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Soil test based fertilizer recommendation under IPNS for cumin in torripsamments of Rajasthan

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Abstract

Soil test crop response correlation studies were conducted with cumin (var. RZ-209) under integrated plant nutrition system (STCR-IPNS) in Torripsamments of Rajasthan during rabi, 2004-05. Fertilizer adjustment equations under IPNS were formulated for cumin following Ramamoorthy's inductive-cum targeted yield model. The nutrient requirement for producing one quintal of cumin was found to be 4.06, 2.71 and 4.88 kg of N, P_2O_5 and K_2O, respectively. The per cent nutrient utilization efficiencies from soil and fertilizer nutrients were found to be 21.81 and 27.43 for N, 49.17 and 23.11 for P_2O_5 and 15.59 and 50.93 for K_2O, respectively. Likewise the per cent nutrient utilization efficiency from farm yard manure (FYM) was 7.43 for N, 11.22 for P_2O_5 and 27.71 for K_2O, respectively. In STCR-IPNS technology, the fertilizer doses are tailored to the requirements of specific yield targets of cumin taking into account the contribution from soil, fertilizers and organics.

Key words : *Cumin, STCR-IPNS, fertilizer adjustment equations, Torripsamments*

Introduction

The modern crop production technology emphasizes the need for integrated plant nutrient supply involving the judicious use of combination of organic and inorganic. The use of chemical fertilizers is a must for Indian agriculture but at least one third of the total nutrients must be in organic form for enhancing the efficiency of the inorganic component, cost effectiveness and reducing the burden of environmental damage (Sankaram, 1997).

Rajasthan stands first in area as well as production among cumin growing states. In Rajasthan cumin is being cultivated in an area of about 2.27 lakh hectare with a production of 1.21 lakh tonnes and average productivity of 5.31 q ha^{-1}. (Anonymous, 2004). After coriander, cumin is the second most important condiment used throughout the world. Cumin seeds and oil are used in culinary preparations for flavouring vegetables, pickles, soups, sauces, cheese, seasoning of breads, cakes and biscuits. Cumin is also valued for its typical pleasant aroma from its volatile or essential oil. Apart from its culinary value, cumin is also extensively used in Ayurvedic medicines. Currently, a general recommendation of 10-15 t FYM, 30 kg N and 20 kg P_2O_5 ha^{-1}, is being followed. fertilizer application based on blanket recommendation results in either over use or under use of fertilizers, hence balanced fertilizer application is a must for realizing higher efficiency and economy of fertilizer use (Velayutham and Reddy, 1990). For fertilizer recommendation the existing soil fertility and crop requirements should be taken into account (Ramamoorthy *et al.*, 1967). This demands the maintenance of soil fertility and plant nutrient supply to an optimum level for desired crop productivity through possible sources of nutrients in an integrated manner. With this background an attempt was made to develop IPNS technology for cumin in torripsamments of Rajasthan.

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Materials and methods

A field experiment based on inductive methodology was conducted in Torripsamments of Bikaner during rabi 2004-05 with cumin (Var. RZ-209). The soil of the experiment field was non-saline (EC_2 0.3 dS m^{-1}), loamy sand in texture with pH 8.4. The initial $KMnO_4$-N, Olsen-P and NH_4OAc-K status were 96.20, 23.70 and 148.90 kg ha^{-1}, respectively. Following the inductive methodology of the Ramamoorthy *et al.* (1967), four fertility gradients were created in the preceding season by dividing the experimental field into four equal strips. The first strip received no fertilizer, whereas second, third and fourth strips, half one and two times the standard dose of N, P and K, respectively. An exhaustive crop of clusterbean (var. RGC-986) was grown prior to experimentation.

By growing the exhaustive crop, the operational range of soil fertility was created in the fertility strips, which was evaluated in terms of variations in yield, uptake and soil

test values. After the harvest of the exhaustive crop, each strip of the fertility gradient was divided into four equal blocks across the strip for farmyard manure (FYM) levels. Then each strip was divided into 32 plots and fertilizer treatments were distributed in such a manner that every treatment was accommodated in each gradient strip as well as in FYM block.

Pre-sowing soil samples were collected from each gradient plot before superimposition of the treatments and were analysed for alkaline KMnO4-N (Subbiah and Asija, 1956), Olsen-P (Olsen *et al.,* 1954) and neutral N NH_4OAc-K (Hanway and Heidel, 1952). Cumin (Var. RZ-209) crop was grown with standard agronomic practices. After the harvest of crop, the grain and stover yields of cumin were recorded plot wise. The plant samples from each plot were analysed for total N, P and K content (Piper, 1966) and total uptake was computed using cumin yield data.

Using the data of cumin yield, nutrient uptake, pre-sowing soil available nutrients and fertilizer doses applied, the essential basic parameters *viz.,* nutrient requirement (kg q^{-1}), contribution of nutrients from soil (Cs) and fertilizer (Cf) were calculated as described by Ramamoorthy *et al.,* (1967). The per cent utilization efficiency of nutrients from applied FYM was also estimated in the similar manner. These parameters were used for the formulation of fertilizer adjustment equations for deriving fertilizer doses. The soil test based fertilizer recommendations were prescribed in the form of a ready reckoner for desired yield target of cumin under IPNS.

Results and discussion

Soil available nutrients and cumin yield

The range and mean values of cumin yield, uptake and available soil nutrients of treated and control plots are furnished in Table 1. The $KMnO_4$-N ranged from 82.20 to 92.80 kg ha^{-1} with a mean of 87.40 kg ha^{-1}, Olsen-P ranged from 22.50 to 35.50 kg ha^{-1} with a mean of 29.87 kg ha^{-1} and NH_4OAc-K ranged from 160.50 to 196.40 kg ha^{-1} with a mean of 175.02 kg ha^{-1}. The cumin yield in fertilizer treated plots ranged from 3.12 to 11.12 q ha^{-1} with a mean value of 6.83 q ha^{-1} and in control plots ranged from 2.92 to 6.12 q ha^{-1} with a mean value of 4.03 q ha^{-1}. The above data clearly indicate that a wide variability existed in the soil test values and cumin yield of treated and control plots, which is a pre-requisite for calculating the basic parameters and fertilizer adjustment equations for calibrating the fertilizer doses for specific yield targets.

Table 1. Range and mean values of available nutrients in the pre-sowing surface soil, yield and nutrient uptake of cumin

Parameters	Range	Mean
Soil test values		
$KMnO_4$-N	82.20 - 92.80	87.40
Olsen-P	22.50 - 35.50	29.87
NH_4OAc-K	160.50 -196.40	175.02
Wheat yield (q ha^{-1})		
Treated plots	3.12 - 11.12	6.83
Control plots	2.92 - 6.12	4.03
Nutrient uptake (kg ha^{-1})		
Treated plots		
N uptake	12.14 - 45.75	27.85
P uptake	9.31 - 33.05	18.51
K uptake	13.42 - 65.39	33.36
Control plots		
N uptake	11.10 - 22.65	14.82
P uptake	9.40 - 18.09	11.09
K uptake	14.59 - 35.12	20.13

Table 2. Nutrient requirement and per cent contribution from soil, fertilizer and FYM for cumin

Parameters	N	P_2O_5	K_2O
Nutrient requirement (kg q^{-1})	4.06	2.71	4.88
Soil nutrient utilization efficiency (%)	21.81	49.17	15.59
Fertilizer nutrient utilization efficiency (%)	27.43	23.11	50.93
Nutrient contribution from FYM (%)	7.43	11.22	27.71

Basic parameters

The basic data, *viz*, nutrient requirement for producing one quintal of cumin yield, the per cent nutrient utilization efficiency for soil, fertilizer and FYM have been calculated (table 2) and were used for formulating the fertilizer prescription equation under IPNS.

The nutrient requirements of N, P_2O_5 and K_2O were 4.06, 2.71 and 4.88 kg q^{-1} of cumin, respectively. The per cent nutrient utilization efficiencies from soil and fertilizer nutrients were found to be 21.81 and 27.43 for nitrogen, 49.17 and 23.11 for phosphorus and 15.59 and 50.93 for potassium. Similarly, the per cent contribution of N, P_2O_5 and K_2O from FYM were 7.43, 11.22 and 27.71, respectively. The data on C_s and C_f indicated that the per cent utilization efficiencies from fertilizer source were greater than that from soil in case of N and K_2O, whereas in P_2O_5 it was reverse.

The application of FYM also contributed for particular nutrients i.e nitrogen, phosphorus and potassium. The findings are in line with those reported by Reddy *et al.* (1994), Rao *et al.* (1997) and Santhi *et al.* (2002).

Fertilizer adjustment equations for desired yield targets of cumin

Soil test based on fertilizer models or equations for

Table 3. Soil based fertilizer equations for targeted yield of cumin

FN	=	14.80 T	-	0.79 SN	-	0.28 FYM
FP	=	11.73 T	-	2.13 SP	-	0.48 FYM
FK	=	9.58 T	-	0.31 SK	-	0.54 FYM

Note : FN, FP and FK- fertilizer N, P_2O_5 and K_2O in kg ha^{-1}, respectively, T- yield target in qha^{-1}, SN, SP and SK- $KMnO_4$-N, Olsen-P and NH_4OAc-K in kg ha^{-1}, respectively.

Table 4. Estimates of soil test based fertilizer recommendations for 8 q ha^{-1} grain yield target of cumin (kg ha^{-1})

Soil test values (kg ha^{-1})			Fertilizer required for grain yield target of 8 q ha^{-1} without FYM/compost			with FYM/compost @ 5 t ha^{-1}		
N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
80	20	160	55.20	51.24	27.04	53.80	48.84	24.34
85	25	170	51.25	40.59	23.94	49.85	38.19	21.24
90	30	180	47.30	29.94	20.84	45.90	27.54	18.14
95	35	190	43.35	19.29	17.74	41.95	16.89	15.04
100	40	200	39.40	8.64	14.64	38.00	6.24	11.94

targeted yield of cumin were formulated using the basic parameters and are furnished in table 3.

On the basis of these equations ready reckoner were prepared for range of soil test values and for yield target of 8.00 q ha^{-1} (Table 4) under different fertilization programmes. For producing 8.00 q ha^{-1} of cumin in Torripsamments, with an average soil test values of 90, 30 and 180 kg ha^{-1} N, P_2O_5 and K_2O, respectively, the required fertilizer doses were 45.90, 27.54 and 18.14 kg N, P_2O_5 and K_2O, respectively with 5 tonnes of FYM.

The findings of these studies indicated that in STCR-IPNS technology, the fertilizer doses could be tailored to the requirement of specific yield target of cumin taking into account the contribution from soil, fertilizers and organics. Hence, there will be a balanced supply of nutrients coupled with recycling of organic waste avoiding either under or over use of fertilizer inputs.

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