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Validation of STCR based fertilizer prescription on the farmer's field

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Abstract
A field experiment was conducted on "Validation of STCR Based Fertilizer Prescription on the Farmer's Field" of Lanjoda village, District-Kondagaon (C.G.)" during *Kharif* season, 2020 with the three objectives; To test the validity of fertilizer prescription equation developed for Rajeshwari variety of rice. The fertilizer prescription equations previously developed for rice (variety-Rajeshwari) in STCR project as FN=5.00T-0.78SN-0.3ON, FP= 1.40T-2.78SP-0.27OP and FK-1.57T-0.10SK-0.09OK were validated on farmer's field with rice variety Rajeshwari. The experimental field was laid out in randomized block design with three replications, consisting of seven treatments as control (N_0 P_0 K_0), farmers practice (N_{80} P_{50} K_{30}), GRD (N_{100} P_{60} K_{40}), STCR based dose for TY 50 q ha^{-1} (N_{102} P_{28} K_{45}), STCR based dose for TY 50 q ha^{-1} with FYM (N_{95} P_{24} K_{39} + 5 t ha^{-1} FYM), STCR based dose for TY 60 q ha^{-1} (N_{151} P_{42} K_{61}) and STCR based dose for TY 60 q ha^{-1} with FYM (N_{145} P_{38} K_{55} + 5 t ha^{-1} FYM). The soil of experimental field belongs to the soil order of *Vertisol* having clayey in texture. The highest mean grain yield was recorded with treatment YT 60 q/ha without FYM (61.44 q/ha) and YT 60 q/ha with FYM (60.25 q/ha) which were statistically at par and significantly higher than rest of treatments. Treatments YT 50 q/ha with FYM, GRD, and YT 50q/ha without FYM gave grain yield as 50.24, 50.06 and 49.44 q/ha, respectively were significantly higher than farmers practice dose (41.32 q/ha) followed by control (24.20 q/ha). Significantly highest straw yield (73.37 q/ha) was recorded under treatment YT 60 q/ha followed by YT60 q/ha with FYM (70.45 q/ha), which were statistically at par and both the treatments gave significantly higher straw yield than other treatments. Lowest straw yield recorded in control plot.

Keywords: STCR, FYM, soil test, *vertisol*

1. Introduction

Soil is considered the principal source of nearly all essential plant nutrients. The soil has been rapidly depleted of plant nutrients as a result of intensive agriculture, which has included the widespread cultivation of high-yielding rice and other crops. Unbalanced and discriminating use of chemical fertilisers has affected soil health (John *et al*., 2001) [4]. Because preserving soil health and quality is essential for boosting agricultural output and feeding the world's expanding population, it can be remedied by using either organic or inorganic fertiliser, or both. The balanced fertilisation of a crop, which also improves yield quality, is one of the most crucial components of sustainable agricultural production. As a result, the administration of fertiliser based on soil analysis is promoted worldwide. Fertilization of a crop is more dependent on the nutritional status of the soil than recommended doses of fertiliser. Therefore, fertiliser dose recommendations should always be determined by analysing the link between soil test values, applied fertiliser doses, and crop yield and uptake. Soil analysis is an excellent scientific tool for determining the nutritional status of soil in a quick and reliable manner. The use of fertilisers determined by soil analysis not only increases crop yield but also improves the benefit-to-cost ratio.

The soil test crop response (STCR) system is one of the most scientific techniques for crop nutrient delivery, using soil test data and yield equations to maintain soil fertility and soil health. These equations are generated by incorporating the contributions of soil nutrients, manures, and fertilisers. In-field soil test crop response studies establish the relationship between soil-test value and crop response to fertilisation and provide essential data for formulating fertiliser recommendations for the desired yield. Soil test crop response-based fertiliser recommendations, also known as "prescription-based fertiliser recommendations," account for soil nutrient standards in order to attain targeted crop yields in a particular agro-climatic environment.

The soil test crop response (STCR) technique for reaching desired yields is extremely precise. It considers both the amount of fertiliser applied based on a soil test and the level of production attained through good management. To maximise crop profitability, farmers use a disproportionate amount of fertilisers that deteriorate soil quality and lower the benefit-to-cost ratio. Therefore, the use of fertiliser without adequate information on soil nutrient status has a negative effect on soil and crop health. STCR ensures that crops receive an adequate supply of nutrients, avoiding both over- and under-fertilization. This simultaneously decreases environmental risks and increases earnings. STCR is essential for sustaining yields and reducing fertiliser expenditures, which in turn reduces cultivation expenses (Saxena *et al*., 2008; Chatterjee *et al*., 2010) [9, 3]. The STCR-based fertiliser recommendations, on the other hand, account for every nutrient present in the soil in order to achieve the desired crop production under a particular agro-climatic condition. Crop requirements are addressed, resulting in increased economic and quality yields while reducing the amount of fertilisers used (Boldea *et al*., 2015) [2].

To improve agricultural output under varied soil-climatic conditions, it is necessary to produce data on optimal nutrient doses for crops. Due to the utilisation of soil and plant tests, STCR-based fertiliser recommendations are more quantitative, accurate, and applicable. It provides an actual balance of nutrients applied from inorganic, organic, or both sources, in addition to the soil's inherent, accessible nutrients. Fertilizer recommendations can help maintain and improve soil fertility, increase crop output, and optimise nutrient utilisation.

Rice (*Oryza sativa*) is the most important crop in India, and more than two-thirds of the population consumes it. Rice provides 43 percent of the calories required by more than 70 percent of the Indian population, hence the slogan "Rice is life" is particularly applicable to India. The rice harvest plays a crucial role in achieving our national food security goals and offers millions of rural communities a source of income. In 2015-16, rice was grown on 37.18 million hectares, yielding 66.20 million tonnes with a productivity of 1,780 kg/ha. (Reddy and Ahmed, 2000) The lack of N, P, and K in the soil is a contributing factor to the poor growth of rice crops.

2. Materials and Methods

2.1 Experimental site and soil characteristics

During *Kharif* season, 2020 the experimental site is situated at the farmer field of village Lanjoda, Kondagaon in district is located near national highway No. 30 at south eastern part of the state of Chhattisgarh in central India. It is lies at 19^0 45'7.16" N latitude and $81^0$39'8.31" E longitudes. It has an average elevation of 593 metres from above mean sea level. The soil of experimental field belongs to the soil order of *Vertisol*. This soil is locally known as Kanhar. It is clayey in texture and dark brown to black in colour. The soil reaction is neutral to alkaline in due to presence of lime concretion in lower horizon. The initial soil test values were as pH 7.2, EC 0.12 dsm^{-1}, organic carbon 5.4 g kg^{-1}, available nitrogen 198 kg ha^{-1}, available phosphorous 15.92 $kgha^{-1}$ and available potassium 365 kg ha^{-1}.

2.2 Treatments

Using seven different combination of fertilizers application along with control ($N_0P_0K_0$), Farmer Practice ($N8_0P_{50}K_{40}$), GRD ($N_{100}P_{60}K_{40}$), STCR based dose for TY 50 q/ha without FYM ($N_{101}P_{28}K_{45}$), STCR based dose for TY 50 q/ha with FYM ($N_{95}P_{24}K_{39}$ + 5 ton FYM), STCR based dose for TY 60 q/ha without FYM ($N_{151}P_{42}K_{61}$) and STCR based dose for TY 60 q/ha with FYM ($N_{145}P_{38}K_{55}$ + 5 ton FYM). The experiment was based on STCR based fertilizer prescription in farmer. The experiment was laid out in RBD design with three replications. For validation of STCR based fertilizer prescription on farmer's field was mention here FN = 5.00T-0.78SN-0.3ON, FP = 1.40T-2.78SP-0.27OP and FK = 1.57T-0.10SK-0.09OK, Where FN, FP and FK are fertilizer N, P_2O_5 and K_2O in kg/ha, respectively. SN, SP and SK are soil test values for available N, P and K in kg/ha, respectively. ON, OP and OK are organic nutrients of N, P and K in kg/ha, respectively. T is targeted yield of rice q/ha. The fertilizer N, P_2O_5 and K_2O were calculated on basis of soil test for the targeted yield treatments by using these equations. The following doses of fertilizer N, P_2O_5 and K_2O were applied to achieving the yield targets of 50 and 60 q/ha based on the soil test values with FYM @ 5 t/ha (treatments T_5 and T_7) and chemical fertilizer alone (treatments T_4 and T_6) in rice variety Rajeshwari.

3. Result and Discussion

3.1 Crop yield and yield attributes of rice

3.1.1 Plant height (cm)

The effect of different fertilizer treatments on plant height was found to be significant and has been presented in Table-1 and Fig.-1. The difference in plant height of rice was observed due to different doses of fertilizers application. This may be because fertilizers play a role in promoting rapid leaf, stem and other vegetative part's growth and development. The maximum plant height (115.42 cm) was recorded with yield target of 60 q/ha with 5 ton FYM followed by yield target of 60 q/ha without FYM (112.86 cm), GRD (112.26 cm), Yield target of 50 q/ha with 5 ton FYM (111.12 cm), Yield target of 50 q/ha (109.35cm) and farmer practice (107.26cm), which were statistically at par with each other's. The plant height (95.76 cm) recorded in control plot was significantly lowest from all other treatments. Similar results reported by Ahmed *et al.* (2005) [1] and Sathiya *et al.* (2009) [8].

3.1.2 Number of effective tillers of rice at harvest

Number of effective tillers per hill has been represented in Table-1 and Fig.-1. Total number of effective tillers per hill were found significantly higher in the treatments targeted yield 60 q/ha with FYM (9.67) followed by treatments targeted yield 60 q/ha without FYM (9.53) to over other treatments. The effective tillers per hill in treatments YT 50 q/ha with FYM, YT 50 q/ha and GRD were observed statistically at par and significantly higher than treatment farmers practice dose. Control plot showed significantly lowest number of effective tillers in all treatments. The increase in number of tillers by application of NPK fertilizers and FYM can be attributed to soil condition with more availability and nutrients uptake, water and growth promoting substances to promote more tillers. Similar report stated by Banerjee *et al.* (2011) and Yosef (2012) [14].

3.1.3 Panicle length of rice at harvest

The result of panicle length has been represented in table-1 and Fig.-1. The panicle length in treatment YT 60 q/ha with FYM (23.53 cm) followed by YT 60 q /ha without FYM (23.40 cm), YT 50 q/ha with FYM (22.97 cm), YT 50 q/ha without FYM (22.59 cm), GRD (22.27 cm) and farmers practice dose (21.43 cm) were observed significantly higher than control. Lowest panicle length recorded in control treatment (17.65). Increasing panicle length might be because nitrogen and balance fertilization contributes in stimulating cell division in the reproductive stage of crop growth. Similar findings reported by Banerjee *et al.* (2011) and Salman *et al.* (2012) [6].

3.1.4 Number of grains per panicle of rice

Table-1 and Fig.-1 show the result of number of grains per panicle. Significantly higher number of grains per panicle observed in treatment YT 60 q/ha with FYM (186.24) followed by YT 60 q/ha without FYM (182.52), YT 50 q/ha with FYM (176.16), GRD (174.12), YT 50 q/ha without FYM (173.76) than farmers practice (156.18). The number of grains per panicle recorded in control (131.18) was significantly lower than farmer's practice. This is due to adequate supply of photosynthates from the source to the sink (grain). Accumulation of photosynthates to sink depends on the availability of nutrients and genetic potentiality of the crops (Yesuf and Balcha, 2014) [13]. Similar finding was observed by Banerjee *et al.* (2011) and Aparna *et al.* (2017).

3.1.5 Test weight of grains of rice

Table-1 and Fig.-1 have shown the effect of different fertilizers treatments on test weight of grains. Test weight of grains showed non-significant difference due applications of various fertilizations and highest weight of 1000 grains was recorded with farmer practice followed by treatments GRD, control, YT 60 q/ha with 5 ton FYM, YT 50/ha and YT of 50 q/ha with FYM. Treatment YT 60 q/ha gave lowest test weight (27.47g). Fertilizer application had non-significant impact on test weight of grains because test weight of a variety is genetically inherent character. Similar report states by Singh *et al.* (2005) [12] and Singh *et al.* (2006) [11].

3.1.6 Grain and straw yield of rice

The data presented in Table-1 and Fig.-1 indicated that grain and straw yield of rice as affect by different fertilizer treatments. The highest mean grain yield was recorded with treatment YT 60 q/ha without FYM (61.44 q/ha) and YT 60 q/ha with FYM (60.25 q/ha) which were statistically at par and significantly higher than rest of treatments. Treatments YT 50 q/ha with FYM, GRD, and YT 50q/ha without FYM gave grain yield as 50.24, 50.06 and 49.44 q/ha, respectively were significantly higher than farmers practice dose (41.32 q/ha) followed by control (24.20 q/ha). The grain yield received under targeted yield treatments YT 50 q/ha and YT 60 q/ha were achieved with + 10% variations due to fertilizer application alone or along with 5 t ha^{-1} FYM as per yield target, so its proved that the fertilizer prescription equations developed previously were valid for rice crop. The grain yields recorded in treatment GRD and YT 50 q/ha with FYM or without FYM were almost equal whereas the fertilizer requirement of N and K_2O was almost equal but in case of fertilizer P_2O_5 as lower than GRD. The fertilizer requirement was substantially low in comparison to general recommended dose (GRD). The similar trend was found in straw yield. Significantly highest straw yield (73.37 q/ha) was recorded under treatment YT 60 q/ha followed by YT60 q/ha with FYM (70.45 q/ha), which were statistically at par and both the treatments gave significantly higher straw yield than other treatments. Lowest straw yield recorded in control plot. Similar report stated by Keram *et al*., (2012 A) [5], Sellamuthu *et al*., (2016) [10] and Saraswathi *et al*., (2016) [7].

Table 1: Effect of different fertilizer treatments on yield and yield attributes of rice at harvest

S. No.	Treatment	Plant height (cm)	No. of tillers per hill	Panicle length (cm)	No. of Grains per panicle	Test weight (g)	Yields (q/ha)	
							Grain	Straw
1	Control (0-0-0)	95.76 b	4.40 d	17.65b	131.18c	28.53	24.20d	28.83d
2	Farmers Practice (80-50-30)	108.26 a	6.20 c	21.43a	156.18b	28.97	41.32c	45.73c
3	GRD (100-60-40)	112.26 a	7.93 b	22.27a	174.12a	28.60	50.06b	58.45b
4	YT 50 q/ha (102-28-45)	110.35 a	8.00 b	22.59a	173.76a	28.37	49.44b	58.57b
5	YT 50 q/ha (95-24-39) + 5 ton FYM	111.12 a	7.93 b	22.97a	176.16a	28.20	50.24b	58.49b
6	YT 60 q/ha (151-42-61)	112.86 a	9.53 a	23.40a	182.52a	27.47	61.44a	73.37a
7	YT 60 q/ha (145-38-55) with FYM	115.42 a	9.67 a	23.53a	186.24a	28.13	60.25a	70.45a
	S.Em±	3.53	0.47	0.95	6.05	1.07	2.59	3.15
	CD	10.88	1.45	2.93	18.66	NS	7.88	9.72

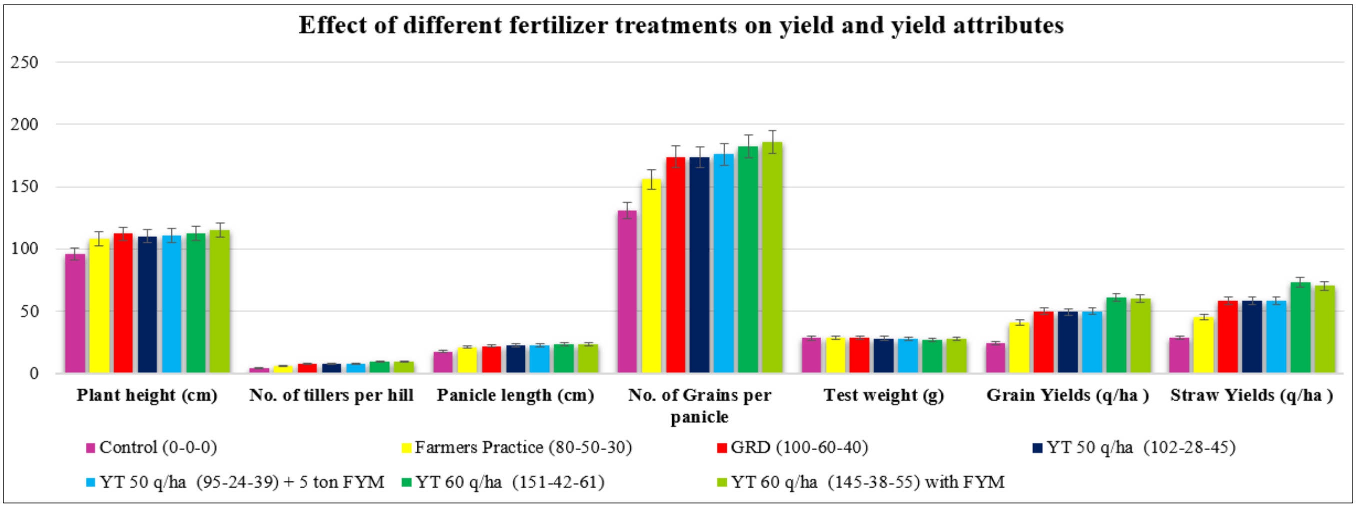

Fig 1: Graphical representation Effect of different fertilizer treatments on yield and yield attributes of rice at harvest

4. Conclusion

The maximum plant height (115.42 cm) was recorded with yield target of 60 q/ha with 5 ton FYM followed which were statistically at par with each-others except control. The plant height (95.76 cm) recorded in control plot was significantly lowest from all other treatments. Total number of effective tillers per hill were found significantly higher in the treatments targeted yield 60 q/ha with FYM (9.67) from other treatments and at par with treatments targeted yield 60 q/ha without FYM (9.53). The effective tillers per hill in treatments YT 50 q/ha with FYM, YT 50 q/ha and GRD were observed statistically at par and significantly higher than treatment farmers practice dose. Control plot showed significantly lowest number of effective tillers in all treatments. The panicle length in treatment YT 60 q/ha with FYM (23.53 cm) were observed statistically at par and significantly higher than control treatment (17.65 cm). Numbers of grains per panicle were significantly higher in treatment YT 60 and statistically at par with all treatments except control. The number of grains per panicle recorded in control (131.18) was significantly lower than farmers practice. Test weight of grains showed non-significant difference due applications of various fertilizations. The highest weight of 1000 grains was recorded with farmer practice and lowest test weight in treatment YT 60 q/ha gave (27.47g). The highest mean grain yield was recorded with treatment YT 60 q/ha without FYM (61.44 q/ha) and YT 60 q/ha with FYM (60.25 q/ha) which were statistically at par and significantly higher than rest of treatments. Treatments YT 50 q/ha with FYM, GRD, and YT 50q/ha without FYM gave grain yield as 50.24, 50.06 and 49.44 q/ha, respectively were significantly higher than farmers practice dose (41.32 q/ha) followed by control (24.20 q/ha). Significantly highest straw yield (73.37 q/ha) was recorded under treatment YT 60 q/ha followed by YT60 q/ha with FYM (70.45 q/ha), which were statistically at par and both the treatments gave significantly higher straw yield than other treatments. Lowest straw yield recorded in control plot. The grain yield received under targeted yield treatments YT 50 q/ha and YT 60 q/ha were achieved with + 10% variations due to fertilizer application alone or along with 5t ha-1 FYM as per yield target, so its proved that the fertilizer prescription equations developed previously were valid for rice crop.

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