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Effect of spacing and integrated nutrient management on yield attributes, yield and quality of cluster bean (*Cyamopsis tetragonoloba* L. Taub) cv. Pusa Navbahar

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Abstract
An investigation entitled "Effect of spacing and integrated nutrient management on yield attributes, yield and quality of cluster bean (*Cyamopsis tetragonoloba* L. Taub) cv. Pusa Navbahar" was carried out during year 2018 at Horticulture Research Farm, Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand. An investigation was laid out in Randomized Block Design (Factorial) with 3 replications and fourteen treatments combination comprising of two levels of spacing *viz*., S_1: 45 × 15 cm and S_1: 30 × 15 cm and seven level of integrated nutrient management *viz.*, F_1 - 25:50:00 NPK kg/ha (Control), F_2 - 30:60:00 NPK kg/ha, F_3 - 50% RDN through inorganic fertilizer + 50% RDN through FYM + seed treatment of *Rhizobium* and Phosphate solubilizing bacteria (each 5 ml/kg of seed), F_4 - 50% RDN through inorganic fertilizer + 50% RDN through vermicompost + seed treatment of *Rhizobium* and Phosphate solubilizing bacteria (each 5 ml/kg of seed), F_5 - 20:40:00 NPK kg/ha + seed treatment of *Rhizobium* (5 ml/kg of seed), F_6 - 20:40:00 NPK kg/ha + seed treatment of Phosphate solubilizing bacteria (5 ml/kg of seed), F_7 – 20 : 40 : 00 NPK kg/ha + seed treatment of *Rhizobium* and Phosphate solubilizing bacteria (each 5 ml/kg of seed). Spacing showed significant effect on yield and quality parameters. However, green pod weight (g) and fiber content (g/100g) did not observed any significant effect of spacing. Spacing 45 × 15 cm (S_1) recorded maximum number of cluster/plant, number of pods/cluster, number of pods/plant, green pod length, green pod yield (g/plant) and crude protein (%) whereas, green pod yield (kg/plot) and green pod yield (t/ha) was found maximum in Spacing 30 × 15 cm (S_2). Maximum number of cluster/plant, number of pods/cluster, number of pods/plant, green pod yield (g/plant), green pod yield (kg/plot) and green pod yield (t/ha) was recorded with treatment F_4 [50% RDN through inorganic fertilizer + 50% RDN through vermicompost + seed treatment of *Rhizobium* and Phosphate solubilizing bacteria (each 5 ml/kg of seed)]. While, maximum green pod length (cm) and crude protein (%) was observed with treatment F_3. While, green pod weight and fiber content found non-significant difference. Interaction effect between S_1F_1 recorded maximum number of clusters/plant.

Keywords: Cluster bean, FYM, Vermicompost, *Rhizobium*, phosphate solublising bacteria

Introduction

Cluster bean (*Cyamopsis tetragonoloba* L. Taub.) belongs to family Fabaceae is an important drought resistant leguminous vegetable crop. It has been grown in India since ancient time for vegetable, green manure and fodder purposes. It is a short duration crop grown mainly in arid and semi-arid regions of tropical India.

India is one of the major cluster bean producing countries of the world contributing around 75 to 80% of the world's total production. Rajasthan is the largest cluster bean producing states in the world as it dominates the Indian production scenario contributing to over 70% of the total production in India. Pods of cluster bean are rich in food value and each 100 g contains 10.8 g carbohydrate, 3.2 g protein, 1.4 g minerals, 316 IU vitamin-A and 47 mg Vitamin-C. It is also used as a nutritious fodder for livestock.

Cluster bean is used for human consumption, cattle feed, medicinal and industrial purposes as well as for soil improvement. Cluster bean is rich source of protein and minerals. For human consumption immature pods are being dried, salted and preserved for vegetable purpose. They are also dried like potato chips. Green pods are also cooked like French beans.

Mucilaginous seed flour is used for making guar gum (galactomannan). Cluster bean gum and its derivatives are widely used in several industries such as food processing, mining, papertextiles, ceramics, paints, cosmetics, pharmaceuticals, explosive, synthetic resins, plastics, photographic technology and oil industries. Thus, it has made considerable value of crop in India.

The spacing depends on the optimum plant stand and varies for different regions having varied rainfall intensities. Plant spacing is the most important yield attributing factor which can be manipulated to attain the maximum production from a unit area.

Use of inorganic fertilizers alone though increases the production at a faster rate but it may not sustain the productivity in long run and affects soil health. Moreover, inorganic fertilizers are costly and their imbalanced use deteriorate soil physio-chemical environment. On the other hand, organic sources of nutrients are cheaper, ecofriendly, improve soil properties and can substitute nutrient requirement of crops partially. Hence, integrated use of inorganic fertilizers, organic manures and low-cost nutrient sources such as bio fertilizers is the better option for sustainable production and maintenance of soil health.

Materials and methods

An experiment was conducted during *Kharif –Rabi* season of the year 2018 at Horticulture Research Farm, Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand. The experiment was laid out in Randomized Block Design (Factorial) with 3 replications and fourteen treatments combination comprising of two levels of spacing *viz.,* S_1: 45 × 15 cm and S_1: 30 × 15 cm and seven level of integrated nutrient management *viz.,* F_1 - 25:50:00 NPK kg/ha (Control), F_2 - 30:60:00 NPK kg/ha, F_3 - 50% RDN through inorganic fertilizer + 50% RDN through FYM + seed treatment of *Rhizobium* and Phosphate solubilizing bacteria (each 5 ml/kg of seed), F_4 - 50% RDN through inorganic fertilizer + 50% RDN through vermicompost + seed treatment of *Rhizobium* and Phosphate solubilizing bacteria (each 5 ml/kg of seed), F_5 - 20:40:00 NPK kg/ha + seed treatment of *Rhizobium* (5 ml/kg of seed), F_6 - 20:40:00 NPK kg/ha + seed treatment of Phosphate solubilizing bacteria (5 ml/kg of seed), F_7 – 20 : 40 : 00 NPK kg/ha + seed treatment of *Rhizobium* and Phosphate solubilizing bacteria (each 5 ml/kg of seed). Biofertilizers were applied as a seed treatment before sowing. Blanket application of FYM 10 t/ha was given at the time of field preparation. Organic manures were given on the basis of its nutrient content. Observations of yield attributes, yield and quality of green pods were recorded during investigation.

Results and Discussion

Yield attributes

Effect of spacing

The data presented in Table – 1 showed that 45 × 15 cm spacing recorded significantly, the highest number of clusters plant (14.70), number of pods/cluster (6.86), number of pods/plant (98.36) and green pod length (11.65 cm). whereas, green pod weight was not significantly affected by different spacing.

It might be due to in wider row spacing better growth and development of individual plant. While, in closer spacing there might have competition between roots of the neighboring plants for uptake of nutrition, water and sunlight, which would have restricted the growth of plants. Similar, results were also reported by Meena *et al.* (2016) [4] in cluster bean.

Effect of integrated nutrient management

Data presented in Table 1 indicated that number of clusters/plant influenced significantly by the effect of integrated nutrient management. The highest number of clusters/plant (16.25), number of pods/cluster (7.44) and number of pod/plant (113.06) were recorded in F_4 but it was remained at par with treatment F_3 for number of clusters per plant (14.91) and number of pods/plant (103.68) whereas, same treatment was at par with F_3 and F_7 for number of pods/cluster (7.00 and 6.82). However, green pod length was found maximum in treatment F_3 (13.01 cm). It might be due to integrated use of inorganic and organic fertilizers along with biofertilizers increased nutrient availability in rhizosphere by soil biological activity which supplied the required nutrients constantly at all stages of crop growth along with better assimilation of photosynthates. Similar, findings were also reported by Reddy *et al.* (2014) [11] and Patel *et al.* (2018) [8] in cluster bean. There was no any significant effect of integrated nutrient management on green pod weight (g).

Interaction effect

Interaction effect of plant geometry and integrated nutrient management on number of clusters/plant was found significant (Table 2). Maximum number of clusters/plant (16.68) was recorded under treatment combination S_1F_1 [45 x 15 cm spacing along with the 25:50:00 NPK kg/ha (Control)] which, was at par with treatment S_1F_4 (16.62), S_2F_4 (15.88), S_1F_3 (15.02), S_2F_3 (14.79), S_2F_6 (14.78) and S_1F_5 (14.23). It might be due to in wider spacing plants utilized the fully available natural resources resulting in improvements in the yield components as compared to narrow spacing and application of integrated nutrient made available nutrient in rhizosphere and proper utilization of photosynthets by plants. Similar, results were also reported by Rajput (2002) [10] and Sharma (2007) [12] in cluster bean.

Table 1: Effect of spacing and integrated nutrient management on yield attributes

Treatments	No. of clusters/plant	No. of pods/cluster	No. of pods/plant	Green pod weight (g)	Green pod length (cm)
Factor A : Spacing					
S_1	14.70	6.86	98.36	1.09	11.65
S_2	13.73	6.37	87.59	1.08	10.48
S. Em.±	0.32	0.16	2.15	0.02	0.20
C. D. at 5%	0.94	0.45	6.24	NS	0.57
Factor B : Integrated Nutrient Management					
F_1	14.09	5.59	78.47	1.07	9.97
F_2	13.13	6.50	84.67	1.11	10.68
F_3	14.91	7.00	103.68	1.17	13.01
F_4	16.25	7.44	113.06	1.05	11.93
F_5	13.61	6.53	89.13	1.07	10.28
F_6	14.10	6.43	90.24	1.09	10.64

F_7	13.40	6.82	91.56	1.04	10.93
S. Em.±	0.60	0.29	4.02	0.04	0.37
C. D. at 5%	1.76	0.85	11.68	NS	1.06
Interaction					
S × F	Sig.	NS	NS	NS	NS
C. V. %	10.42	10.84	10.58	9.88	8.09

Table 2: Interaction effect of spacing and integrated nutrient management on number of clusters/plant.

Spacing	Integrated nutrient management						
	F_1	**F_2**	**F_3**	**F_4**	**F_5**	**F_6**	**F_7**
S_1	16.68	13.64	15.02	16.62	14.23	13.42	13.26
S_2	14.09	12.62	14.79	15.88	12.98	14.78	13.54
S. Em.±	0.85						
C. D. at 5%	2.48						
C. V. %	10.42						

Yield and quality

Effect of spacing

The maximum green pod yield (99.21 g/plant) was found with spacing 45 × 15 cm (Table 3). Increase in green pod yield/plant in the wider spacing might be due to more favourable conditions like space, nutrients, moisture and light available to each plant. Similar, results were also recorded by Vihol (2003) [14] in cluster bean. However, green pod yield (3.61 kg/plot) and green pod yield (14.41 t/ha) was recorded maximum in spacing 30 × 15 cm. Number of plant attributes have been found to be influenced beneficially by wider row spacing, but due to more number of plants per unit area and their cumulative effect on yield resulted in higher yield. Therefore, higher yield potential of plants under wider row spacing could not compensate the total yield obtained from closer row spacing. Similar, results were also reported by Yadav *et al.* (2014) [15] in cluster bean, Naik (1989) [6] and Uddin *et al*. (2001) [13] in garden pea.

Quality parameters crude protein (%) found significant difference among treatments. While, fiber content (g/100g) remain non-significant. Crude protein (3.04%) was found maximum in spacing 45 × 15 cm. The higher protein content under wider row spacing might be due to the fact that roots of the plant may have wider area for absorbing essential nutrients required for the formations for protein. Similar, findings were also reported by Rajput (2002) [10], Sharma (2007) [12] and Midha *et al*. (2015) in cluster bean.

Effect of integrated nutrient management

Data presented in Table 2 revealed that yield and quality were significantly influenced by integrated nutrient management. Treatment F_4 recorded maximum green pod yield (98.21 g/plant), (3.72 kg/plant) and (15.88 t/ha) which remained at par with treatment F_3 (90.33 g/plant, 3.32 kg/plant, 14.25 t/ha, respectively) and F_7 (87.86 g/plant, 3.33 kg/plant, 14.23 t/ha, respectively). Increase in green pod yield might be due to improved soil physical, chemical and biological properties and higher availability of all plant nutrients resulted improvement in growth and yield attributes of plant which ultimately increase the green pod yield. These finding are in conformity with the findings of Reddy *et al.* (2014) [11] in cluster bean, Kumar *et al.* (2004) and Ashwini (2005) in french bean.

Among quality parameters crude protein (%) observed significant difference while, fiber content remained non-significant. Maximum crude protein (3.38%) was recoded in treatment F_3. Nitrogen which is key component for protein synthesis, application of FYM, inorganic fertilizers, biofertilizers increases availability and uptake of such elements and its further assimilation for biosynthesis of protein (Narayana *et al*., 2009). Similar, results were also reported by Prabhavathi (2014) [9] and Manohar *et al*. (2018) [3] in cluster bean.

Table 3: Effect of spacing and integrated nutrient management on yield and quality

Treatments	Green pod yield (g/plant)	Green pod yield (kg/plot)	Green pod yield (t/ha)	Crude protein (%)	Fiber content (g/100g)
Factor A : Spacing					
S_1	99.21	2.93	13.50	3.04	2.52
S_2	72.34	3.61	14.41	2.73	2.39
S. Em.±	1.97	0.08	0.30	0.05	0.05
C. D. at 5%	5.73	0.22	0.89	0.16	NS
Factor B : Integrated Nutrient Management					
F_1	82.75	3.19	13.62	2.49	2.26
F_2	78.33	3.04	13.02	2.60	2.45
F_3	90.33	3.32	14.25	3.38	2.72
F_4	98.21	3.72	15.88	2.97	2.48
F_5	80.44	3.07	13.07	2.99	2.46
F_6	82.48	3.20	13.64	2.92	2.46
F_7	87.86	3.33	14.23	2.85	2.37
S. Em.±	3.69	0.14	0.57	0.10	0.09
C. D. at 5%	10.72	0.41	1.66	0.30	NS
Interaction					
S × F	NS	NS	NS	NS	NS
C. V. %	10.53	10.57	10.01	8.65	8.95

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