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Original Research Article

Evaluation of Soil Test Crop Response Approach for Sustainable Production of Rice in Balodabazar –Bhatapara District of Chhattisgarh

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A B S T R A C T

To assess the soil test crop response (STCR) based nutrient management in rice, demonstrations were conducted at five farmer's field during kharif 2015-16 at village Bakulahi district Balodabazar-Bhatapara (C.G.). Three technology options were assessed and were T1: Farmers' practice (Imbalanced fertilization (250:155:133 kg/ha), T2: Recommeded package of practices (100:50:50 kg/ha) and T3: STCR equation based application of fertilizers (targeted yield: 50 q/ha). The grain yield of rice (variety Mahamaya) was found higher in T3 (47.96 q/ha) and increase was to the tune of 17 per cent over T1. These results clearly indicated that application of fertilizers to crops based on soil test values and target yield approach was effective in getting the higher yield.

Keywords

Nutrient management, STCR, Rice

Introduction

Rice (*Oryza sativa*), the staple food of more than half of the population of the world, is an important target to provide food security and livelihoods for millions. Imminent water crisis, water-demanding nature of traditionally cultivated rice and climbing labour costs ramble the search for alternative management methods to increase water productivity, system sustainability and profitability. This might be due to unbalanced nutrient management which is one of the important reasons for low productivity. For evaluating the effect of STCR (Soil Test Crop Response) equations for targeted yield of rice developed by Department of Soil Science, IGKV, Raipur.

Fertilizer use is a major contributing factor for higher rice production in India. The fertilizer requirement of a crop depends to a larger extent on the native soil fertility and hence, the prescription of doses should always be made by examining the relationships of soil test values with applied fertilizer doses and crop yield (Velayutham and Raniperumal, 1976). Among the nutrients, nitrogen is the primary one in the fertilizer management programme for rice as it is key to realize the yield potential of rice. It is estimated that to achieve average rice yield of 8.0 t/ha^{-1} in Asia by 2025, about 300% increase in N addition will be required with the present levels of fertilizer N efficiency. In this context, efficient use of N fertilizers plays a major role for reducing the amount of N fertilizer application to rice crop (Stalin *et al.*, 2002). To get more and more yield farmers tend to use excess and heavy doses of fertilizers but on other hand they are neglecting the soil health

deterioration. Also in some cases application of fertilizers by the farmers in the field without knowledge on soil fertility status and nutrient requirement by the crop causes adverse effects on soil and crop regarding both nutrient toxicity and deficiency either by over use or inadequate use.

Materials and Methods

A field experiment was conducted on farmer's field at village Bakulahi of district Balodabazar-Bhatapara (C.G.) during *kharif* and *rabi* seasons of 2014-15 and 2015-16 to study the different nutrient management approaches on nutrient use efficiencies and productivity of rice. Treatments comprised of 3 nutrient management approaches *viz.*, recommended dose of fertilizers (RDF; NPK- 120:60:40), farmer's fertilizer practices (NPK – 130:40:20) and soil test crop response (STCR; NPK–133:45:50).

Nutrient management approaches

RDF (Recommended dose of fertilizers)

In rice, under recommended dose fertilizers (N_{120} P_{60} K_{40}), nitrogen was applied through urea, where, half dose of total nitrogen was applied as basal and remaining half was applied in two equal splits *i.e.* at the active tillering and panicle initiation stage. In wheat, under RDF (N_{120} P_{60} K_{40}), nitrogen (N source urea) was applied in three equal splits *i.e.* as basal, 30 DAS and 60 DAS. Full dose of phosphorus and potassium was applied at the time of planting in rice and wheat.

Farmer's fertilizer practices (FFP)

To know the current farmers fertilizer practices in the adjoining area of the experimental site, a planned survey has been made in the adjoining villages namely Bendri, Koshmanda and Gudhelia of District Balodabazar-Bhatapara. An interaction was made with total number of 30 farmers with different categories of farm holdings regarding the information of current fertilizer source, rate, time and method of their application in rice crops and majority of the farmers following the same fertilizer practices were considered as FFP.

Under current farmers fertilizer practices in rice farmers are applying fertilizers as N_{130} P_{40} K_{20}, where, 15 kg of N and complete dose of P and K was applied through NPK mixture [12:32:16] in rice and remaining quantity of nitrogen was applied in two equal splits i.e. at 22-25 DAT and 50 DAT in rice.

STCR based Nutrient Application

The Soil Test Crop Response (STCR) approach takes into account the soil available N, P and K dose required for the targeted yield and it is computed by the equation obtained from the calibration experiments. A yield of 50 q ha^{-1} was taken as targeted yield for rice variety Mahamaya. Based on the soil available nitrogen, phosphorus and potassium the required quantity of fertilizer to attain the targeted yield was calculated.

The fertilizer prescription equation to attain specific yield targets based on soil available nutrients level for the rice experimental field was estimated on the basis of equation prescribed by Department of Soil Science and Agricultural Chemistry, Raipur (C.G.). The required nitrogen was applied through urea in three splits i.e. 50% as basal, 25% at active tillering (22-25 DAT) and 25% at panicle initiation (45-50 DAT) stage in both seasons of rice. Whole quantity of phosphorus and potassium fertilizers was applied as basal in rice in both the seasons.

Table.1 Fertilizer estimation under STCR

Crop	Soil Available Nutrients			Target Yield (q ha^{-1})	Required fertilizers (kg ha^{-1})		
	N	P	K		N	P_2O_5	K_2O
Rice	178	10.72	307.75	50	135	45	50
Wheat	180	8.42	326	40	130	60	40

Table.2 Effect of nutrient management approaches on panicle number, 1000-grain weight, grain yield of rice

Treatments	No. of panicles/m^2			1000 grain weight (g)			Grain Yield (kg ha^{-1})		
	2014	**2015**	**Pooled**	**2014**	**2015**	**Pooled**	**2014**	**2015**	**Pooled**
T1: FFP	206	215	210	24.5	25.5	25.0	3995	4015	4005
T2: RDF	227	220	223	26.8	27.5	27.2	4402	4543	4473
T3: STCR	240	243	242	27.1	28.0	27.5	4773	4820	4796
SEm±	**4.07**	**4.10**	**3.16**	**0.61**	**0.33**	**0.34**	**46.48**	**63.51**	**39.35**
CD at 5%	**14.10**	**16.72**	**9.74**	**2.12**	**1.14**	**1.07**	**160.84**	**219.78**	**121.25**
CV %	**3.63**	**3.63**	**3.97**	**4.68**	**2.45**	**3.70**	**2.11**	**2.84**	**2.51**

(FFP – Farmer's fertilizer practices, RDF – Recommended dose of fertilizers, STCR – Soil Test Crop Response)

Table.3 Comparative study of grain yield, gross return and net profit from rice and wheat under rice-wheat cropping system

Treatments	Parameters studied				Increase or decrease (±)					
	GY (q ha^{-1})	GR (Rs)	TFC (Rs)	GRF (Rs)	Change in grain yield		Change in TFC		Change in profit	
					Over FFP	Over RDF	Over FFP	Over RDF	Over FFP	Over RDF
Rice 2014										
FFP	39.95	53933	3560	50373						
RDF	44.02	59427	5640	53787	+4.07		+2080		+3414	
STCR	47.73	64436	5360	59076	+7.78	+3.71	+1800	-280	+8703	+5389
Rice 2015										
FFP	40.15	54203	3560	50643						
RDF	45.43	61331	5640	55691	+5.28		+2080		+5048	
STCR	48.20	65070	5360	59710	+8.05	+2.77	+1800	-280	+9067	+4019

GY – Grain Yield (q ha^{-1}), GR- Gross Return (Rs ha^{-1}), TFC-Total fertilizer cost, GRF - Gross return above fertilizer cost (Rs. ha^{-1}) [GRF = GR - TFC]

Fig.1 Grain yield of rice as influenced by different nutrient management approaches

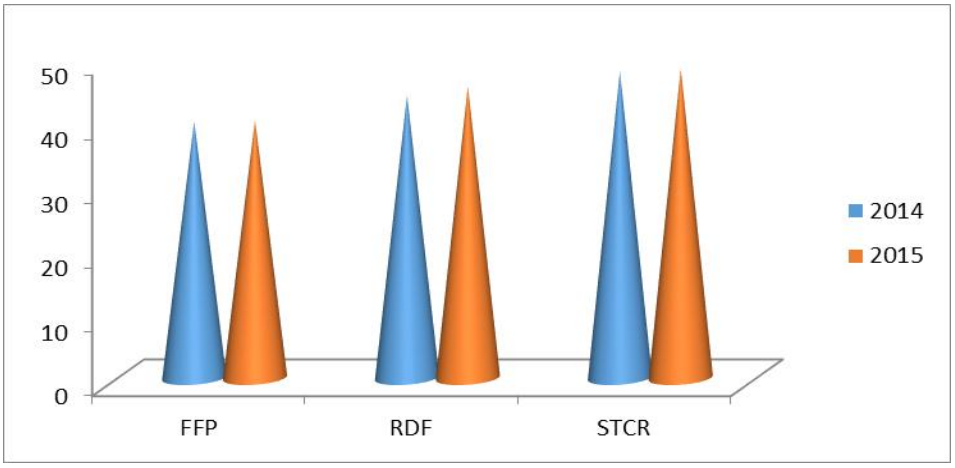


Fig.2 Gross return (Rs ha^{-1}) as influenced by different nutrient management approaches

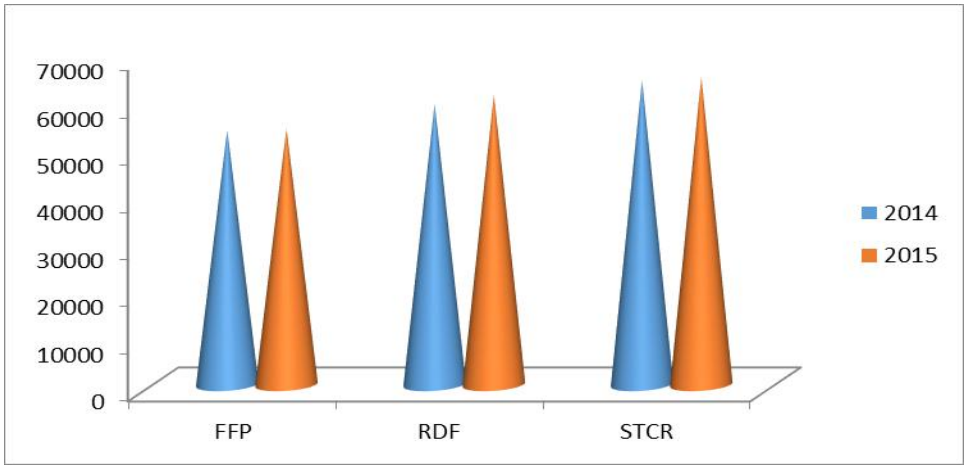
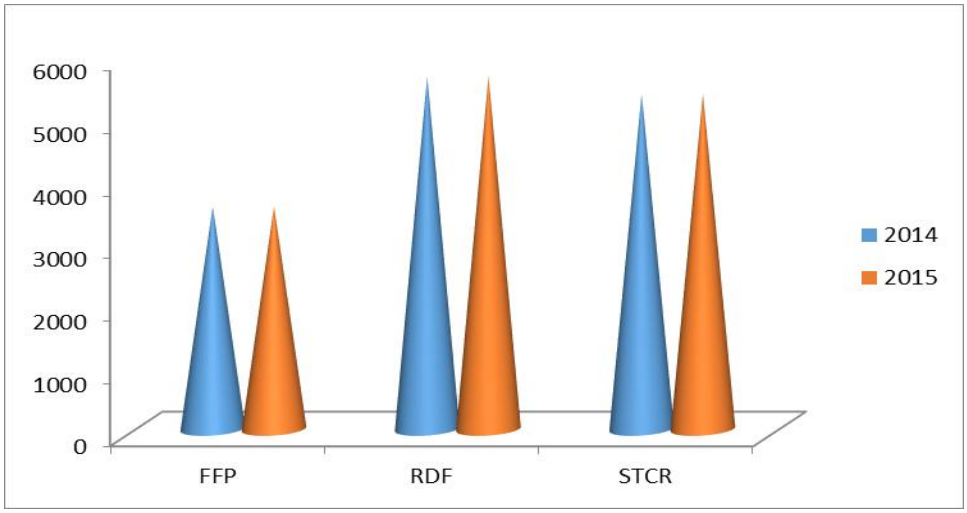


Fig.3 Total fertilizer cost (Rs/ha) in different nutrient managemen approaches



Results and Discussion

Yield and Yield attributes in rice

The highest grain yield (4773 kg ha^{-1}, 4820 kg ha^{-1}) was recorded under STCR in 2014 and 2015 respectively followed by RDF. In comparison to FFP, the STCR technology produced 19.45 and 20.04% more grain yield in 2014 and 2015, respectively. Pooled data of two years showed that comparatively highest grain yield was recorded under STCR treatment followed by RDF [Table-2].

The higher number of panicles (240, 243) and maximum 1000 grain weight (27.1 g, 28.0 g) were obtained under STCR (Soil Test Crop Response) in both the years which differ significantly with recommended dose of fertilizer. The highest yield and yield attributes in STCR might be due to the fact that soil testing helps the farmers to use fertilizers according to needs of crop. Fertilizer use for targeted yield is an approach, which takes into account the crop needs and nutrients present in the soil. The findings are in closely accorded with those reported by Ray *et al.,* (2000) and Meena *et al.,* (2001). Application of fertilizer based on STCR at critical physiological phases would have supported for better assimilation of photosynthates towards grain. Increase in grain yield can also be attributed to favorable effect in accelerating the growth and yield parameters. Higher grain and biomass yield with STCR nutrient management strategies over farmers' practice of nutrient management clearly indicated the benefit of judicious nutrient management in rice.

Economics and profitability

The highest profit during rice 2014 was obtained in STCR treatment, which is Rs 8703 higher than FFP, the total cost of fertilizer incurred by the RDF treatment was higher than other treatments, and therefore, gross return above fertilizer (GRF) cost was lower in RDF than STCR but higher than FFP. Total fertilizer cost in RDF was Rs 5640 higher than fertilizer cost STCR and FFP. Similar trend was also found in 2015 where profit was Rs. 9067 more than FFP and Rs. 4019 more than the RDF. This occurred due to higher productivity and higher gross return above fertilizer (GRF) cost obtained in STCR. Total fertilizer cost in RDF was Rs 280 higher than fertilizer cost in STCR [Table-3].

The nutrient requirement by the crop is based on the fact that there is significant linear relationship between nutrient uptake and grain yield. It shows that for required grain yield production, a definite quantity of nutrient must be absorbed by plant. Once the nutrient requirement for a given yield target is known, the fertilizer requirement can be calculated taking in to account the efficiency of soil and fertilizer nutrients. The STCR technology was effective in changing attitude, skill and knowledge of farmers. Soil test crop response (STCR) based fertilizer recommendation is superior over other nutrient management approaches in terms of grain yield, and profitability. It was also concluded that production of more grain yield with less fertilizer can be obtained in STCR based fertilizer application comparison to the blanket application and other approaches.

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