I J P S INTERNATIONAL JOURNAL OF PLANT SCIENCES
ISSN-0973-1547 Volume 17 | Issue 2 | July, 2022 | 128-132
DOI: 10.15740/HAS/IJPS/17.2/128-132
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RESEARCH ARTICLE

Influence of integrated nutrient application based on STCR approach on nutrient uptake of rice under rice-maize cropping sequence

■ **Amit Kumar Pandey, Ashutosh Singh and Umesh Singh**

SUMMARY

Soil testing helps the farmers to use fertilizers according to need of crops. Fertilizer use for targeted yield is an approach which take into account the crop need and nutrient present in the soil. A study on soil test crop response based integrated plant nutrient ion system (STCR) were conducted adopting targeted yield method in non-calcareous sandy loam soil of Ustifluvents at Mandan Bharti Agriculture College, Agwanpur, Saharsa during the two consecutive of 2018 and 2019. The experiment was laid out in RBD with nine treatments replicated thrice. The STCR approach with or without FYM at low, medium and high target yield markedly increase the yield and uptake of NPK of rice. Thus, the targeted yield model used to develop fertilizer precipitation equations provides a strong basis of soil fertility maintenance consistent with high productivity and efficient nutrient management for sustainable and enduring agriculture. This also improved the relationship between farmers and scientists and built confidence between them.

Key Words : Perception, Adoption, Soil health card, Farmers

How to cite this article : Pandey, Amit Kumar, Singh, Ashutosh and Singh, Umesh (2022). Influence of integrated nutrient application based on STCR approach on nutrient uptake of rice under rice-maize cropping sequence. *Internat. J. Plant Sci.*, **17** (2): 128-132, **DOI: 10.15740/HAS/IJPS/17.2/128-132,**

Article chronicle : Received : 07.01.2022; **Revised :** 07.04.2022; **Accepted :** 09.05.2022

Soil is rightfully called the "Soul of infinite life". This soul, however, has become dilapidated of late due to ill agricultural practices being adapted to feed the ever increasing mouths (Dhawan, 2014). While agricultural intensification model helped in achieving self-sufficiency in the food grain production by the close of 20th century, issue related to soil health degradation become more critical. Indian soils are plagued by abysmally low soil organic carbon less than 0.5%, more than 90% of Indian soils are deficient in available nitrogen (Chander, 2020). The subsidy policy in the fertilizers industries sector has resulted in indiscriminate production and use of fertilizers, neglecting the management principles of nature conservation. Consequently, the

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natural resources has been impaired, especially affecting the soil system through accelerated nutrient depletion (Rattan, 2014 and Sarkar *et al.,* 2017). Further, low use of organic amendments and secondary nutrients and micro nutrients have aggravated the fertility of soil (Sarkar *et al.,* 2021). Nutrient mining is in practice to an extent that cereal crops remove about 20-30 kg N, 4-8 kg P and 18-40 kg K for producing one tonne of grain. The balance sheet comprising the addition and removal of nutrients present a negative nutrient budget in the majority of the Indian soils (Sanyal *et al.,* 2014 and Sharma, 2016). Degradation of soil health has also been reported due to long term imbalanced use of fertilizers nutrients. The partial factor productivity of fertilizers showed a declining trend. Multi nutrient deficiencies have led to the concept of site specific nutrient management (SSNM) (Chaubey *et al.,* 2015). Organic manure are a valuable source of nutrients, but their sole application is not sufficient to meet the nutrient demand of high yielding varieties and often result in poor yield. Furthermore, using the generally recommended dose of fertilizers is not able to maintain to *vis-a-vis* economic return of crops and this requires refinement of balanced crop nutrition (Majhi *et al.,* 2019). The soil test based fertilizer recommendation harmonizes the much debate approach namely "Fertilizing the soil" versus "Fertilizing the crop" ensuring for real balance between the applied fertilizer nutrients among themselves and with the soil available nutrients (Vijayakumar *et al.,* 2017). Based on this concept soil test crop response studies have been undertaken in different parts of India in various crops like rice, wheat and pearl millet. The present study intended to find the relationship between the nutrients supplied by the soil and added by organic and inorganic sources, their uptake and to develop a guideline for judicious application of fertilizers for desired yield target of rice by using STCR model.

MATERIAL AND METHODS

Field experiments were conducted during *Kharif* and *Rabi* seasons of 2017-18 and 2018-19 at Mandan Bharti Agriculture College, Agwanpur, Saharsa on Inceptisols. The texture of the study area was clay loam and medium in fertility status. The study area falls in the eastern part of the state of Bihar, India. It is situated near the bank of Kosi river in the Agro-climatic zone-II of Bihar between 25°88' N latitude and 86°6' E longitude at an altitude of 41 meter above MSL. During the crop growing season, the total rainfall was 1110 mm. The maximum and minimum temperature fluctuated from 30.8 to 42.2 °C while the minimum temperature fluctuated from 12.5 to 25 °C. The experiment was repeated on the same site for two years. The experiments comprises nine treatments replicated thrice was laid down in Randomized Block Design (RBD). The quantity of the fertilizer was calculated based on targeted yield equation developed by STCR scheme. FYM was applied on dry weight basis containing 0.5% N, 0.2% P_2O_5 and 0.5% K_2O. before and start the experiment, soil samples were collected from the different spots at a depth of 0-15 cm from the experimental field and after making a composite, it was shade dried and processed and analyzed for various chemical parameters. The yield of crop were recorded after harvest. The plant samples were oven dried and analyzed for nitrogen, phosphorus, potassium and sulphur by standard procedure. Nutrient uptake by grain and straw was computed by multiplication of grain yield (kg ha^{-1}) with nutrient content in grain (%) and straw yield (kg ha^{-1}) with nutrient content in the straw (%), respectively. The summation of nutrient uptake in the grain and in straw gives the total nutrient uptake by the crops.

Table A: Treatment details of the validating modified STCR equation

Treatments	Symbol
General fertilizer recommendation	T_1
Farmer's practices	T_2
STCR with IPNS for a low target yield	T_3
STCR with IPNS for a medium target yield	T_4
STCR with IPNS for a high target yield	T_5
STCR without IPNS for a low yield target	T_6
STCR without IPNS for a medium yield target	T_7
STCR without IPNS for a high yield target	T_8
Absolute control	T_9

RESULTS AND DISCUSSION

Data on nitrogen uptake by rice under different treatments are given in Table 1. The maximum N uptake by grain and straw and total N uptake was recorded in STCR with IPNS for a high target yield 77.34, 40.32 and 117.66 kg ha^{-1}, respectively which is higher than all other treatments. The lowest N uptake by grain (24.89 kg ha^{-1}), straw (9.54 kg ha^{-1}) and total N uptake (34.43 kg ha^{-1}) was recorded in absolute control. This might be due to application of balanced fertilization based on target

yield resulting in higher uptake. The results are in line with Vijayakumar *et al.,* 2017 and Singh and Sarkar, 2001. The highest P uptake in grain, straw as well as total P uptake was found with the treatment STCR with IPNS for high target yield (Fig. 1). The highest P uptake by grain (17.02 kg ha^{-1}), straw (10.33 kg ha^{-1}) and total uptake (27.33 kg ha^{-1}) were recorded in the treatment T_5 which is higher than other treatment. The lowest value of P- uptake by grain, straw and total uptake was recoded in absolute treatment. The finding of Pachauri and Singh (2001) supported the results of present study. Biradar and Jayadeva (2013) reported significantly higher nutrient uptake in SSNM through fertilizer for targeted yield of 10 t ha^{-1} over 100 per cent RDF. Maximum rice grain K-uptake (28.57 kg ha^{-1}), rice-straw uptake (102.16 kg ha^{-1}) and total K-uptake (130.73 kg ha^{-1}) was found in STCR with IPNS for a high target yield which was higher than the other treatments (Table

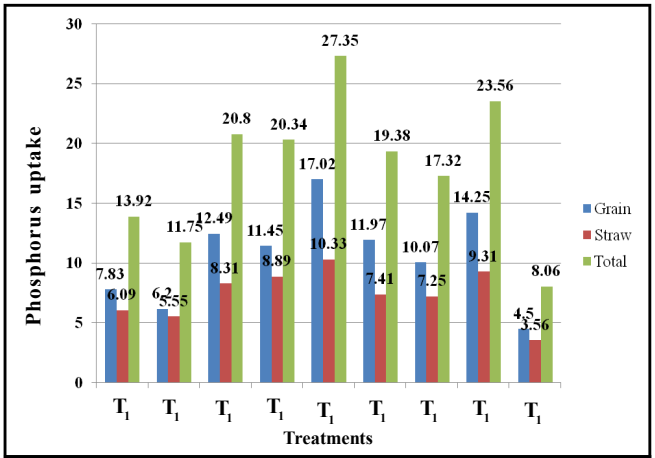

Fig. 1: Phosphorus uptake (kg ha^{-1}) by rice under different nutrition

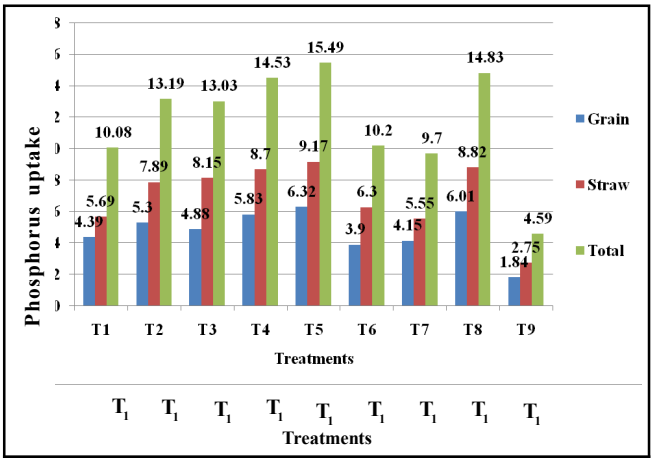

Fig. 2: Sulphur uptake (kg ha^{-1}) by rice under different nutrition

Table 1 : Nitrogen uptake (kg ha^{-1}) by rice under different nutrition

Treatments	Grain	Straw	Total
T_1 (General fertilizer recommendation)	47.25	17.21	64.46
T_2 (General fertilizer recommendation)	37.93	19.56	57.49
T_3 (STCR with IPNS for a medium target yield)	33.99	36.52	70.51
T_4 (STCR with IPNS for a medium target yield)	62.49	36.63	99.12
T_5 (STCR with IPNS for a high target yield)	77.34	40.32	117.66
T_6 (STCR without IPNS for a high yield target)	65.28	28.64	93.92
T_7 (STCR without IPNS for a high yield target)	54.04	24.32	78.36
T_8 (STCR without IPNS for a high yield target)	73.70	34.93	108.63
T_9 (Absolute control)	24.89	9.54	34.43

Table 2 : K- uptake (kg ha^{-1}) by rice under different nutrition

Treatments	Grain	Straw	Total
T_1 (General fertilizer recommendation)	14.62	68.51	83.13
T_2 (General fertilizer recommendation)	13.47	62.66	76.13
T_3 (STCR with IPNS for a medium target yield)	23.40	78.31	101.71
T_4 (STCR with IPNS for a medium target yield)	20.58	79.70	100.28
T_5 (STCR with IPNS for a high target yield)	28.57	102.16	130.73
T_6 (STCR without IPNS for a high yieldtarget)	22.70	80.76	103.46
T_7 (STCR without IPNS for a high yieldtarget)	16.43	74.25	90.68
T_8 (STCR without IPNS for a high yieldtarget)	26.32	87.81	114.13
T_9 (Absolute control)	6.91	44.84	51.75

2). The lowest grain, straw, a total K-uptake 6.91, 44.84 and 51.95 kg ha^{-1}, respectively were recorded with absolute control. Higher uptake rates in STCR with IPNS could be attributed to higher rate of fertilizers which ultimately increase the yield and nutrient concentration in plant (Shubham and Dixit, 2021). Dwivedi *et al.* (2016) reported that all the STCR treatments proved to be superior to blanket treatment and farmer's practice. The increase in uptake of nutrients might be attributed to solubility action of organic acids produced during decomposition of FYM resulting in higher released of N, P and K from soil and the contribution of nutrition from FYM which has increased the yield over the resultant uptake by the crop. The pertaining to the nutrient uptake of S by rice revealed that STCR with IPNS for a higher yield recorded highest in grain (6.32 kg ha^{-1}), straw (9.17 kg ha^{-1}) and total uptake (15.49 kg ha^{-1}) and was found to be comparable with other treatment (Fig. 2). The results are in conformity with outcome of Umesh *et al.* (2014) and Chandel *et al.* (2014) who reported that STCR or SSNM approach recoded significant improvement in uptake of nutrients. Suresh and Santhi (2018) and Kirankumar *et al.* (2019) reported that the higher uptake of nutrient in the STCR-IPNS treatments might be due to higher biomass production coupled with higher availability of nutrient elements after harvest of crop.

Conclusion:

It may be concluded that under rice-maize cropping system application of fertilizer through STCR with IPNS of higher a target yield is the best option for higher productivity, besides improving soil fertility, total nutrient uptake and also higher economic return.

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