Indian Journal of Agronomy **66** (4): 504–508 (December 2021)

Research Communication

Performance of clusterbean (*Cyamopsis tetragonoloba*) under long-term prescription-based fertilizer recommendation in Western Rajasthan

SURESH KUMAWAT[1], S.K. KHARIA[2], S.R. YADAV[3] AND DINESH JINGER[4]

Swami Keshwanand Rajasthan Agricultural University, Bikaner, Rajasthan 334 001

Received: October 2021; Revised accepted: December 2021

ABSTRACT

To understand the impact of prescription-based fertilizer application on the performance of clusterbean [*Cyamopsis tetragonoloba* (L.) Taub.] crop in loamy sandy soil, we started an experiment in 2018 which consisted of 5 treatments; general recommended dose, prescription-based fertilizer recommendation for 1.5 and 2.0 t/ha without compost, prescription-based fertilizer recommendation for 1.5 and 2.0 t/ha with compost. The results revealed that, prescription-based fertilizer recommendation with compost for target yield 2.0 t/ha produced significantly 28.5 and 10.8% higher seed yield than general recommended dose and prescription based fertilizer recommendation for target yield 2.0 t/ha without compost respectively. Similarly, growth and yield attributes parameters such as plant height, leaf area/plant, pod length, clusters/plant, pods/cluster, pods/plant, seeds/pod and test weights were also found significantly higher under prescription-based fertilizer recommendation for target yield 2.0 t/ha with compost than the other treatments. The prescription-based fertilizer recommendation with compost for target yield 2.0 t/ha enhanced significantly macronutrients (N, P and K) content uptake, protein and chlorophyll content.

Key words: Macronutrient, Nutrient uptake, Prescription-based fertilizer recommendation, Seed yield

Clusterbean commonly known as *guar*, is one of the important legume crops grown in Rajasthan. It covers about 17% of the net sown area of the Rajasthan state. It improves soil nitrogen by biological N fixation (30–40 kg/ha) and it has export value to foreign countries. It holds a significant status owing to its use as a raw material for several industries like textiles, paper, oil, pharmaceuticals, food-processing cosmetics, mining explosives, oil drilling etc. It is well suitable to rainfed conditions in arid and semiarid regions of Rajasthan. Its deep penetrating roots allow the plant to uptake available moisture more efficiently and thus extend the scope for rainfed cropping. The productivity of clusterbeans in arid and semi-arid regions is very low compared to its potential (Bhatt *et al*., 2016). Among different methods of formulating fertilizer recommendations, the concept of soil-test-crop response (STCR) has been found quantitative, precise and meaningful (Joshi *et al.,* 2020). In 1967, the Indian Council of Agricultural Research (ICAR) started All India Coordinated Research Project (AICRP) on the STCR approach to obtain a basis for precise quantitative adjustment of fertilizer doses under varying soil-test values and response conditions of the farmers and targeted levels of crop production. In 2008, the soil test-based fertilizer prescription project was started under the clusterbean-wheat (*Triticum aestivum* L.) cropping system. In this project, different equations were developed to calculate fertilizer requirements for this cropping system. Adoption of this approach reduced the fertilizer losses and increased the net return. The use of inorganic fertilizers alone degraded the soil productivity under a continuous intensive cropping system (Kharia *et al*., 2017). The inclusion of organic sources with soil test-based fertilizer prescription enhanced the nutrient content and overall plant growth and yield (Kumawat *et al*., 2017; Singh *et al*., 2019). The addition of compost in the soil can function as an energy source for soil microflora which brings a change of inorganic nutrients content present in the soil in a form that growing plants readily uptake (Gupta *et al.,* 2018). The additional beneficial effect of compost is improvement in soil physical properties. The healthy response of compost to the plant's yield might be attributed to the sufficient NPK nutrients available throughout the growing period.

Based on a part of M.Sc. Thesis of the first author, submitted to the Swami Keshwanand Rajasthan Agricultural University, Bikaner, Rajasthan, in 2018 (unpublished)

[2]Corresponding author's Email: sushil_iari@yahoo.com

[1]Ph.D. Scholar, [2]Assistant Professor, [3]Professor and ZDR, Swami Keshwanand Rajasthan Agricultural University, Bikaner, Rajasthan 334 001; [4]Scientist, ICAR-Indian Institute of Soil and Water Conservation, Research Centre, Vasad, Anand, Gujarat 388 306

Continuous use of this approach will improve soil quality and health. After introducing high-yielding and hybrid varieties, we need to develop a soil-test-based fertilizer prescription model with compost for clusterbeans on loamy sand soil. Keeping all these points in mind, we evaluated the performance of clusterbean crop and soil-test values for achieving the targeted yield of clusterbean after 8 years of continuous use of this approach under the clusterbean-wheat cropping system.

A field experiment was initiated at Agricultural Research Station, Swami Keshwanand Rajasthan Agriculture University, Bikaner, in Rajasthan. It is located in Agro climatic zone Ic (Hyper arid partially irrigated western plain) of Rajasthan, comprising canal irrigated North-Western plains of Bikaner. The experimental field was under clusterbean-wheat cropping system with recommended mineral and organic fertilization for both crops for many years. The climate represents hyper-arid with an annual rainfall of 250 mm. More than 80% of precipitation is received during the rainy (*kharif*) season (July–October) by the South-West monsoon and rest is received through the 'Western Disturbances' from December to February. During summer, the maximum temperature may go as high as 48°C, while in the winters it may fall as low as 0°C. The soil (0–15 cm layer) of experimental field was loamy sand in texture with *p*H 8.37, oxidizable soil organic 2.11 g/kg, electrical conductivity 0.25 dS/m. The available N, P_2O_5 and K_2O were in the rage of 123, 35.4 and 256 kg/ha. The long-term field experiment on prescription-based fertilizer recommendation was initiated in *kharif* 2018 under clusterbean–wheat cropping system with 5 nutrient management treatments, set up in a randomized block design with 4 replications to compare prescription-based fertilizer recommendation for target yield 1.5 and 2.0 t/ha with compost, prescription based fertilizer recommendation for target yield 1.5 and 2.0 t/ha without compost and general recommended dose (20 kg N/ha, 32 kg P_2O_5/ha). For convenience in tractor operation, 2 harrows followed by levelling was done for preparing pulverized soil with fine tilth. Each replication was assigned on a 43.0 m long and 8.5 m wide strip, which was sub-divided into treatments (each treatment 7 m × 4 m). The above-ground biomass of clusterbean and wheat were removed every year. Urea, single superphosphate and muriate of potash were used for applying N, P and K, respectively. Fertilizer adjustment equations were used for calculation of nutrients doses (kg/ha) from fertilizers for targeted yield of clusterbean crop. These requirements were calculated as:

$N = 6.70\ T^* - 0.37\ N^{**} - 0.65\ O^{***}N$

$P = 9.90\ T^* - 2.15\ P_2O_5{}^{**} - 2.05\ X\ 50\ O^{***}\ P_2O_5$

$K = 6.78\ T^* - 0.23\ K_2O^{**} - 0.62\ O^{***}\ K_2O$

where *Target yield, **amount of available nutrient present in soil, ***nutrient per cent in compost.

The chemical composition of compost was 0.68% N, 0.35% P and 0.62% K. Seeds of clusterbean variety 'RGC 1033' were sown on 21 July 2018. Clusterbean seeds were treated with carbendazim 50% WP (fungicide @ 3 g/kg seed) as prophylactic measures against seed-borne diseases followed by phosphate-solubilizing bacteria PSB (@ 5 ml/kg) and *Rhizobium* inoculation (@ 5 ml/kg) before sowing. The seeds were sown by the '*Kera'* method with row-to-row distance of 30 cm and plant-to-plant distance of 10 cm. During crop sowing to harvesting, 5 irrigations were applied by sprinkler-irrigation system. The full dose of N and P was applied basal. For measuring yield, crops were cut from the base of plants at around 3–4 cm above soil, and each plot was tied in bundles and tagged. These bundles were left on the field for sun-drying. After sun-drying, the harvested produce of each plot was weighed to record biological yield. Seed yields of clusterbean were recorded at 12% moisture. After oven-drying at 70°C, straw yields of clusterbean were recorded at a constant weight. Ten random plants were selected from each plot for taking observation on growth and yield attributes. The dried matured pods were harvested and threshed manually and weighed (kg/ha). The harvest index was calculated by using standard formula. The protein content in seed was calculated by multiplying per cent nitrogen content with a factor of 6.25. The N, P and K content and uptake were analyzed according to standard methods. Protein yield (kg/ha) was computed by multiplying protein content (per cent) in seed with seed yield (kg/ha) and divided by 100. Statistical analysis was done by using Statistical Package for the Social Science.

Long-term use of prescription-based fertilizer recommendation approach significantly affected growth parameters of clusterbean crop, viz plant height and leaf area at 30 days after sowing (DAS), 60 DAS and harvesting (Table 1). The highest values of these parameters, viz. plant height at 30 DAS (15.2 cm), 60 DAS (62.0 cm), at harvest (68.1 cm), leaf area at 30 DAS (209 cm^2/plant), 60 DAS (558 cm^2/plant) and at harvesting (491 cm^2/plant) were observed with prescription-based fertilizer recommendation for target yield 2.0 t/ha with compost. While at harvesting, general recommended dose, prescription-based fertilizer recommendation for target yield 1.5 t/ha with compost, prescription-based fertilizer recommendation for target yield 2.0 t/ha without compost, and prescription-based fertilizer recommendation for target yield 2.0 t/ha with compost were found at par with each other. This change might be due to the promotive impact of treatments with organic source could be attributed to the increasing in the plant-available form of nutrients in the soil to cause more energy sources to plant. Similar results were also

Table 1. Effect of prescription based fertilizer recommendation approach on growth and yield attributing parameters in cluster bean

Treatment	Height (cm)			Total leaf area (cm^2/plant)			Clusters/ plant	Pods/ cluster	Pods/ plant	Pod length (cm)	Seeds/ pod
	30 DAS	60 DAS	at harvesting	30 DAS	60 DAS	at harvesting					
General recommended dose	12.5	58.7	63.7	185	507	442	7.25	7.27	36.0	5.68	7.98
Target yield 1.5 t/ha	11.0	56.3	56.5	176	437	375	6.90	7.14	34.1	5.28	7.40
Target yield 1.5 t/ha with IPNS	14.0	60.2	65.0	204	562	455	7.38	7.45	36.8	5.88	8.13
Target yield 2.0 t/ha	11.4	57.2	62.8	181	472	431	7.23	7.23	34.3	5.50	7.83
Target yield 2.0 t/ha with IPNS	15.2	62.0	68.1	209	558	491	7.65	7.42	38.6	6.03	9.10
SEm±	0.95	1.12	1.87	2.83	29	24	0.13	0.08	1.06	0.14	0.40
CD (P = 0.05)	2.9	3.4	5.8	9	89	74	0.40	0.25	3.3	0.42	1.23

DAS, days after sowing

Table 2. Effect of prescription based fertilizer recommendation on yield, protein, chlorophyll, and nutrient content and uptake in clusterbean

Treatments	N content (%)		Total N uptake (kg/ha)	P content (%)		Total P uptake (kg/ha)	K content (%)		Total K uptake (kg/ha)	Chlorophyll content (mg/g)		Protein content (%)	Test weight (g)	Seed yield (t/ha)	Straw yield (t/ha)	HI
	Seed	Straw		Seed	Straw		Seed	Straw		30 DAS	60 DAS					
General recommended dose	3.38	0.76	50.5	0.386	0.180	7.61	0.52	1.31	31.1	3.63	3.61	21.1	35.5	1.05	1.97	0.35
Target yield 1.5 t/ha	3.20	0.65	55.3	0.337	0.169	8.16	0.43	1.20	36.2	3.11	3.14	20.0	34.9	1.21	2.58	0.32
Target yield 1.5 t/ha with IPNS	3.40	0.77	60.3	0.412	0.182	9.45	0.55	1.38	39.8	3.66	3.72	21.2	35.6	1.23	2.41	0.34
Target yield 2.0 t/ha	3.27	0.67	56.3	0.380	0.172	8.89	0.46	1.30	37.5	3.28	3.55	20.4	35.1	1.22	2.46	0.33
Target yield 2.0 t/ha with IPNS	3.45	0.79	66.3	0.417	0.183	10.56	0.57	1.40	45.4	3.84	3.74	21.6	35.9	1.35	2.69	0.34
SEm±	0.06	0.03	3.11	0.015	0.002	0.54	0.03	0.04	2.54	0.14	0.13	0.40	0.23	0.06	0.134	0.02
CD (P = 0.05)	0.20	0.10	9.6	0.047	0.007	1.68	0.09	0.13	7.8	0.45	0.41	1.22	0.7	0.19	0.41	NS

HI, harvest index

obtained by Meena *et al*. (2018) and Sharma (2019).

The prescription-based fertilizer application with compost significantlyimproved the yield attributes and yield of clusterbean (Table 2). Among the treatments, prescription-based fertilizer recommendation for target yield 2.0 t/ha with compost resulted in the highest number of pods/plant (38.6), length of pod (6.03 cm), seeds/pod (9.10), test weight (35.9 g), seed yield (1.35 t/ha), straw yield (2.69 t/ha) and biological yield (4.05 t/ha). However, general recommended dose and prescription-based fertilizer recommendation for target yield 1.5 t/ha with compost were statistically at par with prescription-based fertilizer recommendation for target yield of 2.0 t/ha with compost. Application of nutrient by using prescription-based fertilizer recommendation with compost had significant influence on seed and straw yields as compared to prescription-based fertilizer recommendation without compost. Prescription-based fertilizer recommendation with compost for prescription-based fertilizer recommendation for target yield 2.0 t/ha resulted in 10.7% and 28.6% more yield than nutrient applied according to prescription-based fertilizer recommendation without compost similar target yield and general recommended dose respectively. Results indicate that all the treatment combinations were statistically non-significant in improving the harvest index of cluster bean. Applying inorganic fertilizer with compost to the clusterbean crop increased the plant's availability of primary nutrients in soils mainly because of enhanced root growth and cell multiplication. It leads to more absorption of other plant nutrients from lower soil depths, increasing growth attributes and growth rate of plants.It is further supported that, soil of the experimental field contained available N(123 kg/ha), P(35.4 kg/ha) and K(256 kg/ha) and this might be the cause of high response of the crop to the application of nutrient based on prescription-based fertilizer recommendation for different targeted yield. This may be attributing principally to the beneficial role of inorganic fertilizer with organic manure which enhanced overall physical, chemical and biological status of the soil. Our results support the findings of Rathore *et al*. (2007). With the application of nutrients using prescription-based fertilizer recommendation with compost dose for target 2.0 t/ha resulted in the highest straw yield. The variation in harvest index under various treatments was non-significant.

The highest N content in seed and straw (3.45% and 0.79%), protein content (21.6%), total N uptake (66.3 kg/ha), P content in seed and straw (0.417% and 0.183%), total P uptake (10.56 kg/ha), K content in seed and straw (0.57% and 1.40%), total K uptake (45.4 kg/ha) and chlorophyll content (3.84 and 3.74% at 30 DAS and 60 DAS, respectively) were found with prescription-based fertilizer recommendation with compost for 2.0 t/ha prescription-based fertilizer recommendation (Table 2). While the prescription-based fertilizer recommendation with compost for 1.5 t/ha and general recommended dose treatments were found statistically at par. A better soil environment enhanced the N availability may have boosted theprotein content in seed. The higher NPK content with increased seed and straw yields leads to higher uptake of macronutrients by the cluster bean. The favourable effect of compost on NPK content and uptake may be owing to reduced losses of released NPK during decomposition in the study duration. Thus, the addition of compost and applied inorganic fertilizer increased the availability of NPK in the soil and consequently the higher uptake by plants owing to change in soil physical, chemical and biological conditions and the availability of moisture. Further, the NPK uptake mainly depends on nutrient content and seed and straw yields, which also improved statistically with these parameters. Our results confirm those of Meena and Lal (2018). High protein content with compost could be owing to increased root growth and nodulation, resulting in increased NP content and enhanced activity of N and P solubilizing bacteria, mainly owing to available organic matter, which could have increased soil pool. Thus, adoption of prescription-based fertilizer recommendation approach for nutrient management resulted in significantly higher seed yield, improved growth and yield-attributing parameters of clusterbean crop in loamy sand soil of Rajasthan.

Based on the results it could be concluded that, balanced application of NPK based on STCR approach clusterbean–wheat cropping system significantly improved plant growth parameters and yield attributing characters. Seed and straw yield were found significantly higher under prescription based fertilizer recommendation with compost for 2.0 t/ha.

REFERENCES

Bhatt, R.K., Juklani, A.K. and Roy, M.M. 2016. Cluster bean, an important industrial arid legume: A review. *Legume Research* (4): 207–214.

Gupta, G., Dhar, S., Dass, A., Sharma, V.K., Singh, R.K., Kumar, A., Jinger, D. and Kumar, A. 2018. Influence of bio-inoculant mediated organic nutrient management on productivity and profitability of pigeonpea in a semi-arid agro-ecology. *Indian Journal of Agricultural Sciences* **88**(10): 1,593–1,596.

Joshi, E., Vyas, A.K., Dhar, S., Dass, A., Prajapat, K., Jinger, D. and Sasode, D.S. 2020. Macro-and micro-nutrient uptake pattern and their use efficiencies for maize in maize–wheat–wheat cropping system under nutrient omissions. *Indian Journal of Agricultural Sciences* **90**(9): 1,714–1,721.

Kharia, S.K., Goyal, A., Jinger, D. and Yadav, B. 2017. Impact of resources conservation technologies under rice–wheat cropping system in Indo-Gangetic Plains of India: A review. *Annals of Agricultural Research* **38**(2): 1–9.

Kumawat, C., Yadav, B., Verma, A.K., Meena, R.K., Pawar, R., Kharia, S.K., Yadav, R.K., Bajiya, R., Pawar, A., Sunil, B.H.

and Trivedi, V. 2017.Recent Developments in multi-nutrient extractants used in soil analysis. *International Journal of Current Microbiology and Applied Science* **6**(5): 2,578–2,584.

Meena, H., Meena, R.S., Lal, R., Singh, G.S., Mitran, T., Layek, J., Patil, S.B., Kumar, S. and Verma, T. 2018. Response of sowing dates and bio regulators on yield of cluster bean under current climate in alley cropping system in eastern U.P. *Indian Legume Research* **41**(4): 563–71.

Meena, R.S. and Lal, R. 2018. Legumes and sustainable use of soils. (In) *Legumes for Soil health and Sustainable Management*. R.S. Meena *et al.* (eds.). Springer https://0.1007/978-doi.org/1981-13-0253-4_1.

Rathore, V.S., Singh, J.P., Soni, M.L. and Beniwal, R.K. 2007. Effect of nutrient management on growth, productivity and nutrient uptake of rainfed cluster bean in arid region. *Indian Journal of Agricultural Sciences* **77**(6): 349–353.

Sharma, P., Meena, R.S., Kumar, S., Gurjar, D.S., Yadav, G.S. and Kumar, S. 2019. Growth, yield and quality of clusterbean as influenced by integrated nutrient management under alley cropping system. *Indian Journal of Agricultural Sciences* **89**(11): 124–128**.**

Singh, Y.V., Singh, S.K. and Dey, P. 2019. Soil test-based fertilizer prescriptions under integrated plant nutrient management for linseed in an Inceptisol of eastern plain zone of Uttar Pradesh. *Journal of the Indian Society of Soil Science* **67**(4): 445–449.