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Soil Test Based Fertilizer Recommendation under Integrated Plant Nutrition System for Vegetable Cowpea [*Vigna unguiculata* (L) Walp] in Ultisols of Kerala, India

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A B S T R A C T

To develop fertilizer prescription equations for vegetable cowpea, a field experiment was conducted on Ultisol of STCR field, Kerala Agricultural University, Thrissur by using integrated plant nutrient management system on the basis of STCR approach. Soil test data, cowpea pod yield and NPK uptake by cowpea were used for obtaining four important basic parameters *viz*. nutrients required to produce one tonne of pod yield (NR), contribution of nutrients from fertilizers (%CF), contribution of nutrients from soil (%CS) and contribution of nutrients from organic matter (%CFYM). The nutrient requirement of cowpea to produce one tonne of pod yield in terms of N, P_2O_5 and K_2O were 10.82, 0.52 and8.00 kg t^{-1}, respectively. The per cent contribution of nutrients from soil, fertilizer and FYM were 12.85. 14.28 and0.65 for N; 10.53, 0.71 and 0.55 for P_2O_5; and 6.26, 2.58 and 0.84 for K_2O, respectively. By using these basic parameters, ready reckoner of fertilizer doses was prepared for varying soil test values and desired yield targets of vegetable cowpea for NPK alone and NPK with FYM.

Introduction

Soil test based fertilizer recommendations result in efficient fertilizer use and maintenance of soil fertility. Among the various methods of fertilizer recommendations, the one based on yield targeting (Ramamoorthy *et al.*, 1967) is unique as it not only indicates soil test based fertilizer dose but also the level of yield that can be obtained if appropriate practices are followed in raising the crop. Targeted yield approach also provides scientific basis for balanced fertilization not only between the nutrients from the external sources but also with soil available nutrients. Balanced nutrition doesn't mean the application of nitrogen, phosphorus and potassium alone in certain proportions through fertilizers, but it should ensure that the nutrients in available forms are in adequate quantity and required proportion in the soil to meet the requirements of the crops for obtaining the desired level of yield. Nutrients available in soil are rarely present in adequate amounts and in balanced proportion to meet the nutrient requirement of the crops. This requires intervention by application of external sources of nutrients *i.e.* fertilizers and manures. Soil test provides the requisite information about the amount of

nutrients available in the soil and their imbalances, while fertilizer recommendations aim at correcting the imbalances in nutrients according to crop requirements. The fertilizer recommendations based on qualitative/ semi quantitative approaches or methods do not give expected responses. Therefore, a refined method of fertilizer recommendation for varying soil test values has to be developed.

Cowpea is a typical warm season crop adapted to tropics. Tender pods of cowpea are used as vegetable and dry beans as pulse. Due to its nutritive value and soil nutrient improving properties, it is also used as a fodder, green manure and cover crop. Being a legume crop, cow pea fits well in inter-cropping system. In Kerala, it is grown as a floor crop in coconut gardens, as an inter-crop in tapioca, fringe crop in rice fields and in garden lands. 100 g of green tender pods contain 4.3 g protein, 8.0 g carbohydrates, 74 mg phosphorus, 2.5 mg iron, 13.0 mg vitamin C, 0.9 mg minerals, etc.

The existing Package of Practices recommendations for cowpea in Kerala does not take into account the fertility variations in the field and plant uptake from soil and fertilizers, as it does not take into account the fertility variations resulting in imbalanced use of fertilizer nutrients. So far Soil Test Crop Response correlation studies under Integrated Plant Nutrition System (STCR-IPNS) have not been carried out for cowpea in Ultisols of Kerala. Hence the present study was undertaken to develop balanced fertilizer schedule based on STCR to increase the productivity and fertilizer use efficiency in vegetable cowpea.

Materials and Methods

A field experiment with cowpea (var. *Anaswara*) was conducted during 2014-2015 at STCR field, College of Horticulture, Vellanikkara in Ultisols. Before starting of experiment the gradient crop, maize (cv. *CO-1*) was raised. The experiment was conducted in the same field where the gradient experiment was done. After the harvest of the gradient crop, the soil was analysed from all the three strips and the following data were obtained (Table 1). The soils were in general low to medium in available N, medium to high with respect to available P and high in available K status.

Each strip was divided into 24 plots/beds of 2.5 x 3m size. The 24 plots in each strip were allotted with 21treatment combinations of NPK and 3 controls. The FYM at three levels were superimposed in the treatment structure.

The treatment structure was in such a way that each strip received all the treatment combinations. Each strip contained three control plots that had no fertilizers or FYM. The remaining 21 plots of each strip received either FYM or fertilizer or a combination of both. The fertilizer treatment combinations were based on the existing state Package of Practices recommendations *i.e.* 20 kg ha^{-1} of N, 30 kg ha^{-1} of N and10 kg ha^{-1} of K_2O, which was also included as one of the treatment combinations (Table 2).

The organic manure as per the treatments was applied in the plots along with full dose of P, half dose of N and K as basal. The remaining quantities of N and K were applied one month after sowing.

The plants were uprooted carefully after harvest, cleaned and the fresh weight was taken and the yield was recorded and expressed as t ha^{-1}. The nutrient uptake was computed separately for the fruits and for the biomass (including stems, leaves and roots). The plant samples were analysed separately for the contents of N, P and K after harvest as per standard procedures as described by Piper, 1966. The total uptake of N, P and K were

computed from the nutrient contents and dry weight of plant parts and expressed as kg ha^{-1}as per standard procedures. The fertilizer prescription equations were developed based on the data of soil test values, fruit yield and the nutrient uptake by the vegetable cowpea.

Plot-wise soil test data, fertilizers doses, yield and uptake were used for obtaining NR (nutrient required to produce one tonne of pod yield), %CS (per cent contribution of nutrients from soil), %CF (per cent contribution of nutrients from fertilizers) and %CFYM (per cent contribution of nutrients from FYM), as per method described by Ramamoorthy *et al.,* (1967).

Nutrient requirement in kg t^{-1} of grain (NR) = Total uptake of nutrient (kg ha^{-1}) in plot / Grain yield (t ha^{-1}) in plot

Per cent contribution of nutrients from soil (%CS) = (Total uptake of nutrient in control plot (kg ha^{-1}) / (Soil test values of nutrient in control plot (kg ha^{-1})) × 100

Percent contribution of nutrients from fertilizer (%CF) = {(Uptake of N/ P_2O_5/ K_2O by grain+ straw in kg ha^{-1}) – (Soil test value for available N / P_2O_5/ K_2O in kg ha^{-1} x Percent contribution of N / P_2O_5/ K_2O from soil/100) × 100} / Fertilizer N / P_2O_5/ K_2O applied in kg ha^{-1}

These parameters were used to develop equations for soil test based fertilizer recommendations for desired yield targets of vegetable cowpea under NPK alone as well as NPK plus FYM.

Results and Discussion

Soil available nutrients and pod yield

The range and mean values of soil available nutrients and pod yield of cowpea in treated and control plots are furnished in table 3. In the NPK treated plots (plots that received NPK alone or NPK + FYM), $KMnO_4$-N increased from 100 to 526 kg ha^{-1} with a mean value of 372 kg ha^{-1}. The Bray-P ranged from 28.94 kg ha^{-1} in strip I to 38.07 kg ha^{-1} in strip III with a mean value of 33.51 kgha^{-1}, while the NH_4OAc-K status varied from 502 kg ha^{-1} in strip I to 517 kg ha^{-1} in strip III with a mean value of 510 kg ha^{-1}. In the NPK treated plots that received NPK alone or NPK + FYM, the pod yield of cowpea ranged from 2.00 to 5.72 t ha^{-1} with a mean value 4.01 t ha^{-1}. In the control plots, the yield ranged from 1.77 to 4.54 t ha^{-1} with a mean value of 3.14 t ha^{-1}. In the control plot the $KMnO_4$-N ranged from 176 to 298 kg ha^{-1} with a mean of 246 kg ha^{-1}, Bray-P status ranged from 5.0 to 32.03 kg ha^{-1} with a mean value of 20.73 kg ha^{-1}, and the NH_4OAc-K status varied from 376 to 653 kg ha^{-1} with a mean value of 500 kg ha^{-1}.

These soils are medium in available N and medium to high in available P and high in available K. The above data clearly indicate the existence of operational range of soil test values for available N, P and K status and yield of treated and control plots, which is a prerequisite for calculating the basic parameters and fertilizer prescription equations for calibrating the fertilizer doses for specific yield targets. The results were similar to the findings of Sellamuthu *et al.,* (2015). Almost similar results were found by Bera *et al.,* (2006) and Dwivedi *et al.,* (2009) for on-farm evaluation of soil test based site specific nutrient management in pearl millet-based cropping systems on alluvial soils.

Basic parameters

The basic data viz., nutrient requirement for producing one tone pod yield of cowpea, percent contribution of nutrients from soil (CS), fertilizer (CF) and FYM (CFYM) have been calculated and furnished in table 4.

These basic parameters were used for developing the fertilizer prescription equations under NPK alone and IPNS. The nutrient requirement of cowpea to produce one tonne of pod yield is 10.82N kg, 0.52 kg P_2O_5 and 8.00 K_2O, respectively. The percent contribution of nutrients from soil and fertilizers were found to be 12.85 and 14.28 for N, 10.53and 0.71 for P_2O_5 and 6.26and 2.58 for K_2O. Similarly the percent contribution of N, $P_2O_5$and K_2O from FYM were 0.65, 0.55and 0.84, respectively.

Table.1 Gradient crop: Complex experiment

Sl. No.	Strips	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})
1	S0	245.80	20.73	500.35
2	S1	339.75	28.94	501.87
3	S2	404.09	38.07	517.25

Table.2 Treatment structure of complex experiment

Nutrient Levels	Fertilizer doses (kg ha^{-1})			FYM (t ha^{-1})
	N	P	K	
0	0	0	0	0
1	15	25	5	10
2	20	30	10	20
3	30	40	20	--

Table.3 Available nutrients in soil and yield of vegetable cowpea

Parameters	NPK treated plot			Control plot		
	Range	Mean	SEm	Range	Mean	SEm
$KMnO_4$-N (kg ha^{-1})	100-526	372	± 17.44	176-298	246	± 5.31
Bray-P (kg ha^{-1})	5.00-79.59	33.51	± 4.77	5.00-32.03	20.73	± 1.83
NH_4OAc-K (kg ha^{-1})	255- 691	510	± 21.89	376- 653	500	± 12.70
Yield (t ha^{-1})	2.00-5.72	4.01	± 0.177	1.77-4.54	3.14	± 0.156

Table.4 Basic data of vegetable cowpea experiment

Nutrient	NR (kg t^{-1})	CS (%)	CF (%)	COM (%)
F N	10.82	12.85	14.28	0.65
F P_2O_5	0.52	10.53	0.71	0.55
F K_2O	8.00	6.26	2.58	0.84

Table.5 Ready reckoner for vegetable cowpea (without FYM) for different targets

Nutrients			Yield target, 4 t ha^{-1}			Yield target, 5 t ha^{-1}			Yield target, 6 t ha^{-1}		
$KMnO_4$ N	Bray`s P	NH_4OAc -K	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
100	5	100	213.07	217.51	998.96	288.84	290.33	1309.43	364.60	363.16	1619.90
150	7	200	168.07	188.00	756.06	243.84	260.82	1066.52	319.60	333.65	1376.99
200	9	300	123.07	158.49	513.15	199	231	824	275	304	1134
250	12	400	78.07	114.22	270.24	153.84	187.04	580.71	229.61	259.86	891.17
300	14	500	33.07	84.70	27.33	108.84	157.53	337.80	184.61	230.35	648.27
350	16	600	0.00	55.19	0.00	63.84	128.01	94.89	139.61	200.84	405.36
400	18	700	0.00	25.68	0.00	18.84	98.50	0.00	94.61	171.33	162.45

Table.6 Ready reckoner for vegetable cowpea (with FYM) for different targets

	Nutrients										
$KMnO_4$ N	Bray`s P	NH_4OAc K	Yield target 4 t ha^{-1}			Yield target 5 t ha^{-1}			Yield target 6 tha^{-1}		
			N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
100	5	100	78	0	932	154	12	1243	229	85	1553
150	7	200	33	0	689	109	0	1000	184	55	1310
200	9	300	0	0	446	64	0	757	139	26	1067
250	12	400	0	0	204	19	0	514	94	0	824
300	14	500	0	0	0	0	0	271	49	0	582
350	16	600	0	0	0	0	0	28	4.34	0	339
400	18	700	0	0	0	0	0	0	0	0	96

Fertilizer Prescription Equations under IPNS for desired yield target

Nutrients		With FYM	Without FYM
N	=	75.77 T – 0.90 SN – 0.05 ON	75.77 T – 0.90 SN
P_2O_5	=	72.82 T – 14.76 SP – 0.77 OP	72.82 T – 14.76 SP
K_2O	=	310.47 T – 2.43 SK – 0.33 OK	310.47 T – 2.43 SK

Fertilizer prescription equations under IPNS for desired yield target

Soil test based fertilizer prescription equations for desired yield target of cowpea were formulated using the basic parameters and are furnished below:

Where, FN, FP_2O_5 and FK_2O are fertilizer N, P_2O_5 and K_2O in kg ha^{-1}, respectively; T is the yield target in t ha^{-1}; SN, SP and SK, respectively are alkaline $KMnO_4$-N, Bray-P and NH_4OAc-K in kg ha^{-1}in soil. ON, OP and OK are the quantities of N, P and K supplied through FYM in kg ha^{-1}. Using the above equations, ready reckoners were formulated for a range of soil test values and desired yield targets (4, 5 and 6 t ha^{-1}) of cowpea with chemical fertilizers alone as well as in combination with FYM (Tables 5 and 6).

For achieving yield target of 5 t ha^{-1} with soil test values of 200: 9: 300 kg ha^{-1} of $KMnO_4$-N, Bray-P and NH_4OAc-K, the fertilizer N, P_2O_5 and K_2O doses required were 199, 231 and 824 kg ha^{-1}, respectively. When FYM (1.15, 0.65 and 1.21 per cent of N, P and K, respectively) was applied @ 10 t ha^{-1} along

with NPK, the required fertilizer N, P_2O_5 and K_2O doses were 64, 0 and 757 kg ha^{-1}, respectively. Under IPNS system the required dose of fertilizer is low due to nutrient availability increased by FYM through mineralization. The results were in accordance with the findings of Singh *et al.*, (2015). Santhi *et al.,* (2010) reported that under integrated plant nutrient system, required dose of fertilizer to achieve desired yield target are reduced. These results clearly showed that the fertilizer requirements varied with the soil test values for the same level of crop production. Hence, balanced fertilization through soil testing becomes essential for increasing crop production. Similar results were found by Avtari *et al.,* (2010) for 2 tha^{-1} yield of yellow mustard.

Use of integrated plant nutrient system (IPNS) resulted in saving of fertilizer nutrients in vegetable cowpea. Target yield equations generated from STCR-IPNS technology ensures not only sustainable crop production but also economies use of costly fertilizer inputs.

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References

Avtari, S., Singh, S. and Kumar, S. 2010. Fertilizer prescription for target yield of yellow sarson *Brassica rapa* var. PYS 1 in Mollisols of Utarakhand. *Pantnagar J. Res.*, 8: 2-6.

Bera, R., Seal, A., Bhattacharyya, P., Das, T. H., Sarkar, D. and Kangjoo, K. 2006. Targeted yield concept and a framework of fertilizer recommendation in irrigated rice domains of subtropical India. *J. Zhejiang Univ.,* 7: 963-968.

Dwivedi, B.S., Singh, D., Tiwari, K.N., Swarup, A., Meena, M.C., Majumdar, K., Yadav, K.S. and Yadav, R.L. 2009. On-farm evaluation of SSNM in pearl millet based cropping systems on alluvial soils. *Better crops- India* pp. 25-27.

Piper, C. S. 1966. Soil and Plant Analysis. Hans Publications, Bombay.

Ramamoorthy, B., Narasimham, R. L. and Dinesh, R. S. 1967. Fertilizer application for specific yield targets on Sonora 64 (wheat). *Indian Farming*, 17: 43-45.

Santhi, R., Selvakumari, G. and Rani Perumal. 2010. Soil test based fertilizer recommendations under integrated plant nutrition system for rice-rice-pulse cropping sequence. *J. Indian Soc. Soil Sci.,* 47: 288-294.

Sellamuthu, K. M., Santhi, R., Maragatham, S. and Dey, P. 2015. Balanced fertilizer prescription for glory lily through inductivecum- targeted yield model on an Alfisol. *Res. Crops*. 16 (3): 555-561.

Singh, V. V., Manoj Parihar., Singh, S. K., Sharma, P. K., Dey, P. 2015. Soil test based fertilizer prescriptions under integrated plant nutrient management system for maize in an Inceptisol of Varanasi. *J. Indian Soc. Soil Sci.* 63: 83-87.

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