Effect of STCR-IPNS technology for targeted yield in rice under sodic soil

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ABSTRACT

For evaluating the effect of STCR-IPNS (soil test crop response-integrated plant nutrient supply) equations for targeted yield of rice under sodic soils developed by department of Soil Science and Agricultural Chemistry, AICRP-STCR unit, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, demonstrations based on targeted yield in rice were conducted at farmers' fields by Krishi Vigyan Kendra, Vamban, Pudhukottai, Tamil Nadu at different locations of sodic soil areas with rice varieties CO43Sub1 (medium fine grained) and TRY 3 (bold grain) during rabi 2020 -2021. The STCR-IPNS technology was used for computation of fertilizer doses based on soil test values and targeted yield of 60 q/ha and compared with farmers' practice. The demonstrated STCR-IPNS technology was able to increase yield of rice over farmers' practice under sodic soil to the tune of 41.68 and 38.34 per cent for medium fine and bold rice varieties respectively. Value of net return from demonstrated STCR-IPNS technology was observed to be Rs 42,000 and 44,000 in comparison to farmers' practice ie Rs 21,000 and Rs 17,500 for medium fine and bold rice varieties respectively. The benefit-cost ratio of STCR technology with farmers' practice was 2.16 and 2.25 and 1.55 and 1.46 for medium fine and bold rice respectively. The STCR-IPNS technology ie application of fertilizer doses based on initial soil test values with FYM @ 12.5 tonnes/ha along with gypsum application was effective in changing attitude, skill and knowledge of farmers and can be recommended for achieving higher yield (ie up to 6 tonnes/ha), response ratio and BCR for rice on Alathur series (Vertic Ustropept) and allied soil series especially sodic soils of Tamil Nadu. This also improved the relationship between farmers and scientists and built confidence among the farmers.

Keywords: STCR technology; sodic soil; targeted yield; rice; reclamation

INTRODUCTION

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. Average productivity of rice in Tamil Nadu under sodic soil is much lower than the other prominent rice producing states. This might be due to unbalanced nutrient management which is one of the important reasons for low productivity in sodic soils. Degradation of soil health has also been reported due to long-term imbalanced use of fertilizer nutrients. Although overall nutrient use ($N:P_2O_5:K_2O$) of 4:2:1 is considered ideal for Indian soils, the present use ratio of 6.8:2.8:1 is far off the mark (Chaubey et al 2015).

This imbalanced nutrient use has resulted in wide gap between crop removal and fertilizer application. According to estimates, the present area under salt-affected soils (6.73 million ha) in the country would almost treble to 20 million ha by 2050 (Sharma et al 2014). The growing realization that climate change would adversely affect global food output adds to the worry of the majority of developing countries as they are likely to be worst affected by the climate change-induced food scarcity and hunger risks (Godfray et al 2010). Multi-nutrient deficiencies have led to the concept of site-specific nutrient management (SSNM). The number of nutrient elements deficient in Indian soils increased from just one in 1950 to nine in the year 2005-06 which might further increase by the year 2025 if the imbalanced fertilization continues. Due to

inadequate knowledge about soil and crop requirement, costly inputs like fertilizers, chemicals, water and other inputs go waste resulting in monetary loss and adverse effect on environment. The current status of nutrient use efficiency is quite low in case of P (15-20%), N (30-50%), S (8-12%), Zn (2-5%), Fe (1-2%) and Cu (1-2%) (Hegde and Babu 2004). Sodic soil reclamation, which essentially aims to replace the sodium by calcium on exchange sites and the subsequent removal of exchanged sodium by the application of good quality water, is often context-specific and depends on the availability of amendments and the crops to be grown. Declining soil fertility and mismanagement of plant nutrients have made this task more difficult.

Balanced NPK fertilization has received considerable attention in India (Ghosh et al 2004, Singh et al 2008). Soil testing helps the farmers to use fertilizers according to needs of crop. Fertilizer use for targeted yield (Ramamoorthy et al 1967) is an approach which takes into account the crop needs and nutrients present in the soil. In the intensive agriculture system integrated fertilizer recommendation is an urgent need since it balances soil and applied nutrients from inorganic as well as organic sources to balance nutrition of crops and maintenance of soil health (Subba Rao and Reddy 2009).

The present study was conducted to find out the effect of STCR-IPNS (soil test crop response-integrated plant nutrient supply) technology for targeted yield in rice under sodic soil areas of Manikandam block, Tiruchirapalli district with hybrid rice varieties CO43 Sub1 and TRY3 during Rabi 2020 -2021.

MATERIAL and METHODS

Demonstrations based on STCR-IPNS targeted yield in rice were conducted at farmers' fields by Krishi Vigyan Kendra, Vamban, Pudhukottai, Tamil Nadu at different locations of sodic soil areas of Manikandam block, Tiruchirapalli district with hybrid rice varieties CO43 Sub1 and TRY3 during Rabi 2020 -2021. For evaluating the nutrient supplying capacity of soil in terms of available nitrogen, phosphorus and potassium, soil samples were taken from farmers' fields and after analysis of soil pH, EC, exchangeable sodium percentage (ESP), available nutrients, values of fertilizer nutrients were calculated using appropriate STCR-IPNS equations for targeted yield of rice developed for sodic soils by the Department of Soil Science and Agricultural Chemistry, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu.

The computed value of fertilizer nutrients for 6 tonnes/ha yield target was applied at farmers' fields keeping one local check of farmers' practice. The dose of gypsum requirement was calculated to reduce the ESP level (initial soil ESP 35.04) to below 15. Field leveling along with required quantity of gypsum application was done. Bunds were raised in order to pond the field with rain water. After two days the field was drained. The same procedure was repeated for three times till the ESP of experimental soil was reduced to below 15 (Fig 1). The primary data were collected from the selected farmers with the help of personal interview schedule. The per cent increase in yield and B-C ratio was calculated by using following formulae:

Fig 1. Sodic soil reclamation with gypsum at Poongudi village, Tiruchirapalli, Tamil Nadu

Per cent increase in yield= 100 × (Yield of STCR-IPNS – Yield of FP)/Yield of FP

where FP= Farmers' practice

B-C ratio= Gross return/Gross cost

RESULTS and DISCUSSION

Data in Table 1 indicate that demonstrated STCR-IPNS technology showed higher yield over the farmers' practice. The demonstrated STCR-IPNS technology was able to increase yield of CO44Sub1 (6444) and TRY3 rice varieties over the framers' practice by 41.68 and 38.34 per cent respectively under sodic soil along with proper soil reclamation with gypsum. Ghosh et al (2004) showed importance of balanced fertilization for maintaining soil health and sustainable agriculture in problematic soils. State recommendations (SR) and farmers' practice (FP) clearly found that the FP even though contained higher levels of N or P, gave lower yields thus advocating the superiority of economic performance of STCR-IPNS technology over farmers' practice ie cost of cultivation, gross return, net return and B-C ratio (Table 2). The data indicate that the net return from the improved practice (STCR-IPNS technology) was substantially higher than the FP for both the rice varieties. For CO44Sub1 and TRY3 rice varieties, value of net return from demonstrated STCR-IPNS technology was observed to be Rs 42,000 and 44,000 in comparison to Rs 21,000 and 17,500 respectively in farmers' practice. Application of 50 per cent gypsum requirement reduced the ESP level from dangerous to normal (Table 3) which might be due to replacement of Na^+ by Ca^{2+} in sodic soil. Also STCR-IPNS technology could be able to replace 42 kg N, 18 Kg P_2O_5 and 32 Kg K_2O from the recommended dose of fertilizer based on soil test values, if FYM @ 12.5 tonnes/ha with a manurial

Table.1 Effect of STCR-IPNS technology in terms of yield and economic parameters in rice

Rice variety	Yield (q/ha)			
	Targeted	Demonstration	Farmers' practice	Increase in yield
CO43Sub1	60	55.4	39.1	41.68
TRY3	60	55.2	39.9	38.34

Table 2. Effect of STCR-IPNS technology in terms of average cost of cultivation, gross return, net return and B-C ratio

Rice variety	Cost of cultivation (Rs/ha)		Gross return (Rs/ha)		Net return (Rs/ha)		B-C ratio	
	Demo	FP	Demo	FP	Demo	FP	Demo	FP
CO43Sub1	36,000	38,000	78,000	59,000	42,000	21,000	2.16	1.55
TRY3	35,000	37,500	79,000	55,000	44,000	17,500	2.25	1.46

Demo= Demonstration, FP= Farmers' practice

Table 3. Exchangeable sodium percentage (ESP) of sodic soils under STCR-IPNS package

Rice variety	pH		EC (dS/m)		ESP		50% GR
	Initial	Final	Initial	Final	Initial	Final	
CO43Sub1	9.03	8.30	0.83	0.35	35.04	13.36	1.1 tonne/ha
TRY 3	9.31	8.40	0.76	0.27	26.50	11.25	0.75 tonne/ha

ESP= Exchangeable sodium percentage, EC= Electric conductivity. GR= Gross return

composition of N 0.6 per cent, P_2O_5 0.3 per cent, K_2O 0.5 per cent and MC 30 per cent were applied.

CONCLUSION

The reclamation of sodic soils using gypsum is well understood and once the nutrient requirement for a given yield target is known, the fertilizer requirement can be calculated taking into account the efficiency of soil and fertilizer nutrients particularly in sodic soils. Therefore soil test crop response-based fertilizer prescriptions under integrated plant nutrition system (STCR-IPNS for 6 tonnes/ha) ie application of fertilizer N, P_2O_5 and K_2O based on initial soil test values with FYM @12.5 tonnes/ha along with reclamation procedure (50% gypsum requirement) can be recommended for achieving higher yield, net return and BCR for rice on sodic soils of Tamil Nadu.

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