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Soil Test Based Fertilizer Prescriptions under Integrated Plant Nutrient Supply for Hybrid Rice (cv. US – 382) in Alluvial Soils of Jorhat District of Assam, India

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A B S T R A C T

Field experiments were conducted during 2015-16 to gauge the fertilizer requirements for hybrid rice (cv. US-382) under Integrated Plant Nutrient Supply in Alluvial soils of Jorhat district of Assam. Following Ramamoorthy's Inductive cum targeted yield model, the nutrient requirement per quintal of grain production and contribution from soil, fertilizer and vermicompost (CVC) were evaluated for hybrid rice. The per cent contribution of nutrients from soil (CS), fertilizer (CF) and vermicompost (CVC) were found to be 35.15, 48.65 and 26.50 for N, 47.17, 23.06 and 12.08 for P_2O_5 and 60.32, 55.68 and 28.69 for K_2O respectively. The fertilizer prescription equations were developed and nomograms were formulated based on the equations for a range of soil test values and desired yield target for rice. Under NPK + VC @ 10.0 t ha $^{-1}$, 30, 11, 28 kg ha^{-1} of fertilizer N, P_2O_5 and K_2O, respectively could be saved for attaining yield target of 80 q ha^{-1} for hybrid rice as compared to NPK fertilizers alone.

Introduction

Fertilizer is one of the costliest inputs in agriculture. Its application is one of the most efficient and effective means of increasing agricultural profitability. The fertilizer prices have gone up and hence the use of right amount of fertilizer is fundamental for farm profitability and environment protection. Accordingly, at present, much attention is given to the integrated use of organic and mineral nutrition for meeting the economic needs of farmers as well as for sustainability of the production system. Soil test based fertilizer approach result in proficient fertilizer use and maintenance of soil fertility. Several approaches have been used for fertilizer recommendation based on chemical soil tests so as to attain maximum yield per unit of fertilizer use. Among these, the targeted yield approach Ramamoorthy *et al.*, (1967) gained popularity in India. The most comprehensive targeted yield approach of fertilizer application by incorporating soil test values, nutrient requirement of the crop, contribution of nutrients from soil, fertilizers and fixing yield targets is possible only through Soil Test Crop Response (STCR) approach. This method not only estimates soil test based fertilizer dose but also the level of yield the farmer can achieve with that particular dose. Targeted yield approach also provides

scientific basis for balanced fertilization of crop by creating the balance among the nutrients from the external sources and that from the soil. In India, rice (*Oryza sativa* L.) is the most important food grain crop contributing about 41.5% to the total food grain production of the country. Rice is the most important and staple food crop for more than two thirds of the population in Assam. The gross and net cropped area for rice in Assam is 3.84 and 2.75 million hectare (Mha), respectively. Winter (*Sali*) rice is the most important variety with productivity of 2.02 t ha^{-1} followed by autumn (*Ahu*) rice with a productivity of 1.36 t ha^{-1}in Assam. The total rice productivity in Assam is 2.11 t ha^{-1}. Rice fulfills 43 per cent of calories requirement of more than 70 per cent of the Indian population. The productivity of hybrid rice in Assam is 65 to 100 q ha^{-1}.One of the reasons for lower productivity is imbalanced fertilization of N, P and K nutrients. High cost of fertilizers is the persistent constraint for the farmers to apply adequate amount of fertilizers. Greater economy in fertilizer use can be made if fertilizers are applied under integrated plant nutrient supply system on the basis of soil test. Such studies are possible only through inductive-cum-targeted yield approach Ramamoorthy *et al.,* (1967). In Assam, this type of work has not yet been initiated. Hence, it is pertinent to develop soil test–crop response relationship for giving fertilizer recommendations under IPNS for desired yield targets for hybrid rice in Alluvial soils of Assam.

Materials and Methods

A field experiment was conducted based on STCR approach with hybrid rice variety (US – 382) in Assam Agricultural University Experimental Farm, Jorhat located at a latitude of 26°48’ N and longitude of 95°50’ E during Kharif season of 2015 - 16 in an acidic Alluvial soils. The soils of experimental site was sandy clay loam in texture and acidic in reaction having pH value of 5.10 and organic carbon of 0.60 per cent. The amount of available N, P_2O_5 and K_2O were 212.66, 32.95 and 118.47 kg ha^{-1}, respectively. Following the inductive methodology of Ramamoorthy *et al.,* (1967), the experiment was conducted in two phases. In the first phase, fertility gradient stabilizing experiment was conducted by raising rice (cv. Ranjit) as an exhaust crop during 2015 to minimise the interference of other soil and management factors affecting crop yield.

A STCR-test crop experiment Ramamoorthy *et al.,* (1967) composed of three gradient strips and four blocks which were fertilized with $N_0P_0K_0$, $N_1P_1K_1$ and $N_2P_2K_2$ levels. The recommended fertilizers ($N_1P_1K_1$) were 60, 20 and 40 kg ha^{-1} of N, P_2O_5 and K_2O, respectively. Consequently, in the second phase, after harvest of the exhaust crop, test crop experiment with hybrid rice (cv. US - 382) in sequence was conducted on the site of fertility gradient experiment during 2016. Hybrid rice (cv. US - 382) was transplanted on 25th July 2016 and harvested on 16th November 2016. Maximum and minimum temperature during this period ranged from 29.4 to 24.6 °C and 30.2 to 18.0 °C, respectively.

Altogether 24 treatments involving various selected combination levels of nitrogen (0, 30, 60, 90 and 120 N kg ha^{-1}), phosphorus (0, 20, 40, 80 kg P_2O_5 ha^{-1}), potassium (0, 40 and 80 kg K_2O ha^{-1}) and vermicompost (0, 2 and 3 t ha^{-1}) were made (Table 1). Vermicompost was incorporated in the soil 15 days prior to transplanting of rice. Whole of SSP and MOP were applied by broadcasting at the time of transplanting whereas, urea was applied in 2 splits, viz. as basal application, and panicle initiation stage. Pre-sowing soil samples were collected from each plot, before the superimposition of the treatments and were

analyzed for available N (alkaline potassium permanganate method), available P (Bray's-I method) and available K (ammonium acetate method). Using the data on crop yield, nutrient uptake, pre-sowing soil available nutrients and fertilizer doses applied, the basic parameters viz., nutrient requirement (NR), contributions of nutrient from soil (CS), fertilizer (CF) and vermicompost (CVC) were calculated as per procedure described by Ramamoorthy *et al.,* (1967) and Santhi *et al.,* (2002). These parameters were used for formulation of fertilizer prescription equations for deriving fertilizer doses and the soil test based fertilizer recommendations were prescribed in the form of aready reckoner for desired yield target of hybrid rice under NPK alone as well as NPK + vermicompost.

Results and Discussion

Soil available nutrients

Strip-wise range and mean soil test values of pre-sowing stage for available nutrients are given in (Table 2). The average content of available nutrients was found to increase with increasing fertility strips and the highest content was exhibited in strip L_2. The average available N content increased from 183.1 to 356.9 kg ha^{-1} as we move down the strips. This increase could be acceptable due to addition of double dose of NPK fertilizers resulting in higher root and shoot growth and thus increased in production of biomass. The highest available P_2O_5 value was found in strip L_2 followed by strip L_1 and it was the lowest in strip L_0.

Medium level of available P_2O_5 increased to high level indicating that fertility gradient in relation to P_2O_5 was created more intensely as compared to available N. Similar trend was also noted for available K_2O in different strips (Table 2). There was an increase 172.1 kg and 237.5 kg in the content of available K_2O ha^{-1} in the strip L_2 over strip L_0 for hybrid rice. This increase in availability could be due to graded dose of fertilizer application which has created fertility gradient in the same field. This result corroborates with the findings of Santhi *et al.,* (2002) and Chatterjee *et al.,* (2010).

Grain yield and nutrient uptake

Range and mean values of grain yield and nutrient uptake under different strips are given in (Table 3). Maximum yield for hybrid rice was obtained in strip L_2 followed by strip stripL$_1$and strip L_0in order. Similarly, strip-wise average nutrient uptake was in the order of strip L_2> strip L_1> strip L_0. The results indicated that a wide variability existed in the soil test values, grain yield and nutrient uptake which is a pre-requisite for calculating the basic parameters and fertilizer prescription equations for calibrating the fertilizer doses for specific yield targets Santhi *et al.,* (2002); Chatterjee *et al.,* (2010).

Basic parameters

The basic data viz., the nutrient requirement for producing one quintal of hybrid rice the per cent contributions of nutrients from soil, fertilizer and vermicompost were calculated by using the initial soil test values, crop yield and nutrient uptake, and are furnished in (Table 4). These basic parameters were used for formulating the fertilizer prescription equation for NPK alone as well as with vermicompost. The nutrient requirements for production of one quintal of hybrid rice were computed as 2.00 kg of N, 0.31 kg of P_2O_5 and 2.35 kg of K_2O. The results (Table 4) also indicated that the percent contribution of N from fertilizer source was higher than from soil. This might be due to split application of N at the critical stages of crop growth. Meena *et al.,* (2001) recorded similar type of higher efficiency of N for rice.

Table.1 Treatment details for test crop experiment

Strip I	Strip II	Strip III
$N_4 P_0 K_0 OM_3$	$N_0 P_0 K_2 OM_3$	$N_3 P_3 K_2 OM_3$
$N_1 P_1 K_0 OM_3$	$N_3 P_1 K_1 OM_3$	$N_4 P_2 K_1 OM_3$
$N_1 P_1 K_1 OM_3$	$N_3 P_1 K_2 OM_3$	$N_4 P_2 K_2 OM_3$
$N_0 P_3 K_0 OM_3$	$N_3 P_3 K_0 OM_3$	$N_4 P_3 K_1 OM_3$
$N_2 P_0 K_2 OM_3$	$N_3 P_3 K_1 OM_3$	$N_4 P_3 K_2 OM_3$
$N_0 P_0 K_0 OM_3$	$N_0 P_0 K_0 OM_3$	$N_0 P_0 K_0 OM_3$
$N_2 P_1 K_0 OM_3$	$N_3 P_3 K_2 OM_3$	$N_4 P_0 K_0 OM_3$
$N_2 P_1 K_1 OM_3$	$N_4 P_2 K_1 OM_3$	$N_1 P_1 K_0 OM_3$
$N_2 P_2 K_0 OM_2$	$N_4 P_2 K_2 OM_2$	$N_1 P_1 K_1 OM_2$
$N_2 P_2 K_1 OM_2$	$N_4 P_3 K_1 OM_2$	$N_0 P_3 K_0 OM_2$
$N_2 P_2 K_2 OM_2$	$N_4 P_3 K_2 OM_2$	$N_2 P_0 K_1 OM_2$
$N_0 P_0 K_0 OM_2$	$N_0 P_0 K_0 OM_2$	$N_0 P_0 K_0 OM_2$
$N_0 P_0 K_2 OM_2$	$N_4 P_0 K_0 OM_2$	$N_2 P_1 K_0 OM_2$
$N_3 P_1 K_1 OM_2$	$N_1 P_1 K_0 OM_2$	$N_2 P_1 K_1 OM_2$
$N_3 P_2 K_2 OM_2$	$N_1 P_1 K_1 OM_2$	$N_2 P_2 K_0 OM_2$
$N_3 P_3 K_0 OM_2$	$N_0 P_3 K_0 OM_2$	$N_2 P_2 K_1 OM_2$
$N_3 P_3 K_1 OM_1$	$N_2 P_0 K_1 OM_1$	$N_2 P_2 K_2 OM_1$
$N_0 P_0 K_0 OM_1$	$N_2 P_1 K_0 OM_1$	$N_0 P_0 K_0 OM_1$
$N_3 P_3 K_2 OM_1$	$N_2 P_1 K_1 OM_1$	$N_0 P_0 K_2 OM_1$
$N_4 P_2 K_2 OM_1$	$N_2 P_2 K_0 OM_1$	$N_3 P_1 K_1 OM_1$
$N_4 P_3 K_1 OM_1$	$N_2 P_2 K_1 OM_1$	$N_3 P_2 K_2 OM_1$
$N_4 P_3 K_2 OM_1$	$N_0 P_0 K_0 OM_1$	$N_3 P_3 K_0 OM_1$
$N_0 P_0 K_0 OM_1$	$N_0 P_0 K_2 OM_3$	$N_3 P_3 K_1 OM_1$
$N_4 P_0 K_0 OM_3$	$N_0 P_0 K_2 OM_3$	$N_0 P_0 K_0 OM_1$

Where,

N_0 = 0 kg ha^{-1} P_0 = 0 kg ha^{-1} K_0 = 0 kg ha^{-1} Vermicompost (OM_0) = 0.0 ha^{-1}

N_1 = 30 kg ha^{-1} P_1 = 20 kg ha^{-1} K_1 = 40 kg ha^{-1} Vermicompost (OM_1) = 2 t ha^{-1}

N_2 = 60 kg ha^{-1} P_2 = 40 kg ha^{-1} K_2 = 80 kg ha^{-1} Vermicompost (OM_2) = 3 t ha^{-1}

N_3 = 90 kg ha^{-1} P_3 = 80 kg ha^{-1}

N_4 = 120 kg ha^{-1}

Table.2 Initial soil test values before rice transplanting

	Available N (kg ha^{-1})		Available P_2O_5(kg ha^{-1})		Available K_2O(kg ha^{-1})	
	Range	Mean	Range	Mean	Range	Mean
Strip L_0	115.0 – 312.7	183.1	8.2 – 24.1	14.7	111.2 – 234.6	172.1
Strip L_1	140.3 – 362.9	271.0	14.4 – 32.3	25.3	142.2 – 269.4	219.9
Strip L_2	243.3 – 477.4	356.9	20.9 – 41.8	29.7	158.4 – 301.4	237.5

Table.3 Grain yield and nutrient uptake by rice under different strips

Particulars	Strip L_0		Strip L_1		Strip L_2	
	Range	Mean	Range	Mean	Range	Mean
Grain yield (q ha^{-1})	35.3– 67.9	50.9	34.9 – 74.0	53.7	37.9 – 74.7	57.3
N uptake (kg ha^{-1})	64.9-112.5	93.5	73.8 – 133.6	105.3	71.7 – 166.1	123.8
P_2O_5 uptake (kg ha^{-1})	7.9 – 17.9	12.2	9.6 – 26.6	15.7	16.9 – 26.8	20.6
K_2O uptake (kg ha^{-1})	39.4 – 150.4	108.4	70.2 – 168.7	126.9	62.6 – 162.2	135.8

Table.4 Basic parameters for hybrid rice (cv. US – 382)

Basic data	N	P	K
Nutrient requirement (kg q^{-1})	2.00	0.31	2.35
Per cent contribution from soil (CS)	35.15	47.17	60.32
Per cent contribution from fertilizer (CF)	48.65	23.06	55.68
Per cent contribution from vermicompost (CVC)	26.50	12.08	28.69

Table.5 Soil test based fertilizer prescription equations for targeted yield of rice

Particulars	Hybrid rice
	Fertilizer alone
FN	4.12 * T – 0.72 * STVN
FP_2O_5	1.33 * T – 2.05 * STVP
FK_2O	4.22 * T – 1.08 * STVK
	Fertilizers with vermicompost
FN	4.12 * T – 0.72 * STVN – 0.54 * M
FP_2O_5	1.33 * T – 2.05 * STVP – 0.52 * M
FK_2O	4.22 * T – 1.08 * STVK – 0.52 * M

Note: FN, FP, FK-Fertilizer N, P_2O_5, K_2O; T-Targeted yield; STVN, STVP, STVK - Soil test values for N, P_2O_5, K_2O; M-vermicompost

Table.6 Fertilizer recommendation (kg ha^{-1}) for yield targets of rice under NPK and NPK + vermicompost (10 t ha^{-1})

Soil test values	NPK alone			NPK + vermicompost (10 t ha^{-1})		
N: P_2O_5: K_2O (kg ha^{-1})	60 (qha^{-1})	70 (qha^{-1})	80 (qha^{-1})	60 (qha^{-1})	70 (qha^{-1})	80 (qha^{-1})
150: 10: 120	140: 56: 124	180: 69: 166	221: 82: 208	109: 45: 86	150: 58: 138	191: 71: 180
200: 15: 125	104: 45: 118	144: 58: 160	185: 71: 203	73: 34: 91	114: 47: 133	155: 60: 175
250: 20: 130	67: 34: 113	108: 47: 155	149: 60: 197	37: 23: 85	78: 36: 127	119: 49: 170
300 25: 135	00 : 23: 107	36: 36: 150	77: 49: 192	01 : 12: 80	42: 25: 122	83: 38: 164
350: 30: 140	00: 12: 102	00: 25: 144	41: 38: 186	00: 01: 74	02: 14: 117	47: 27: 159

The per cent contribution of nutrients from soil (CS) and fertilizer (CF) and vermicompost (CVC) were found to be 35.15, 48.65 and 26.50 for N, 47.17, 23.06 and 12.08 for P_2O_5 and 60.32, 55.68 and 28.69 for K_2O respectively (Table 4). The per cent contribution of P_2O_5 from soil was 47.17, while that from fertilizer was 23.06 per cent. This increase of soil phosphorus might be due to solubilization of the native P resulting in release of various organic acids during the decomposition of organic matter. The contribution of K_2O from fertilizer was high and this might be due to the interactive effect of high doses of N, P_2O_5 and primary effect of K_2O dose in the treated plots causing the release of soil K from unavailable to available form. Santhi *et al.,* (1999) also recorded similar potassium results in rice. The per cent contribution of N, P_2O_5 and K_2O from vermicompost was 26.50, 12.08 and 28.69 per cent, respectively. The data showed that contribution of K_2O was the highest followed by N and P_2O_5 (Table 4). This is because of luxury consumption of K_2O.

Fertilizer prescription equations for desired yield targets

Based on the basic parameters, fertilizer prescription equations for targeted yield of hybrid rice under NPK alone as well as NPK + vermicompost were calculated and are furnished in (Table 5). On the basis of these equations, a ready reckoner was prepared for making fertilizer recommendations for different soil test values to meet specified yield targets of rice under NPK alone and NPK + vermicompost (Table 6).

Based on the fertilizer prescription equations for hybrid rice for NPK alone, fertilizer N recommendation was found in the range from 41 to 221 kg ha^{-1}, fertilizer P_2O_5 from 38 to 82 kg ha^{-1} and fertilizer K_2O from 186 to 208 kg ha^{-1} for attaining a target yield of 80 q ha^{-1} for hybrid rice (Table 6). When vermicompost@ 10 t ha^{-1} was applied along with NPK fertilizers, fertilizer requirement of N, P_2O_5 and K_2O was found in the range from 47 to 191 kg ha^{-1}, 27 to 71 kg ha^{-1} and 159 to 180 kg ha^{-1}, respectively at the same level of soil test values. Under NPK + VC @ 10.0 t ha^{-1}, 30, 11, 28 kg ha^{-1} of fertilizer N, P_2O_5 and K_2O, respectively could be saved for attaining yield target of 80 q ha^{-1} for hybrid rice as compared to NPK fertilizers alone. Similar results were also reported by Santhi *et al.,* (2002).

The findings of the study revealed that the fertilizer prescription equations developed under NPK alone and NPK + vermicompost could be used in Jorhat district of Assam as effectual guide for achieving the desired yield target of rice and maintenance of soil fertility. The fertilizer application rates could be shortened with conjoint use of NPK fertilizer with vermicompost @ 10 t ha^{-1} over NPK fertilizer alone. Therefore, this practice of fertilizing crops on the basis of yield targets is accurate, significant and eco-friendly, and it is required to make it popular among farmers to obtain higher productivity and profitability.

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References

Chatterjee, D., Srivastava, A. and Singh, R.K. (2010) Fertilizer recommendations based on targeted yield concept involving integrated nutrient management for potato (*Solanum tuberosum*) in Tarai belt of Uttarakhand. *Indian Journal of Agricultural Sciences* 80, 1048-1053.

Meena, M., Ahmed, S.R., Reddy, K.C. and Rao, Prasad, B.R.C.P. (2001) Soil test crop response calibration studies on onion (*Allium cepa*) in Alfisols of Andhra Pradesh, India. *Journal of the Indian Society of Soil Science* 49, 709-713.

Ramamoorthy, B., Narasimham, R.L. and Dinesh, R.S. (1967) Fertilizer application for specific targets of Sonara-64. *Indian Farming* 17, 43-45.

Santhi, R., Nateson, R. and Selvakumari, G. (2002) Soil test crop response correlation studies under integrated plant nutrition system for onion (*Allium cepa* L. var. *Aggregatum*) in Inceptisols of Tamil Nadu. *Journal of the Indian Society of Soil Science* 50, 489-492.

Santhi, R., Selvakumari, G. and Perumal, R. (1999) Soil Test based fertilizer recommendations under integrated plant nutrition system for rice-rice-pulse cropping sequence. *Journal of the Indian Society of Soil Science* 47, 288-294.

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