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RESEARCH PAPER

Influence of soil test based fertilization on nutrient uptake of rice under rice-wheat cropping system

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Abstract : A field investigation on rice under rice-wheat cropping system was carried out in the two consecutive of 2018 and 2019 at Mandan Bharti Agriculture College, Agwanpur, Saharsa for the development and validation of soil test crop response (STCR) to fertilizer and for assessing the performance of STCR treatments as compared to general recommended dose in terms of yield and nutrient uptake of rice. The STCR approach with or without FYM at low, medium and high target yield markedly increase yield, NOK uptake and use efficiency. Therefore, the STCR-target yield approach could improve the yield, and nutrient uptake for rice.

Key Words : STCR, Cropping system, Nutrient uptake

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INTRODUCTION

Rice is the major crop of India and occupied largest cropped area of 42.4 million hectares with an annual production of 100 million tones and the productivity 2462 kg ha^{-1}Vijaykumar *et al.* (2017). Rice is cultivated in 38 district of Bihar. Out of this, 25 district are falling under low productivity group which accounts for 63% of 36.57 lakh hectares of total area under rice in state. According to the conventional estimate, food grain demand will be 355 Mt by 2030 in India, while on the other hand, the response ratio and factor productivity of crop are continuously declining every year, due to the applied fertilizer in intensive cultivation Majhi *et al.* (2016). The use efficiency of nitrogen, phosphorus and potassium are 30-50%, 15-20% and 60-70%, respectively which is certainly low and enhance the cost of cultivation. During the past few decades the use of fertilizers for enhancing food production has increased many folds and which if it exceeds the crop requirement, often causes environmental pollution. The imbalance use of inorganic fertilizer in India has resulted in a net negative balance may rise upto 15 MT y^{-1}. Resource poor farmers of the nation used to follow an imbalance fertilization, which disturbs the nutrient availability leading to a decrease in soil productivity in a long run Majhi *et al.* (2021). Apart from this, increasing fertilizer prices and their availability is one of the main hurdles to balance fertilization. Excessive chemical fertilizer application has aggravated the deficiencies of secondary and micro nutrients in different soils Singh *etal.* (2021). Furthermore, inadequate nutrition of crops worsens the situation, in terms of declined soil

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fertility. Using the generally recommended dose of fertilizer is not able to maintain yields; due to fatigue in soil health and this requires refinement for balanced crop nutrition. Therefore the sole use of neither organic manure nor chemical fertilizer can enhance the sustainability of an intensive production system. The use of appropriate combination of organic manure and chemical fertilizers, depending on soil fertility status is a step forward for providing balanced fertilization to crops Nanda *et al.* (2016). An inadequate and imbalanced fertilizer use for crop production without proper knowledge of the inherent soil capabilities and crop requirement is also one of the cause that prevent gaining the fully yield potential of crops and the deterioration of soil health as well as economic losses to farmers. Furthermore, fertilizer use requires knowledge of the expected grain yield response which depends upon the crop nutrient requirement and the fate of fertilizer applied to the soil. Therefore, a comprehensive approach, considering soil tests, field research could be employed for fertilizer use. Thus the soil test crop response (STCR) methodology can be adopted for calculating N, P and K requirement as needed. This study intended to find out the relationship between the nutrients supplied by the soil and added by organic inorganic sources and their uptake to develop guideline for judicious application of fertilizer for desired yield target of rice by using STCR model.

MATERIAL AND METHODS

The study area falls in eastern part of the state of Bihar, India with a sub-humid climate. It is situated near the eastern bank of Koshi river. Studies on soil test crop response based fertilization for rice, fertilizer prescription equation under IPSN were developed foe Entisols of Saharsa district during 2018-19 following the inductive cum targeted yield model of Ramamoorthy *et al.* (1967). The field experiment was conducted at Mandan Bharti Agriculture College, Agwanpur, Saharsa at Saharsa district of Bihar which is located in the agro-climatic zone II of Bihar between 25°88' N latitude and 86°60' E longitude at an altitude of 41 meter above MSL. During the rice growing season, the total rainfall was 1155 mm. the maximum temperature fluctuated from 30.8 to 42.2 °C while the minimum temperature fluctuated from 12.5 to 25.2°C. The soil texture of the study area was clay loam. The experiment comprised of nine treatments *viz.,* T_1- General fertilizer recommendation, T_2- Farmer's practices, T_3-STCR with IPNS for a low target yield, T_4-STCR with IPNS for a medium target yield, T_5-STCR with IPNS for a high target yield, T_6-STCR without IPNS for a low yield target, T_7-STCR without IPNS for a medium yield target, T_5-STCR without IPNS for a high yieldtarget and T_9- Absolute control were conducted during 2018. The field experiment was laid out in a Randomized Block Design (RBD) with three replications. Before the start of experiment, soil samples were collected from 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 properties. Total N, P and K content of the economic plant parts *i.e.* grain and straw were obtained as per 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 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 NPK uptake (grain, straw and total) by rice under different treatments are given in Table 1 to 3. The maximum N uptake by grain and straw and total N uptake was recorded in STCR with IPNS for a high target yield (79.33, 41.40 and 120.73 kg ha^{-1}) Table 1 which is higher than all other treatments. The lowest N uptake by grain (25.40 kg ha^{-1}), straw (9.76 kg ha^{-1}) and total N uptake (35.16 kg ha^{-1}) was recorded in absolute control. Vijaykumar *et al.* (2017) also reported maximum nitrogen uptake (140.00 kg ha^{-1}) in the treatment STCR-IPNS-9 tha^{-1}. The highest P uptake in grainas well as total P uptake was found with the treatment STCR with

IPNS for high target yield (Table 2). The highest P-uptake by grain (17.23 kg ha^{-1}), straw (10.45 kg ha^{-1}) and total P (27.68 kg ha^{-1}) were recorded in this treatment (T_5) which is higher than the other treatments. The lowest value of P-uptake by grain (4.60 kg ha^{-1}), straw (7.60 kg ha^{-1}) and total P uptake (8.20 kg ha^{-1}) was recorded in absolute control treatment. The finding of Pachauri and Singh (2001) supported the results recorded in the present study. Maximum rice-grain K uptake (29.25 kg ha^{-1}), rice straw K uptake (106.63 kg ha^{-1}) was found in STCR with IPNS for a high target yield which was higher than the other treatments. The lowest grain, straw and total K uptake (7.27, 45.90 and 53.17 kg ha^{-1}), respectively were recorded with absolute control. Santhi *et al*. (2002) also supported the results of the present study. The favourable soil condition with STCR treatments might have paved the way for better absorption and mobilization in tune with the growth and activity of roots, which may have caused better production of dry matter and absorption of nutrients and increased grain and straw

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

Treatments	Grain	Straw	Total
T_1 (General fertilizer recommendation)	48.22	17.58	65.80
T_2 (General fertilizer recommendation)	38.79	20.03	58.32
T_3 (STCR with IPNS for a medium target yield)	37.65	37.54	75.19
T_4 (STCR with IPNS for a medium target yield)	63.91	37.38	101.29
T_5 (STCR with IPNS for a high target yield)	79.33	41.40	120.73
T_6 (STCR without IPNS for a high yield target)	66.96	29.32	96.28
T_7 (STCR without IPNS for a high yield target)	55.72	24.90	80.62
T_8 (STCR without IPNS for a high yield target)	75.67	35.79	111.46
T_9 (Absolute control)	25.40	9.76	35.16

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

Treatments	Grain	Straw	Total
T_1 (General fertilizer recommendation)	7.92	6.16	14.08
T_2 (General fertilizer recommendation)	6.27	5.62	11.89
T_3 (STCR with IPNS for a medium target yield)	12.65	8.42	21.07
T_4 (STCR with IPNS for a medium target yield)	11.59	9.00	20.59
T_5 (STCR with IPNS for a high target yield)	17.23	10.45	27.68
T_6 (STCR without IPNS for a high yield target)	12.11	7.50	19.61
T_7 (STCR without IPNS for a high yield target)	10.18	7.34	17.52
T_8 (STCR without IPNS for a high yield target)	14.44	9.43	23.87
T_9 (Absolute control)	4.60	3.60	8.20

Table 3 : Potassium uptake (kg ha^{-1}) by rice under different nutrition

Treatments	Grain	Straw	Total
T_1 (General fertilizer recommendation)	15.23	71.71	86.94
T_2 (General fertilizer recommendation)	13.82	64.93	78.75
T_3 (STCR with IPNS for a medium target yield)	24.37	81.72	106.09
T_4 (STCR with IPNS for a medium target yield)	21.27	82.67	103.94
T_5 (STCR with IPNS for a high target yield)	29.25	106.63	135.88
T_6 (STCR without IPNS for a high yield target)	23.17	82.58	105.75
T_7 (STCR without IPNS for a high yield target)	17.80	76.22	94.02
T_8 (STCR without IPNS for a high yield target)	27.69	91.40	119.09
T_9 (Absolute control)	7.27	45.90	53.17

yield and N, P and K contents, which were reflected in their higher uptakes Singh *et al.* (2021).

Conclusion:

To conclude soil test based IPNS for desired yield target of rice was developed and validated at Mandan Bharti Agriculture College, Agwanpur, Saharsa in the present study taking into account the nutrient requirement and contribution of N, P and K from various nutrient sources. The STCR with IPNS for a high yield target was effective as compared with other treatments. The study area will help to make guidelines for the amount of fertilizer used in rice cultivation.

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