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Evaluation of STCR Targeted Yield Approach on Pumpkin (*Cucurbita moschata*) Under Rice-Pumpkin Cropping System

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ABSTRACT: *A field experiment was conducted under rice- pumpkin cropping system on a Vertic Ustochrepts soils of Orissa to formulate the fertilizer prescription equation based on targeted yield of pumpkin. Nutrient requirement for production of one quintal of pumpkin was found to be 1.75, 0.56, and 1.74 kg N, P_2O_5, and K_2O respectively. Efficiency of soil nutrient was 45%, 57%, 47% of N, P_2O_5, and K_2O while that of fertilizer N, P_2O_5 and K_2O were 36%,21%, and 86% . It was observed from the multiple regression equations that initial soil phosphorus, uptake of N & P and fertilizers N, P, K made significant contribution towards the fruit yield of pumpkin. The results showed that Fertilizer rates increased as yield targets of pumpkin increased and the fertilizer rates decreased as the initial soil test level increased. The targeted yield approach was also found superior to fertilizer doses prescribed by soil testing laboratories.*

Key words: *Pumpkin, Vertic Ustrochrepts, Targeted yield.*

INTRODUCTION

Pumpkin is one of the most important vegetable crop of Orissa known as poor man's vegetable grown in both rainy and summer season. The pumpkin cultivation in Orissa is becoming more and more popular because of low cost of production; due to which market price is also low and hence this is called as poor man's vegetable.

Soil test based fertilizer use is must for sustainable agriculture (Rao and Shrivastava, 2000). The fertilizer application by the farmers in the field without knowledge of soil fertility status and nutrient requirement of different crops usually leads to adverse effect on soil as well as crops by way of nutrient deficiency or toxicity due to over use or inadequate use of fertilizers. In this regard, targeted yield approach has been found to be beneficial which recommends balanced fertilization considering available nutrient status in the soil and the crop needs. Targeted yield approach was first developed by Troug (1960) Ramamoorthy *et al*. (1967) established theoretical basis and experimental technique to suit it to Indian conditions. They showed linear relationship between grain yield and nutrient uptake. For obtaining a given yield, needed fertilizer can be estimated considering efficiency of soil and fertilizer nutrient. The targeted yield approach circumvents the effect of soil heterogenity, management practices and climatic conditions on the response behaviour of crops through native and fertilizer nutrients. Besides balanced nutrition of growing crops, the approaches give due consideration to soil fertility and strikes a real balance between the nutrients already available in the soil and those required by the crops to achieve a predetermined yield target. This will help to maintain soil fertility. The present studies were therefore, aimed at fertilizer recommendation based on soil test for yield targets of pumpkin under rice – pumpkin cropping system of Inceptisols of Orissa.

MATERIALS AND METHODS

A field experiment was conducted at the E- block of the Farm of Central Research Station of Orissa University of Agriculture and Technology, Bhubaneswar on a Vertic Ustrocherpts soil during 2005-2006. For this experiment, the whole field (0.3 ha) was divided into four equal blocks during *kharif* to create fertility gradient strip (L_0, $L_{1/2}$, L_1 and L_2) and rice (cv Khandagiri) was allowed to grow upon addition of 25% dose, full dose of P and K at the rate of no N, P, K (L_0; control) in Block-I, $N_{40}P_{20}K_{20}$ ($L_{1/2}$; half of the recommended dose) in Block-II, $N_{80}P_{40}K_{40}$ (L_1; full recommended dose) in Block-III, $N_{160}P_{80}K_{80}$ (L_2; twice the recommended dose) in Block-IV. After harvest of the rice crop, these four Blocks (B-I to B-IV) were ploughed and each block was divided into 24

subplots (19 treatment + 5 absolute control) resulting in 96 (24 × 4) plots. On these sub plots, pumpkin (cv Guamal) was grown in *rabi* season. For pumpkin the graded doses of N were 40, 80, 120, and 160, P_2O_5 were30, 70, 105, and 140 and that of K_2O were 0, 40, 80, 120 kg ha^{-1} respectively. Soil samples were collected from each plot at a depth of 0-15 cm before the application of fertilizer to rice and after the harvest of both gradient (rice) and test (pumpkin) crop. The soil samples were analyzed for available N (Subbiah and Asija, 1956), P (Brays *et al*., 1954) and K (Jackson, 1973). After harvesting of pumpkin, plant sample were also collected from each plot, Yield data were recorded and analysed for N, P, K (Jackson, 1973) contents and their uptake values were computed.

The experimental site was a medium land, sandy loam in texture both surface and subsurface layers. Soil was moderately acidic (pH ranges from 5.39 to 6.31) in reaction and low in O.C (varies from 0.37% to 0.59%). CEC of the surface soil was 4.5 Cmol(P^+)kg^{-1} with 65.11 % base saturation. The soil was classified as fine, mixed, hyperthermic family of Vertic Ustochrepts.

RESULTS AND DISCUSSION

Fruit yield and nutrient uptake

Data presented in table-indicated that the fruit yield, plant yield and nutrient uptake of pumpkin was highest in L_1 strips from treatment, T_{20} with the fertilizer dose of 120 : 105 : 80 Kg N : P_2O_5 : K_2O per hectare. The range and mean average yield of pumpkin, soil test values and NPK uptake in different fertility gradient strips are presented in Table 1. It was observed that with increase in graded doses of fertilizer, the pumpkin fruit yield and NPK uptake increased with increase in the fertility gradient strips upto L_1 and then it decreased. The decrease yield of fruit and nutrient uptake in fertility gradient strip L_2(twice the recommended dose) may be due to use of over doses of nitrogen to pumpkin which causes excessive vegetative growth and more susceptible to insect, pest and disease. However, soil test values of available NPK were increased with fertility gradient upto L_2.

The parameters needed for formulating fertilizer prescription equation for targeted yield were experimentally obtained for a given soil type-crop-agro climatic condition. These parameters were Nutrient requirement (NR), Soil efficiency (CS) and Fertilizer efficiency (CF).

These parameters are then transferred to a workable equation as follows.

$$FD = \frac{(NR \times 100 \times T)}{CF} - \frac{(CS \times STV)}{CF}$$

Where,

FD = Fertilizer dose (kg ha^{-1}),
T = Yield Target (q ha^{-1})
STV = Soil Test value for available NPK kg ha^{-1}.

Based on these parameters, the fertilizer prescription equation for Pumpkin (cv Guamal) has been formulated from the data of soil test value, yield of pumpkin and uptake of nutrients (Table 2). Pumpkin crop required 1.75 kg N, 0.56 kg P_2O_5, and 1.74 kg K_2O q^{-1} production. Contribution of N, P_2O_5 ,and K_2O was estimated from soil and fertilizer sources was 45%, 57%, 47% and 36%,21% , 86% respectively. The results indicate that nutrient contribution from K_20 fertilizer for pumpkin was more (86%). This high value of K due to interaction effect of higher doses of N, P and the primary effect of starter K doses in the treated plots, which might have caused the release of soil potassium form resulting in the higher uptake from the native soil source by the crop (Ray *et al*., 2000). Similar type of higher efficiency potassic fertilizer was also reported for rice by Ahmed *et al*., (2002) in alluvial soil, for maize by Reddy *et al*., (2000) in Inceptisols.

Table 1
Range and average yield of Pumpkin (cv. Guamal), Soil test values and NPK total uptake in different fertility gradient strips

		Fertility gradient strips			
Particulars		L_0	$L_{½}$	L_1	L_2
Fruit yield	Range	1427-5449	1821-6556	2594-8546	2262-7445
(Kg ha^{-1})	Average	3253	3984	5047	4516
Av. N	Range	128.9-144.6	145.8-156.7	157.6-166.3	168.2-175.2
(Kg ha^{-1})	Average	137.6	150.8	161.5	171.6
Av. P	Range	14.6-18.2	18.7-22.4	22.9-26.3	26.9-30.0
(Kg ha^{-1})	Average	15.6	20.5	24.4	28.5
30Av.K	Range	64.6-74.0	76.4-84.8	58.9-95.3	95.3-107.3
(Kg ha^{-1})	Average	69.8	80.2	90.6	100.2
N uptake	Range	32.8-72.6	46.9-87.8	51.0-100.7	48.1-96.9
(Kg ha^{-1})	Average	55.87	68.36	78.93	75.35
P uptake	Range	10.0-33.6	10.7-41.3	28.8-52.3	11.9-46.5
(Kg ha^{-1})	Average	18.7	21.6	28.3	26.1
K uptake	Range	33.2-117.4	36.4-125.6	39.3-137.4	37.1-132.0
(Kg ha^{-1})Average		64.3	71.6	79.2	75.9

Table 2
The fertilizer Prescription equation developed by AICRP on STCR , BBSR for pumpkin

	Basic data			
Nutrients	*NR(kg/q)*	*CS(%)*	*CF(%)*	*Targeted yield equation*
N	1.75	45.0	36.0	FN = 4.94 T-1.25 SN
P_2O_5	0.56	57.0	21.0	$FP_2O5 = 2.67T-2.71\ SP_2O_5$
K_2O	1.74	47.0	86.0	$FK_2O = 2.02\ T-0.55\ SK_2O$

Ramamoorthy *et al*., (1967) reported that economics of fertilizer application was dependent on these parameters. It was on the basis that prescription method of fertilizer recommendation for targeted yield of corn was advocated by Troug (1960).

Fertilizer prescription equation were transformed into ready reckoner for requirement of fertilizer NPK for different yield targets of pumpkin on soils of Orissa with varying soil test values (Table 3). Fertilizer rates increased as yield targets of pumpkin increased and the fertilizer rates decreased as the initial soil test level (175 : 35 : 140) increased. The multiple regression equation of interaction of different factors (soil nutrient, uptake and fertilizer dose) is presented in Table 4. Multiple regression equation of the average yield of the four fertility gradient strips with respect to initial soil nutrient (N, P, and K), uptake of nutrients and applied fertilizer dose were calibrated. It is obvious from the equations that initial soil phosphorus, uptake of N & P and fertilizers N, P, K made significant contribution towards the fruit yield of pumpkin.

By using these fertilizer adjustment equations, if initial soil test values are known then we can prescribe fertilizer dose for targeting specific yield of pumpkin which is superior to blanket application of fertilizer. Similar results were reported by Mishra *et al*., (2008) in inceptisols of Orissa for rice and sesamum. Kadam and Sonar, (2006) also found that targeted yield approach was superior as per soil treatment. Fertilizer adjustment for specific yield target will not only maintain soil health for sustainable crop production but it will also enable the farmers to reduce the use of costly fertilizer input depending on financial condition of the farmers of Orissa.

Table 3
Fertilizer Prescription for pumpkin based on targeted yield concept

InitialStatus	*25(q/ha)*	*35(q/ha)*	*45(q/ha)*	*55(q/ha)*
80:15:60	24:16:23	75:53:38	122:80:58	171:106:78
100:20:80	9:2:7	48:39:27	97:66:47	147:92:67
125:25:100	12:26:6	12:26:20	66:52:35	116:79:86
150:30:120	Nil	0:10:5	35:40:25	84:66:48
175:35:140	Nil	Nil	4:25:14	53:52:34

Table 4
Multiple Regression Equations

1. Y = - 472.92.17 + 77.08 SN + 868.70 SP + 237.12 SK, R = 0.668**
2. Y = - 918.88 + 39.57** UN + 69.87** UP + 9.80 UK, R = 0.992**
3. Y = - 2180.88 + 11.71** FN + 14.30** FP + 9.33** FK, R = 0.988**
4. Y = - 2520.13 + 2.13 SN + 24.69 SP + 1.62 SK + 26.08 UN + 55.22* UP + 115.26 UK + 2.34 FN + 2.19 FP + 2.07 FK, R = 0.993**

Where Y = Yield, SN, SP, SK = Initial Soil Test Values (UN, UP, UK) = Uptake of Nutrients, FN, FP, FK = Applied Fertilizer

Treatment Details

Plot size		5.5 × 4.0 m
Spacing		1.5 × 1.5m
T_1 – N_0 P_0 K_0		T_{13} – N_0 P_0 K_0
T_2 – N_1 P_1 K_0		T_{14} – N_3 P_0 K_0
T_3 – N_1 P_1 K_1		T_{15} – N_3 P_1 K_1
T_4 – N_0 P_0 K_0		T_{16} – N_3 P_2 K_2
T_5 – N_2 P_0 K_0		T_{17} – N_3 P_3 K_0
T_6 – N_2 P_0 K_1		T_{18} – N_0 P_0 K_0
T_7 – N_2 P_1 K_0		T_{19} – N_3 P_3 K_1
T_8 – N_2 P_1 K_1		T_{20} – N_3 P_3 K_2
T_9 – N_0 P_0 K_0		T_{21} – N_4 P_4 K_2
T_{10} – N_0 P_2 K_0		T_{22} – N_4 P_3 K_3
T_{11} – N_2 P_2 K_1		T_{23} – N_4 P_4 K_2
T_{12} – N_2 P_2 K_2		T_{24} – N_4 P_4 K_3
N Level (Kg/ha)	*P level (Kg/ha)*	*K Level (Kg/ha)*
N_0 – 0	P_0 – 0	K_0 – 0
N_1 – 40	P_1 – 35	K_1 – 40
N_2 – 80	P_2 – 70	K_2 – 80
N_3 – 120	P_3 – 105	K_3 – 120
N_4 – 160	P_4 – 140	

Treatment details in rice

Treatment	*Fertilizer dose*
Lo	Control (No, N, P, K)
L1/2	40 : 20 : 20kg N : P2O5 : K2O/ha (half recommended dose for rice)
L1	80 : 40 : 40 kg N : P2O5 : K2O /ha (Recommended doses for rice)
L2	160 : 80 : 80 kg N : P2O5 : K2O/ha (Recommended dose rice)

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