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Formulation of targeted yield equations for cucumber (C*ucumis sativus*) under rice-vegetable cropping system in *Inceptisols*

JYOTIRMAYEE JENA, SUBHASHIS SAREN*, PRIYANKA NAYAK, ANTARYAMI MISHRA AND PRADIP DEY[1]

Department of Soil Science and Agricultural ChemistryOdisha University of Agriculture and Technology, Bhubaneswar 751 003, Odisha

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ABSTRACT

Three fertility gradient stripes were created in Inceptisols of Odisha by applying no fertilizer, recommended dose of fertilizer (RDF) and double of the RDF and rice was grown during kharif, 2018 in the Central Research Farm of OUAT, Bhubaneswar. These three stripes were subdivided into 24 sub-plots and cucumber was grown with different graded doses of fertilizers and manures during rabi, 2018-19. Initial soil nutrient status, nutrient uptake, nutrient requirement, soil efficiency, fertilizer efficiency, organic matter efficiency and yield data were recorded. The highest cucumber yield (118.2 q ha^{-1}) was obtained with 70 kg N, 40 kg P_2O_5 and 100 K_2O ha^{-1}. Fertilizer prescription equations were derived for targeted yield of cucumber in Inceptisols of Odisha. Nutrient requirement for producing of one quintal of cucumber yield on this technique is 0.44, 0.15, and 0.63 kg N, P_2O_5 and K_2O. This enables the farmers to make the most efficient and profitable use of the costly inputs in farming.

Keywords: Cucumber, fertilizer prescription equations, Inceptisols, targeted yield, STCR-IPNS

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is a widely-cultivated vegetable crop which belongs to the *Cucurbitaceae* family. In a 100-gram reference serving, raw cucumber (with peel) contains 95% water, 4% carbohydrates, 1% protein, and negligible amount of fat. It provides 67 kJ of energy and supplies less amount of micronutrients. It is a good source of vitamins A, C and K. Application of fertilizers increases crop yield, but application of too less or too much fertilizer causes suffering due to malnutrition or can cause wastage and increases cost of cultivation and can reduce the farm profit. Thus, there is a need for soil test crop response (STCR) study which can recommend the fertilizer application on the basis of initial soil test values and desired yield target. Ramamoorthy *et al*., (1967) established the theoretical basis and experimental technique for Indian conditions. Fertilizer application on the basis of targeted yield showed higher yield, net benefit and B:C ratio which indicate superiority over general fertilizer recommendation (Pande and Singh, 2016). This approach is considered as a soil-and fertilizer-based precision farming strategy to meet nutrient demands for a specified yield. No such equation has been developed for cucumber in various soil fertility status in *Inceptisols.* Hence, the present study was initiated using cucumber as test crop.

MATERIALS AND METHODS

The field experiment was conducted under AICRP on Soil Test Crop Response (STCR) experimental field at Central Research Farm of Odisha University of Agriculture and Technology, Bhubaneswar (20^{0}15.937'N latitude and 85^{0}47.851'E longitude) during the year 2018-19. The experimental site was classified as fine, mixed, hyperthermic family of *Vertic Haplustepts.* The site is characterized by hot and humid climate, medium land, sandy loam texture both in surface and subsurface layers. Soil was moderately acidic (pH 5.39) in reaction, medium in organic carbon content (5.8 g kg^{-1}), low in available N (143.5 kg ha^{-1}), medium in available P_2O_5 (51.0 kg ha^{-1}) and medium in available K_2O (162.8 kg ha^{-1}) content. The experimental site (0.3 ha) was divided into three equal blocks to create different fertility gradient stripes. Rice (*cv. Lalat*) was grown in three fertility gradient stripes, viz. without application of N, P, K in Block I, $N_{80}P_{40}K_{40}$ (recommended dose) in Block

Corresponding author email: saren.soil@yahoo.co.in, ICAR-Indian Institute of Soil Science, Bhopal (M.P.)

II and $N_{160}P_{80}K_{80}$ (double of the recommended dose) in Block III; thus, three fertility gradient stripes B I, B II and B III were created. During *rab*i, 2018-19 these three blocks were ploughed and each fertility gradient strip was divided into 24 sub-plots (4m x 3.35m each) and different levels of fertilizer was applied at different combinations of NPK (Table 1). Initial soil samples were collected from each sub-plot for initial nutrient status. Also, fruit and biomass samples were collected for chemical analysis. Available soil N was analysed by alkaline permanganate method (Subbiah and Asija, 1956), available soil P by Bray's No. 1 method (Bray and Kutrz, 1945) and soil available K by neutral normal ammonium acetate method (Hanway and Heidel, 1952). In each strip, out of 24 sub-plots, 21 plots were superimposed with different graded doses of N, P, K; two plots were given FYM at 5 t and 10 t ha^{-1} respectively and one plot was kept as absolute control. Fruit and biomass samples from each sub-plot were collected and processed after proper drying for laboratory analysis to study the nutrients uptake. Total plant N content was analysed by micro-kjeldahl method (Jackson, 1973), total plant P and K were determined by digesting the sample with di-acid followed by determination of P by spectrometer and flame photometer for K content. Yield data were also noted down to study the nutrient uptake followed by formulation of fertilizer prescription equations for specific yield target. The basic parameters for formulating fertilizer prescription equations for targeted yield were experimentally obtained for a given soil type-crop-agroclimatic condition. Nutrient requirement (NR), soil efficiency (Cs) and fertilizer efficiency (Cf) were determined following the procedure reported earlier. The available soil nutrient content is considered while estimating soil efficiency and fertilizer efficiency (Ramamoorthy *et al*., 1967).

Table 1: Levels of nitrogen, phosphorus, potassium and FYM used in experiment

N level (kg ha^{-1})	P_2O_5 level (kg ha^{-1})	K_2O level (kg ha^{-1})	FYM (t ha^{-1})
0	0	0	0
30	20	50	5
50	30	75	10
70	40	100	-

RESULTS AND DISCUSSION

The experimental result showed a linear relationship between applied plant nutrients and yield of cucumber with highest yield in B III (103.6 q ha^{-1}) and lowest yield in B I (66.8 q ha^{-1}) as it did not receive any fertilizer. It was also observed that the uptake of N, P and K increased with increase in the fertility status (from B I to B III strip). The mean uptake of N was 26, 40.4 and 47.1 kg ha^{-1}; that of P was 9.3, 13, 18 kg ha^{-1} and mean K uptake was 40.9, 52.1 and 69.2 kg ha^{-1} in B I, B II and B III stripes, respectively by cucumber (Table 2). The results also showed that uptake of nutrients were correlated positively with fruit yield and biomass yield of cucumber. Similar finding was also reported by Bagavathi *et al.* (2019) and Luthra *et al.* (2022).

Table 2: Range and average yield of fruit and biomass, soil test values and NPK uptake in different fertility gradient stripes

Parameter	Block-I		Block -II		Block-III	
	Range	Mean ±SEm	Range	Mean ±SEm	Range	Mean ±SEm
Fruit yield (q ha^{-1})	54.9-75.0	66.8 ±0.73	70.1-93.1	83.9±0.75	88.5-118.2	103.6±0.83
Biomass yield (q ha^{-1})	29.8-54.5	41.2±1.19	35.4-58.8	45.7±1.07	41.8-67.8	55.7±1.06
Av. N (kg ha^{-1})	110-129	116.8±0.43	128-159	146.8±0.55	156-181	166.8±0.59
Av. P_2O_5 (kg ha^{-1})	28-41	34.1±0.66	38.0-55.0	44.7±0.64	65-81	74.3±0.48
Av. K_2O (kg ha^{-1})	120-138	127.8±0.45	151-171	160.6±0.50	190-210	199.9±0.42
N uptake (kg ha^{-1})	15.8-41.3	26.0±1.50	24.5-53.8	40.4±1.72	31.2-68.2	47.1±1.82
P uptake (kg ha^{-1})	6.2-13.2	9.3±0.83	7.5-20.4	13.0±1.23	10.1-26.7	18.0±1.44
K uptake (kg ha^{-1})	32.1-48.5	40.9±0.80	37.8-67.1	52.1±1.28	57.1-82.3	69.2±0.86

The nutrient requirement (NR) for producing one quintal of cucumber was 0.44kg N, 0.15 kg P_2O_5 and 0.13kg K_2O. Soil efficiency (Cs) was found to be 16, 18 and 26%; fertilizer efficiency (Cf) was 32, 19 and 19 % and organic matter efficiency (Co) was 4.0, 2.0 and 6 % for

Table 3: Basic data required for fertilizer adjustment equations of cucumber in *Inceptisols.*

Basic data	N	P_2O_5	K_2O
Nutrient requirement (kg q^{-1})	0.44	0.15	0.63
Soil efficiency (Cs, %)	16	18	26
Fertilizer efficiency (Cf, %)	32	19	19
Organic matter efficiency (Co, %)	4.0	2.0	6.0

N, P_2O_5 and K_2O, respectively (Table 3). The results showed that contribution of potassium from soil source was higher as compared to the fertilizer source. This may be due to the release of soil potassium from the native source which resulted in the higher uptake of K from soil source by the crop. Similar result was also reported by Singh *et al*. (2021).

Targeted yield equations for cucumber (*cv. Manini*) thus formulated without and with application of farm yard manure are presented in Table 4. In the equations, the yield target (T) is to be fixed based on the yield potential of the crop and input supplying capacity, the SN, SP_2O_5 and SK_2O values stand for available soil nitrogen, soil phosphorus and soil potassium respectively of the soil.

Table 4: Fertilizer adjustment equations for cucumber

Fertilizer dose	Without FYM	With FYM
Nitrogen (kg ha^{-1})	FN = 1.37 T - 0.5 S N	FN = 1.37 T - 0.5 S N - 0.13 O N
P_2O_5 (kg ha^{-1})	FP = 0.78 T - 0.94 S P	FP = 0.78 T - 0.94 S P - 0.11 O P
K_2O (kg ha^{-1})	FK = 3.31 T - 1.36 S K	FK = 3.31 T - 1.36 S K - 0.31 O K

The O N, O P_2O_5 and O K_2O values stand for nitrogen, phosphorus and potassium through organic sources. A ready reckoner for fertilizer doses can be used for achieving a specific yield target at different soil fertility status (Table 5). These equations may be useful in red, laterite and yellow soils (*Inceptisols* and *Alfisols*). Similar study and results were also reported by various workers in different crops like carrot (Singh *et al*., 2021) and Finger millet (Ayushi *et al*., 2022).

Table 5: Ready reckoner for fertilizer recommendations to achieve specific yield targets of Cucumber under different soil fertility status

Available soil nutrients (kg ha^{-1})			Fertilizer nutrient required (kg ha^{-1})								
			Targeted yield (80 q ha^{-1})			Targeted yield (100 q ha^{-1})			Targeted yield (120 q ha^{-1})		
N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
80	10	80	70	53	156	97	69	222	124	84	288
100	15	100	60	48	129	87	64	195	114	80	261
120	20	120	50	44	102	77	59	168	104	75	234
140	25	140	40	39	74	67	55	141	94	70	207
160	30	160	30	34	47	57	50	113	84	65	180
180	35	180	20	30	20	47	45	86	74	61	152
200	40	200	13	25	19	37	40	59	64	56	125
220	45	220	13	20	19	27	36	32	54	51	98
240	50	240	13	15	19	17	31	19	44	47	71
260	55	260	13	11	19	13	26	19	34	42	44

Targeted yield approach may be advantageous for balanced fertilization on crop taking into account of the soil available nutrient status and the crop need. Target yield based fertilizer recommendations not only supply the required quantity of nutrients to achieve a specific yield target but also it maintains the soil fertility status. Thus, it prevents not only the over dose of fertilizers but also crop suffering due to less supply of fertilizers.

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