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Soil Test Based Fertilizer Recommendation for Targeted Yield of Pumpkin (*Cucurbita moschata*) under Rice-Pumpkin Cropping System in an Inceptisol of Orissa

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Abstract

A field experiment was conducted during 2005-2006 to study the response of pumpkin (*Cucurbita moschata*) to graded doses of fertilizer and to formulate soil test based fertilizer recommendation for targeted yield of pumpkin under rice-pumpkin cropping system in a lateritic soil. Before taking up the experiment, detailed morphological and physico-chemical study of a typifying pedon of the experimental site was made. In *kharif* season four fertility gradient strips were created (L_0, $L_{1/2}$, L_1 and L_2) by application of no fertilizer, half the recommended dose of fertilizer (40:20:20 kg N:P_2O_5 : K_2O kg/ha), recommended dose (80:40:40 kg N : P_2O_5 : K_2O/ha) and twice the recommended dose (160:80:80 kg N : P_2O_5 : K_2O/ha) for rice, respectively. Rice (cv Khandagiri) was grown in these four fertility gradient stripes in *kharif* season. After harvest of rice crop, each of these fertility gradient strip were divided into 24 sub-plots and super imposed with 19 different combinations of N, P, K and five absolute controls plots. Pumpkin (cv Guamal) was taken up during *rabi* season. For pumpkin, the graded dose of N was 40, 80, 120 and 160 that of P_2O_5 was 35, 70, 105 and 140 and that of K_2O was 0, 40, 80, 120.
Key words : Pumpkin, Inceptisol, Targeted yield.

Fertilizer is one of the most important agricultural input for increasing the crop production. Soil testing is now accepted as an important tool for the recommendation of the fertilizer doses for various crops in India. But soil testing would become a more useful tool only when it is based on intimate knowledge of soil-crop-variety fertilizer claimate management interaction for a given situation (1). According to Rao and Srinivas (2) soil test based fertilizer use is a must for sustainable agriculture. 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 and 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 Truog (3). Ramamoorty et al. (4) established theoretical basis and experimental technique to suit it to Indian conditions. They showed linear relationship between yield and nutrient uptake. For obtaining a given yield, fertilizer needed can be estimated considering efficiency of soil and fertilizer nutrients. Though fertilizer prescription equation has been developed for field crops, no such equation was available for vegetable crops for Orissa state (5, 6). Therefore an attempt was made in the present investigation to formulate fertilizer prescription equation for targeted yield of pumpkin considered as a poor man's vegetable of farmers for its low cost for Orissa condition.

Methods

The experimental site (0.3 ha) was divided with four equal blocks during *kharif* to create fertility gradient strip and rice (cv Khandagiri) was allowed to grow upon addition of 25% of dose of N, full dose of

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

Particulars		Fertility gradient strips L_0	$L_{1/2}$	L_1	L_2
Grain yield (kg/ha)	Range	1427—5449	1821—6556	2594—8546	2262—7445
	Average	3253	3984	5047	4516
Av N (kg/ha)	Range	128.9—144.6	145.8—156.7	157.6—166.3	168.2—175.2
	Average	137.6	150.8	161.5	171.6
Av P (kg/ha)	Range	14.6—18.2	18.7—22.4	22.9—26.3	26.9—30.0
	Average	15.6	20.5	24.4	28.5
30 Av K (kg/ha)	Range	64.6—74.0	76.4—84.8	58.9—95.3	95.3—107.3
	Average	69.8	80.2	90.6	100.2
N uptake (kg/ha)	Range	32.8—72.6	46.9—87.8	51.0—100.7	48.1—96.9
	Average	55.87	68.36	78.93	75.35
P uptake (kg/ha)	Range	10.0—33.6	10.7—41.3	28.8—52.3	11.9—46.5
	Average	18.7	21.6	28.3	26.1
K uptake (kg/ha)	Range	33.2—117.4	36.4—125.6	39.3—137.4	37.1—132.0
	Average	64.3	71.6	79.2	75.9

P and K at the rate of no N, P, K in Block-I, $N_{40}P_{20}K_{20}$ (half recommended dose) in block-II, $N_{80}P_{40}K_{40}$ (recommended dose) in Block-III and $N_{160}P_{80}K_{80}$ (twice the recommended dose) in block-IV. After harvest of rice crop, soil samples were collected along with grain and straw samples for chemical analysis based on the methods of Jackson (7).

Then these four blocks (B_1 to B_4) were ploughed and each block was divided into 24 sub-plots. Initial soil samples were collected from each plot for analysis. Our of 24 sub-plots 19 plots were for imposition of treatments and 5 absolute controls. On these sub-plots, pumpkin (CV Guamal) was grown in *rabi*. N levels were 0, 40, 80, 120, 160 P levels were (0, 35, 70, 105, 140), and K levels (0,40, 80, 120). After harvest of pumpkin, post-harvest soil and plant samples were collected and yield data were recorded for analysis.

The experimental site was a medium land, sandy loam in texture both surface and subsurface layers. Soil was moderately acidic (pH 5.39) in reaction and low in OC (0.37%). CEC of the surface soil was 4.5 cmol (p^+)/kg with 65.11% base saturation. The soil was classified as fine, mixed, hyperthermic family of Vertic Ustochrepts.

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

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_2O_5=2.67T—2.71 SP_2O_5
K_2O	1.74	47.0	86.0	FK_2O=2.02 T—0.55 SK_2O

Results and Discussion

It was observed that with increase in graded doses of fertilizer the pumpkin fruit yield increased with increase in the fertility gradient strips (L_0, $L_{1/2}$, L_1 and L_2 respectively) (Table 1).

The parameters needed for formulating fertilizer prescription equation for targeted yield were experimentally obtained for a given soil type-crop-agroclimatic condition. These parameters were nutrient requirement, soil efficiency (CS) and fertilizer efficiency (CF).

$$\text{Nutrient requirement (NR) kg/q} = \frac{\text{Uptake of nutrients (kg/ha)}}{\text{Fruit yield (q/ha)}}$$

Table 3. Fertilizer prescription for pumpkin based on targeted yield concept.

Initial status	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

Percent contribution from soil available nutrient

$$(CS) = \frac{\text{Total uptake in absolute control plot (kg/ha)}}{\text{Soil test value of nutrients in control plot (kg/ha)}}$$

Percent contribution from fertilizer nutrient

$$(CF) = \frac{\text{Total uptake in treated plot (kg/ha)} - \text{Soil test value} \times Cs}{\text{Fertilizer applied (kg/ha)}}$$

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, T=Yield target (q/ha), STV = Soil test value.

Based on these parameters the fertilizer prescription equation for pumpkin (cv Guamal) was formulated from the data of soil test value, yield of pumpkin and uptake of nutrients (Table 2).

Fertilizer prescription equation were transformed into ready reckoner for requirement of fertilizer NPK for different yield targets of pumkin on soils of Orissa with varying soil test values (Table 3). Fertilizer rates increased with increasing yield targets of pumpkin and decreased with increase in the soil test values. 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, K), uptake of nutrients and applied fertilizer dose were calibrated. It is obvious from the equations that initial soil phosphorus, uptake of N and P and fertilizers N, P, K made significant contribution towards the fruit yield of pumpkin.

Conclusion

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. These 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.

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