Annals of Arid Zone 45(1): 19-23, 2006

Soil Test Based Fertilizer Recommendation for Clusterbean in Torripsamments of Rajasthan

I.J. Gulati, S.R. Yadav and S.P. Singh

STCR Project, Agricultural Research Station, Rajasthan Agricultural University, Beechwal, Bikaner 334 006, India

Abstract: Soil test crop response correlation studies were conducted with clusterbean (var. RGC-986) in Torripsamments of Rajasthan during kharif 2001. Fertilizer adjustment equations were formulated for clusterbean following Ramamoorthy's inductive-cum-targeted yield model. The nutrient requirement for producing one quintal of clusterbean was found to be 7.16, 1.10 and 3.70 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 45.98 and 69.11 for N, 53.72 and 51.87 for P_2O_5 and 51.17 and 40.21 for K_2O, respectively. Fertilizer adjustment equations formulated for clusterbean were verified by conducting follow-up trials. In STCR technology, the fertilizer doses are tailored to the requirements of specific yield targets of clusterbean taking into account the contribution from soil and fertilizers.

Key words: Clusterbean, STCR, fertilizer adjustment equations, Torripsamments.

Fertilizer recommendations are usually given for different crops by taking into consideration only the available nutrient status of soil, prior to planting the crop. These are generalized recommendations and do not take into account, the actual crop requirement and large scale soil variations. Fertilization based on blanket recommendation results in either over use or under use of fertilizers, so balanced fertilization is must for realizing higher efficiency and economy in fertilizer use (Velayutham and Reddy, 1990). In fertilizing the crop existing soil fertility and crop requirement should be taken into account (Ramamoorthy *et al.*, 1967). This demands the maintenance of optimum balance between all essential nutrients, as per the requirement of the crop and their availability in the soil. Keeping this in view, the present investigation was undertaken.

Materials and Methods

A field experiment, based on inductive methodology, was conducted in Torripsamments of Bikaner during kharif 2001 with clusterbean (var. RGC-986). The soil of the experimental field was loamy sand in texture with pH 8.3 and non-saline (EC_2 0.3 dS m^{-1}). The initial $KMnO_4$-N, Olsen-P and NH_4OAc-K status were 104.00, 21.30 and 195.10 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 which were fertilized with $N_0P_0K_0$, $N_{0.5}P_{0.5}K_{0.5}$ $N_1P_1K_1$ and $N_2P_2K_2$ levels. An exhaust crop of fodder (oats var. Kent) was grown. After harvest of the exhaust crop, each strip of the fertility gradient was divided into 28 plots and distributed fertilizer treatments.

Pre-sowing soil composite samples were collected from each gradient plot before superimposition of the treatments and were analyzed for alkaline $KMnO_4$-N (Subbiah and Asija, 1956), Olsen-P (Olsen *et al.*, 1954) and neutral N NH_4OAc-K (Hanway and Heidel, 1952). Clusterbean crop was grown with usual agronomic practices. After harvest grain and stover yields of clusterbean were recorded. The plant samples from each plot were analyzed for total N, P and K contents (Piper, 1950) and total uptake was computed using clusterbean yield data.

Follow-up trials on clusterbean (var. RGC-986) were conducted during kharif 2003 to test the validity of the fertilizer equations developed for clusterbean before recommending for adoption by extension agencies. Trials were conducted on farmers field at two locations in village Lunkaransar (Rajasthan). Each trial had five treatments; T_1- control; T_2- farmers practice (N_7 P_{18}); T_3- fertilizer dose recommended at the state level namely $N_{20}P_{35}K_0$; T_4- fertilizer N, P and K needed to attain yield target of 12 q ha^{-1} (grain) on the basis of soil test values and T_5- fertilizer N, P and K needed to attain yield target of 18 q ha^{-1} (grain) for clusterbean on the basis of soil test values. After harvest, the grain yield was recorded for each treatment and economic aspects of each treatment were worked out.

Using the data of clusterbean yield, nutrient uptake, pre-sowing soil available nutrients and fertilizer doses applied, the basic parameters, viz., nutrient requirement (kg q^{-1} grain), contribution of nutrients from soil (Cs) and fertilizer (Cf) were calculated according to Ramamoorthy (1993). For calculation of nutrient requirement (NR) of clusterbean, the uptake of nutrients regressed with the yield and obtained the nutrient requirement in kg q^{-1} grain. Similarly, for obtaining the values of soil nutrient utilization efficiency (Cs) and fertilizer nutrient utilization efficiency (Cf), the uptake of nutrient from all the plots were regressed with their respective soil test values (soil nutrients) and fertilizer dose of particular nutrient and identified the two coefficients, respectively, as Cs and Cf. Soil test based fertilizer recommendations were also prescribed in the form of a ready reckoner for desired yield target of clusterbean.

Results and Discussion

Soil available nutriments and clusterbean yield

The $KMnO_4$-N ranged from 104.00 to 128.40 kg ha^{-1} with a mean of 114.05 kg ha^{-1}, Olsen P ranged from 21.30 to 36.10 kg ha^{-1} with a mean of 29.30 kg ha^{-1} and NH_4OAc-K ranged from 195.10 to 272.20 kg ha^{-1} with mean of 239.45 (Table 1). The clusterbean yield in fertilized plots ranged from 6.40 to 29.10 q ha^{-1} with a mean of 16.94 q ha^{-1}. In control plots yield ranged from 5.33 to 6.00 q ha^{-1} with a mean of 5.66 q ha^{-1}. The above data clearly indicate that a wide variability existed in the soil test values and clusterbean 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 (Ramamoorthy *et al.*, 1967).

Basic parameters

The basic data, viz., nutrient requirement for producing one quintal of clusterbean yield, the per cent nutrient utilization

Table 1. Range and mean values of available nutrients in the pre-sowing surface soil and yield of clusterbean

Parameters	Range	Mean
Soil test values		
$KMnO_4$-N	04.00-128.40	114.50
Olsen-P	21.30-36.10	29.30
NH_4OAc-K	195.10-272.20	239.45
Clusterbean yield (q ha^{-1})		
Treated plots	6.40-29.10	16.94
Control plots	5.33-6.00	5.66
Nutrient uptake (kg ha^{-1})		
Treated plots		
N uptake	40.32-199.34	116.78
P uptake	5.63-30.85	17.45
K uptake	22.40-105.63	60.11
Control plots		
N uptake	33.58-37.97	35.68
P uptake	4.69-5.28	4.95
K uptake	16.79-19.02	17.85

efficiency for soil and fertilizer are presented in Table 2. The requirements of N, P_2O_5 and K_2O obtained were 7.16, 1.10 and 3.70 kg q^{-1}, respectively, of clusterbean. The per cent nutrient utilization efficiencies from soil (Cs) and fertilizer nutrients (Cf) were found to be 45.98 and 69.11 for nitrogen, 53.72 and 51.87 for phosphorus (P_2O_5) and 51.17 and 40.21 for potassium (K_2O).

Fertilizer adjustment equations for desired yield targets of clusterbean

Soil test based fertilizer models equations for targeted yield of clusterbean were formulated using initial soil test values and the data on NR, Cs and Cf are presented in Table 3.

On the basis of these equations, a ready reckoner was prepared for range of soil test value and for a yield target of 12.0 and 18.0 q ha^{-1} (Table 4) under different fertilization program. For producing 12.00 and 18.00 q ha^{-1} of clusterbean grain yield in Torripsamments, the fertilizer doses required for the average soil test values of 105, 20 and 200 kg ha^{-1} N, P_2O_5 and K_2O, respectively, were found to be 55.02 and 117.20, 4.64 and 17.36 and 0.00 and 0.00 kg N, N_2O_5 and K_2O, respectively.

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

Parametes	N	P_2O_5	K_2O
Nutrient requiremnt (kg q^{-1})	7.16	1.10	3.70
Soil nutrient utilization efficiency (%)	45.98	53.72	51.17
Fertilizer nutrient utilization efficiency (%)	69.11	51.87	40.21

Table 3. Soil-based fertilizer equaiton for targeted yield of clusterbean

FN	=	10.36T-0.66SN
FP	=	2.12-1T-04SP
FK	=	0.02T-1.27SK

FN, FP and FK: Fertilizer N, P_2O_5 and K_2O in kg ha^{-1}, respectively; T- Yield target in q ha^{-1}; SN, SP and SK - $KMnO_4$-N, Olsen-P and NH_4OAc-K in kg ha^{-1}, respectively.

Subba Rao and Srivastava (1999) reported similar results on the basis of a large amount of data obtained from different soil agro-climatic regions of the country under the All India Coordianted Research Project on Soil Test Crop Response Correlation. The present study amply demonstrates that the STCR based recommendations lead to balanced supply of nutrients avoiding either under or over uses of fertilizer inputs, as in the technology fertilizer doses are tailored to the requirements of specific yield targets of crop taking into account the contribution from soil and fertilizers (Naidu *et al.*, 1999). Hence there will be balanced supply of nutrients avoiding either under or over uses.

Table 4. Estimates of soil test based fertilizer recommendations for 12 and 18 q ha^{-1} grain yield of clusterbean (kg ha^{-1})

Soil test values (kg ha^{-1})			Fertilizer for 12 q ha^{-1}			Fertilizer for 18 q ha^{-1}		
N	P_2O_5	K_2O	N	P_2O_5	K2O	N	P_2O_5	K2O
100	15	180	58.32	9.84	-	120.50	22.56	-
105	20	200	55.02	4.64	-	117.20	17.36	-
110	25	220	51.72	-	-	113.90	12.16	-
115	30	240	48.42	-	-	110.60	6.96	-
120	35	260	45.12	-	-	107.30	1.76	-
125	40	280	41.82	-	-	104.00	-	-
130	45	300	38.52	-	-	100.72	-	-

Table 5. Verification of fertilizer adjustment equations for clusterbean during kharif 2003

Treatment	Site I			Site II		
	Grain yield (q ha^{-1})	± Deviation (%)	B:C ratio	Grain yield (q ha^{-1})	± Deviation (%)	B:C ratio
T_1	6.00	-	1.45:1	7.00	-	1.73:1
T_2	6.20 (7:18)	-	1.35:1	7.50 (7:18)	-	1.63:1
T_3	10.00 (20:35)	-	1.95:1	10.30 (20:35)	-	2.00:1
T_4	12.80 (11:19:20)	+6.66	2.68:1	12.30 (7:13:20)	+2.50	2.68:1
T_5	17.50 (49:43:20)	-2.50	3.08:1	19.00 (45:38:20)	+5.55	3.44:1

Values in parenthesis indicates the N, P_2O_5 and K_2O kg ha^{-1} fertilizer applied as per treatment.

Verification of fertilizer adjustment equations for clusterbean.

The yield targeted and actually obtained in follow-up trials are in close conformity (Table 5). These are positive upto 12 q ha^{-1} yield target of clusterbean. Per cent deviations from targeted yield are within ± 10 in case of above targets. These results showed a very close correspondence between targeted yields and the yields actually obtained and are an evidence of the usefulness of soil testing within limits of variations under field conditions.

The B:C ratio is higher in case of yield target treatments on soil test basis rather than other treatments (Table 5). It may be due to fact that soil test based fertilizer recommendation not only maximized yields, but also lead to balanced fertilization, thereby economizing nutrient dose of the crop (Subba Rao and Srivastava, 1998).

References

Hanway, J.J. and Heidal, H. 1952. Soil analysis methods used in Iowa State College soil testing laboratory. *Iowa Agronomy* 57: 1.

Naidu, L.G.K., Hunsigi, G. and Mohan, N.G.R. 1999. Soil test based fertilizer recommendation to sugarcane – A rational approach. *Fertilizer News* 44: 29-36.

Olsen, S.R., Cole, C.V., Watanabe, F.S. and Dean, L. 1954. Estimation of available phosphorus in soil by extraction with sodium bicarbonate. *USDA Circular 939*, US Govt. Printing Office, Washington, DC.

Piper, C.S. 1950. *Soil and Plant Analysis*. Hans Publications, Bombay.

Ramamoorthy, B. 1993. Soil fertility and fertilizer use aspects for increasing rice production. *Dr. G.V. Chalam Memorial Lecture*, TNAU, Coimbatore.

Ramamoorthy, B., Narasimham, R.L. and Dinesh, R.S. 1967. Fertilizer application for specific yield target of Sonora-64 wheat. *Indian Farming* 17: 43.

Subba Rao, A. and Srivastava, S. 1998. Role of plant nutrients in increasing crop productivity. *Fertilizer News* 43: 65-75.

Subha Rao, A. and Srivastava, S. 1999. Experiences on current status of crop responses to fertilizers in different agro-climatic zones as learnt from AICRP on Soil Test Crop Response Correlation. *Fertilizer News* 44: 83-95.

Subhiah, B.V. and Asija, G.L. 1956. Rapid procedure for estimation of available nitrogen in soils. *Current Science* 25: 259.

Velayutham, M. and Reddy, K.C.K. 1990. *Soil Fertility and Fertilizer Use*. Vol. IV, IFFCO, New Delhi.