mitigate the food demand of state. Chemical fertilizer consists of high amount of nutrient and is quickly available to the crop. Long term use of chemical fertilizer leads to harassment of soil health and to maintain the soil health, farmers need, combined use of organic and inorganic fertilizer (Premi and Kalia, 2003) [10]. Government recommendations for fertilizer takes into account the average fertility level of the soil. As a result, the Soil Test Crop Response (STCR) technique is needed to apply the right amount of nutrients to the soil depending on crop response. The STCR approach aims to acquire a basis for precise quantitative adjustment of fertilizer doses for targeted levels of crop production under varying soil test value and farmer response conditions. The STCR technique minimizes cultivation cost while also assisting in achieving the production target (Kumar *et al*., 2018) [8]. The variety under research work is "Chhattisgarh Zinc Rice-1" the 1st bio fortified rice variety in country. The variety discovered with the rich zinc content has a maturity period of 110 days and is suitable in adverse climatic condition.

2. Material and Methods

The experiment was conducted in *kharif* season of 2021 at Krishi Vigyan Kendra, Kondagaon (C.G). The experimental site was situated at geographical coordinates of 81^0 39'8.31" E longitudes and 19^0 45'7.16" N latitude and about 593 m above from mean sea level lies in the Bastar platue agro climatic zone of Chhattisgarh. The soil of the experimental site is *vertisol* with 7.7 pH. The soil sample (0-15cm depth) was collected from experimental site before initiation of experiment and fertility status of soil was assessed. The field experiment was laid out in randomized block design with seven treatments and three replications. Fertilizer treatments were based on STCR value.

Table 1: Calculation of STCR based fertilizer recommendation is given below

STCR equation for fertilizer recommendation	Initial nutrient content in soil kg ha^{-1}	Nutrient content in FYM (%)
FN = 4.21T – 0.5 SN - 0.19 ON	SN= 174.4	N = 0.45
FP = 1.69T – 3.13 SP – 0.17 OP	SP = 12.6	P = 0.30
FK = 1.99T – 0.20SK – 0.03 OK	SK = 200.4	K = 0.80

Where, FN, FP and FK are the doses of fertilizer nitrogen, phosphorus and potassium to be applied (kg ha^{-1}) respectively. T- Targeted yield of rice (kg ha^{-1}) and SN, SP and SK are the soil available nitrogen, phosphorus and potassium (kg ha^{-1}) respectively. ON, OP and OK are the organic nitrogen phosphorus and potassium applied through FYM respectively. The N, P and K is applied by using urea (46% N), DAP (46% P_2O_5 and 18% N) and MOP (16% K_2O), respectively.

For further analysis, five tagged plants from each plot were collected and recorded the data at different growth stages i.e. 30, 60, 90 DAT and at harvest.

Table 2: Treatment details of fertilizer dose based on STCR calculation

Treatment		FN kg ha^{-1}	FP kg ha^{-1}	FK kg ha^{-1}
T1	Control	0.0	0.0	0.0
T2	Farmers practice	80	50	30
T3	Recommended dose of fertilizer	100	60	40
T4	STCR dose for TY1 (40 t ha^{-1})	81.2	28.2	39.5
T5	STCR dose for TY1 (40 t ha^{-1}) with 5t FYM	76.9	25.6	38.3
T6	STCR dose for TY2 (50 t ha^{-1})	123.1	44.6	59.4
T7	STCR dose for TY2 (50 t ha^{-1}) with 5t FYM	119.0	42.5	58.2

3. Result and Discussions

3.1 Plant height (cm)

Data revealed that significant increased in plant height at various growth stages *viz*. 30, 60 90 DAT and at harvest The maximum plant height was observed in STCR dose for TY 50 q ha^{-1} i.e. (58.66, 86.91, 105.03 and 106.83 cm) at 30, 60, 90 DAT and at harvest, respectively which was followed by STCR dose for TY (50q ha^{-1}), RDF and STCR dose for TY (40 q ha^{-1}) with 5t FYM while, control had minimum plant height (47.13, 56.25, 81.06 and 83.44 cm) at 30, 60, 90 DAT and at harvest, respectively. Similar result was reported by Ahmed *et al*. (2005) and Sathiya *et al*. (2009) [2, 12].

3.2 Number of effective tillers hill^{-1}

The average number of effective tillers hill^{-1} was observed between 5.27 to 8.72. Data showed that the maximum number of effective tillers was observed in STCR dose for TY (50 q ha^{-1}) with 5t FYM which was statistically equivalent to STCR dose for TY (50 q ha^{-1}) and RDF. On other hand, control plot had least number of effective tillers (5.27). Salunke *et al.* (2006) [14] also reported the same result.

3.3 Dry matter accumulation per hill (g plant^{-1} day^{-1})

Dry matter accumulation hill^{-1} was significantly influenced by different fertility levels. Higher dry matter accumulation was found in STCR dose for TY (50 q ha^{-1}) with 5t FYM (13.93 and 21.97 g hill^{-1}) at 30 and 60 DAT, which were statistically at par with STCR dose for TY (50 q ha^{-1}) and RDF. At 90 DAT, STCR dose for TY (50 q ha^{-1}) (32.53) was found highest and at par with STCR dose for TY (50 q ha^{-1}) with 5t FYM and RDF. Similar result was observed by Kalyan sundaram and Kumar (2003) and Barik *et al.* (2006) [6, 3].

Table 3: Effect of different nutrient management practices on growth attributes

Treatment	Plant height (cm)				Number of effective tillers	Dry matter accumulation (g plant^{-1} day^{-1})		
	30 DAT	60 DAT	90 DAT	At harvest		30 DAT	60 DAT	90 DAT
T1	47.13	56.25	81.06	83.44	5.27	9.27	13.75	13.75
T2	50.82	74.51	100.31	102.36	7.55	9.63	15.50	24.03
T3	55.02	79.32	104.38	105.67	8.24	11.93	20.67	30.23
T4	51.96	69.11	96.12	96.83	7.88	10.37	17.23	24.60
T5	52.07	74.21	102.10	103.11	6.83	10.27	18.20	26.30
T6	57.33	84.75	104.25	106.25	8.35	12.67	21.60	32.53
T7	58.66	86.91	105.03	106.83	8.72	13.93	21.97	31.67
S.Em	1.848	2.785	2.877	2.797	0.624	0.913	1.118	1.592
CD(P=0.05)	5.695	8.582	8.866	8.617	1.924	2.814	3.445	4.905

3.4 Crop growth rate (CGR)

At initial stage, CGR was slow up to 30 DAT due to minimum biomass production. After that sharp increase in CGR up to 60 DAT followed by pronounced decline up to 90 DAT. Treatment STCR dose for TY (50 q ha^{-1}) with 5t FYM (0.2, 0.46, 0.71 and 0.55 g plant^{-1} day^{-1}) produced significantly higher dry matter in per unit area and per unit time with respect to other treatments. It was followed by STCR dose for TY (50 q ha^{-1}) (0.19. 0.42, 0.68 and 0.52 g plant^{-1} day^{-1}) than RDF (0.18, 0.40, 0.64 and 0.49 g plant^{-1} day^{-1}). Increase in crop growth rate is due to increase in availability and uptake of nutrient by the crop which results in better growth. The result was similar with the findings of Dass *et al.* (2009) [4].

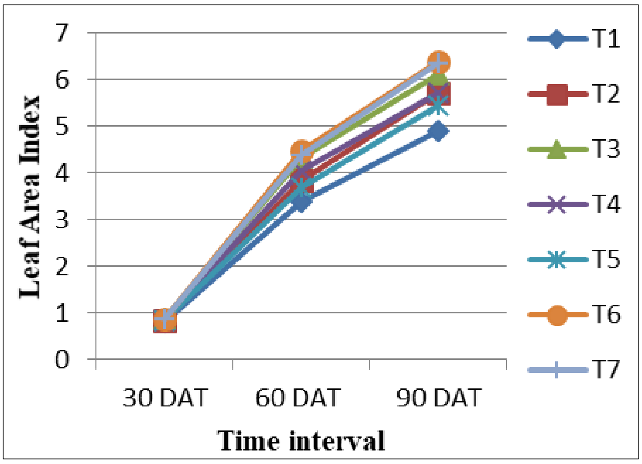

Fig 1: Leaf area index

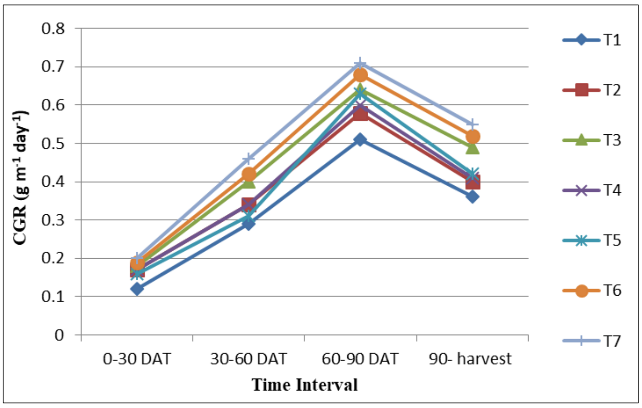

Fig 2: Crop Growth Rate

3.5 Leaf area index

LAI increased at every stages of crop growth. The highest LAI was observed in TY (50 q ha^{-1}) with FYM (0.89) and TY (50 q ha^{-1}) without FYM (0.89) at 30 DAT. However, at 60 and 90 DAT, LAI was highest in TY (50q ha^{-1}) without FYM (4.46, 6.38) were statistically at par with TY (50 q ha^{-1}) with FYM (4.39, 6.35) and RDF (4.32, 6.11). Similar trend was reported by Yadav and Meena (2014) [15] and Patra *et al.* (2017) [9]

3.6 Grain and straw yield of rice (q ha^{-1})

Data showed the seed and straw yield increased significantly with increase in fertility levels. Both grain and straw yield varied significantly and ranged from 49.28 q ha^{-1} to 19.81 q ha^{-1} and 61.28 q ha^{-1} to 24.26 q ha^{-1}, respectively. Results revealed that the significant effect with maximum seed yield was recorded under TY (50 q ha^{-1}) with FYM (49.28 q ha^{-1}) which were statistically at par with TY (50 q ha^{-1}) without FYM (48.59 q ha^{-1}) and significantly superior to RDF (43.48 q ha^{-1}) > TY (40 q ha^{-1}) with FYM (38.50 q ha^{-1}) > TY (40 q ha^{-1}) without FYM (37.29 q ha^{-1}) > farmers practices (36.21 q ha^{-1}) which was significantly increased over the control (19.81q ha^{-1}).

Straw yield showed a similar pattern to seed yield. The treatment TY (50 qha^{-1}) with FYM considerably produced the highest straw yield (61.28 q ha^{-1}) followed by YT (50 q ha^{-1}) without FYM (59.24 q ha^{-1}) which were statistically at par and produced significantly more straw yield than other treatments. The increase in grain and straw yield associated with greater levels of NPK may be attributable to enhanced nutrient absorption, which is linked to increased photosynthetic accumulation, higher biomass output, and improved growth and yield attributes. Similar report was stated by Keram *et al.* (2012), Sellamuthu *et al.* (2016) and Saraswathi *et al.* (2016) [7, 13, 11].

3.7 Harvest index (%)

All the treatments were not found to be statistically significant. However, application of nutrients for TY (40 qha^{-1}) recorded the highest harvest index (46.02%), while the minimum harvest index was observed at 44.57%.

Table 4: Treatment details

	Treatment	Seed yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index (%)
T1	Control (0:0:0 NPK)	19.81	24.26	44.95
T2	Farmer's practice (80:50:30 N, P_2O_5, K_2O kg ha^{-1})	36.21	43.52	45.43
T3	RDF (100:60:40 N, P_2O_5, K_2O kg ha^{-1})	43.48	51.75	45.65
T4	STCR dose for TY1 (40 q ha^{-1}) (81.18: 28.23: 39.5 N, P_2O_5, K_2O kg ha^{-1})	37.29	44.50	45.58
T5	STCR dose for TY1 (40 q ha^{-1}) with 5 t FYM (76.9: 25.6: 38.3 N, P_2O_5, K_2O kg ha^{-1})	38.50	45.14	46.02
T6	STCR dose for TY2 (50 q ha^{-1}) (123.09: 44.56: 59.4 N, P_2O_5, K_2O kg ha^{-1})	48.59	59.24	45.07
T7	STCR dose for TY2 (50 q ha^{-1}) with 5 fft FYM (119: 42.5: 58.2 N, P_2O_5, K_2O kg ha^{-1})	49.28	61.28	44.57
	S.Em±	1.191	1.500	0.436
	CD(P=0.05)	3.669	4.621	NS

4. Conclusion

The result of study demonstrated that the soil test value crop response (STCR approach) significantly improved the growth parameters of rice i.e. plant height, number of tillers, dry matter accumulation CGR and LAI of rice hence increased in yield of rice.

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