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Impact of Row Spacing on Growth and Yield of Cluster bean (*Cyamopsis tetragonoloba* L.) Varieties

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ABSTRACT: The field experiment was conducted during *Kharif* 2020 at Research Farm, Krishi Vigyan Kendra, Sangaria, Hanumangarh (Rajasthan). The treatment consists of three different row spacing of (30 cm, 45 cm and 60 cm) and three different varieties HG 2-20, HG 365 and RGC 1002, whose effect was observed on Cluster bean. The experiment was laid out in Randomized Block Design in which consist of nine treatments which are replicated thrice. The result showed that seeds of variety HG 365 sown with 45 cm row line up significantly increased the growth parameters of cluster bean *viz*, plant height (119.13 cm), Dry weight (36.11 g/plant), number of branches (10.00), number of leaves (299.73). Also in yield, Variety HG 365 sown in 45 cm row line up showed significantly excessive pods per plant (53.73), total seed weight (1075.67 kg/ha), stalk yield (2581.60 kg/ha), Gross profit (69703₹/ha), Net profit (50398₹/ha), Benefit cost ratio (3.61) followed by variety HG 2-20 with 60 cm row spacing. The higher harvest index (38.46 %) was obtained under variety RGC 1002 with both 30 cm and 45 cm row line up sowing. The 1000 seeds weight also recorded higher in variety RGC 1002. In growth parameters variety HG 2-20 at 60 cm row spacing shows higher leaf area (598.81 cm^2). Seed per pods (8.60) also recorded higher in variety HG 2-20 at 60 cm row spacing. So, the unite effect of growth and yield attributes were ultimate review in production of highest seed yield by sowing of cluster bean variety HG 365 at 45 cm row line up and variety HG 2-20 at 60 cm row line up should be recommended for farmers of that region of Rajasthan.

Keywords: Cluster bean, Row Spacing, Variety, Growth.

INTRODUCTION

Cluster bean [*Cyamopsis tetragonoloba* (L.) Taub] popularly known as "Guar" is an important legume crop mainly grown under rainfed condition in arid and semi-regions of Rajasthan during *kharif* season. It is very hardy and drought tolerant crop. Cluster bean is a leguminous crop and can fix 37-196 kg N/ha per year. (ijcmas.com and Kalyani, 2012). Cluster bean is used for human consumption, cattle feed, medicinal and industrial purposes as well as for soil improvement (www.lap-publishing.com). 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 (Hymowitz, 1972). Its young pods are used as vegetables, which also known for cheap source of energy (16Kcal), protein (3.2 g), fat (1.4 g), carbohydrate (10.8 g), vitamin A (65.3 IU), vitamin C (49 mg), calcium (57 mg) and iron (4.5 mg) for every 100g of edible portion (ejplantbreeding.org and Kumar *et al.*, 2018). Mature seeds are used as an emergency pulses in times of famine which contain about 31% protein. Guar is being grown mainly in arid and semiarid region of North Western states of Rajasthan, Gujarat, Haryana, Punjab, parts of Uttar Pradesh, Madhya Pradesh and Tamil Nadu covering about 3.34 million hectares with a production of 0.4 million tonnes of guar seed. Rajasthan occupies the largest area under guar cultivation (82.1%), followed by Haryana (8.6%), Gujarat (8.3%) and Punjab (1%) which in turn produced 64, 22, 12 and 2% guar seeds, respectively (ijcmas.com). Rajasthan is the largest producer accounting for 70% of total guar production followed by Gujarat, Haryana and Punjab. Rajasthan has an area of 46.30 lakh hectare, production of 27.47 million tonnes with a productivity of 593 kg/ha www.ijcmas.com (Reddy and Reddy 2011).

Although cluster bean can be grown in area of erratic rainfall but growing of improved genotypes and thus higher yield and quality could be achieved with proper row spacing and varieties. Taneja *et al.*, (1982) delineate higher seed yield in 30 cm row spacing due to more number of plants per unit area and pods per plant.

But, 1000 seed weight did not differ due to different spacing. The varieties have their own ability for growth, development and yield, yet some encouraging varieties of guar have shown much variation particularly in yield potentials under different row spacing. In view of above scenario, a field experiment was laid out to study the effect of row spacing and varieties on growth and yield of cluster bean. Crop raised yield with 30 row lineup has proved to be a better option for getting higher productivity under irrigated condition (Singh and Singh 2021).

MATERIALS AND METHODS

The experiment was conducted during the *Kharif* season 2020, at the Research Farm, Krishi Vigyan Kendra, Sangaria, Hanumangarh, Rajasthan, India which is located at geographical coordinate's 29°51' 39.14" N latitude, 74°20' 51.96"E longitude and 192.81 m altitude above the mean sea level. Location of KVK is about 26 Km from district head quarter on Dholnagar road in North-West direction and tri junction of Rajasthan, Punjab and Haryana. The annual rainfall is 313.6 mm. The experimental soil contained low organic carbon 0.24%, medium available nitrogen 199 kg ha^{-1}mediumavailable phosphorus 39 kg ha^{-1}, high available potash 490 kg ha^{-1} with pH 8.40 and electrical conductivity of 0.58 (dS m^{-1}). Experiment was laid out in randomized block design in which nine treatments which is replicated thrice. The treatment consists of three different row spacing of (30 cm, 45 cm and 60 cm) and three different varieties HG 2-20, HG 365 and RGC 1002, whose effect was observed on Cluster bean. The recommended dose of fertilizer is nitrogen 20 kg, phosphorus 40 kg and potash 20 kg which were given as a basal dose at time of sowing Rawat *et al*., (2013). Nitrogen, phosphorus and potash used in form of urea, diammonium phosphate and muraite of potash respectively. For plant protection purpose Alachalor and copper were used Sharma *et al.*, (2014). In all plots 5 plants were tagged for observation recording and yield recording from net plot. Under growth attributes plant height, average branches, mean number of leaves were recorded from tagged plants at consistent meantime. Wherever, anhydrous basis, leaf area and leaf area index (LAI) different sampling method were workout observation for 5 uprooted plants from outer line up of each and every plots.

Leaf area was measured by disc method on dry weight basis as per the procedure suggested by Vivekanandan *et al*., (1972)

$$LA = \frac{Wa \times A}{Wd}$$

Where,

LA = Leaf area (cm^2 $plant^{-1}$)

Wa = Oven dry weight of all leaves (inclusive of 10 disc (cm^2)

WD = oven dry weight of 10 disc in gram,

A = Area of the 10 discs (cm^2) (krishikosh.egranth.ac.in)

Leaf area index was worked out by dividing the leaf area per plant by land area occupied by the plant (oar.icrisat.org)

$$LAI = \frac{\text{Leaf area per plant}}{\text{Land area occupied by the plant}}$$

Before harvesting of whole crop plants 5 marked plants pulled out from each and every plots for recording of yield attributes. A composite sample of seeds was drawn from threshed pods from each net plot and 1000 seeds were weighted in gram. And harvest index calculated by following formula (Donald and Hambline, 1976).

$$\text{Harvest index (\%)} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

The data collected were arranged in appropriate tables and analyzed statistically by applying analysis of variance technique (ANOVA) (Gomez *et al.*, 1984). The significance of variance was tested by error mean square method of Fisher Snedecor's F-test at the probability level of 0.05 for appropriate degree of freedom ($p<0.05$). Standard error of mean i.e. SEm (±) were used in all cases (ijcmas.com).

RESULTS AND DISCUSSION

A. Effect on growth attributes

The plant vertical growth plays a vital in outstanding yield production. During research trial crucially plant height (119.13 cm) recording in variety HG 365 sown at row spacing of 45 cm followed by variety HG 2-20 sown at 30 cm row spacing in which plant vertical growth (116.10 cm) recorded (Table 1). Closer spacing gained much more growth in vertical direction as compare to wider spacing, this happened due to competitive behavior of plants for moisture, light, air and minerals (Vishal *et al*., 2014). The total number of branches notably higher (10.00) recorded in variety HG 365 sown with 45 cm row spacing. However, variety HG 2-20 sown at 60 cm row spacing recorded branches (9.40) at par to genotype HG 365 with 45 cm line up. Variety HG 365 sowing with row line up of 45 cm set down significantly higher anhydrous basis (36.11 g) and figure of leaves (333.66) per plant. Where, variety HG 2-20 sown at 60 cm row spacing (35.02 g), variety HG 2-20 sown at 45 cm row spacing (34.60 g) and variety HG 365 with 60 cm row spacing (33.00 g) found to be at par to higher combination. In number of leaves variety HG 2-20 sown at 60 cm row spacing (280.93), variety HG 2-20 sown at 45 cm row spacing (281.13) and variety HG 365 with 60 cm row spacing (210.46) found to be at par to variety HG 365 with 45 cm row line up. This might be due to bona-fide adjustment of plants which simplify more photosynthesis, interception of light and easy aeration. These resulting are in line with that of Kumar *et al*., (2008). The high up examined leaf area (598.81) found in 60 cm row spacing which indicates the conventional arrangements of plant populations. And higher leaf area index (1.05) observed in closer row spacing i.e. 30 cm row spacing due to more population per unit area.

Table 1: Impact of row spacing and varieties on growth attributes of cluster bean.

Treatments	Plant height (cm)	Branches (No.)	Leaves per plant (No.)	Plant dry weight (g)	Leaf area (cm^2)	Leaf area index
30 cm row spacing + HG 2-20 variety	116.10	5.73	161.20	20.77	472.50	1.04
30 cm row spacing + HG 365 variety	109.70	5.80	133.00	21.47	476.02	1.05
30 cm row spacing + RGC 1002 variety	94.36	5.40	92.93	17.53	412.88	0.91
45 cm row spacing + HG 2-20 variety	104.06	6.46	281.13	34.60	561.75	0.82
45 cm row spacing + HG 365 variety	119.13	10.00	299.73	36.11	553.82	0.81
45 cm row spacing + RGC 1002 variety	94.50	5.40	101.06	16.88	462.10	0.68
60 cm row spacing + HG 2-20 variety	104.66	9.40	280.93	35.02	598.81	0.66
60 cm row spacing + HG 365 variety	103.06	6.33	210.46	33.00	580.65	0.64
60 cm row spacing + RGC 1002 variety	93.93	5.33	131.73	20.13	530.98	0.58
S.Em(±)	5.07	0.24	31.41	4.48	20.88	0.03
CD (P=0.05)	15.21	0.72	94.16	13.43	62.59	0.09

B. Effect on yield and yield attributes

The mean figure of pods per plant (53.73), weight of seed (1075.67 kg ha^{-1}) and stalk yield (2581.60 kg ha^{-1}) recorded higher in variety HG 365 with 45 cm row spacing (Table 2). However, in both parameters mean number of pods and seed yield variety HG 2-20 with 60 cm row spacing (47.86 and 980.75 kg ha^{-1} resp.), variety HG 365 with 60 cm row spacing (41.73 and 965.82 kg ha^{-1} resp.), variety HG 2-20 at 45 cm row spacing (39.86 and 881.68 kg ha^{-1} resp.) and variety HG 2-20 at 30 cm row line up (36.13 and 841.50 kg ha^{-1} resp.) found at par to variety HG 365 which were sown at 45 cm row spacing. The variety HG 365 with 60 cm row spacing shows significant impact on average number of seeds per pod (8.60).

However, variety HG 2-20 with 60 cm row spacing found to be at par to higher treatment. The genotype HG 365 showed superiority over the rest due to production of higher dry matter that leads to effective translocation and distribution of photosynthates from the source to sink in turn more pod yield per plant (Ashwini *et al.*, 2019). 1000 seed weight found high up in variety RGC 1002. This might be due to better penetration of light, free air circulation to the lower layers of the crop canopy and reduction of inter-row crop competition (ijcmas.com). The optimum seed yield performance of blackgram under summer season maintaining a wider spacing of 30 × 10 cm. Whereas, optimum growth was observed with a wider spacing of 40 × 10 cm (Rashmitha *et al*., 2021).

Table 2: Impact of row spacing and varieties on yield and yield attributes of cluster bean.

Treatments	Pod per plant (No.)	Seeds per pod (No.)	Test weight (g)	Seed yield (kg ha^{-1})	Stalk yield (kg ha^{-1})	Harvest index (%)
30 cm row spacing + HG 2-20 variety	29.40	5.60	29.80	841.50	1335.68	35.71
30 cm row spacing + HG 365 variety	22.46	5.80	30.80	785.70	1514.69	37.03
30 cm row spacing + RGC 1002 variety	17.66	4.93	32.30	488.05	800.87	38.46
45 cm row spacing + HG 2-20 variety	39.86	6.93	30.90	881.68	2124.79	31.25
45 cm row spacing + HG 365 variety	53.73	5.93	32.10	1075.67	2581.60	29.41
45 cm row spacing + RGC 1002 variety	3.93	5.60	33.20	572.42	915.86	38.46
60 cm row spacing + HG 2-20 variety	47.86	8.00	32.20	980.75	1939.69	33.33
60 cm row spacing + HG 365 variety	41.73	8.60	31.00	965.82	1961.50	31.25
60 cm row spacing + RGC 1002 variety	36.13	6.20	33.10	698.98	1188.26	35.80
S.Em(±)	5.05	0.63	4.62	87.48	176.76	0.41
CD (P=0.05)	15.13	1.88	-	262.26	529.91	1.23

C. Effect on economics

The maximum cost of cultivation observed in 30 cm row spacing sowing method (Table 3). Weather gross expenditure (69703.41₹/ha), net expenditure (50398.01₹/ ha)and benefit cost ratio (3.61) were higher found in variety HG 365 sown at 45 cm row spacing followed by variety HG 2-20 at 60 row spacing (62724.39₹/ha, 43494.09₹/ha and 3.26 resp.). This is due to more seed rate used in closer spacing (14.5 kg ha^{-1}) as compare to wider (7.25 kg ha^{-1}) (Chaudhari and Kumar 2016).

Table 3: Impact of row spacing and varieties on economics of cluster bean.

Treatments	Cost of production (INR ha^{-1})	Gross expenditure (INR ha^{-1})	Net expenditure (INR ha^{-1})	B:C ratio
30 cm row spacing + HG 2-20 variety.	19737.8	53161.37	33423.57	2.69
30 cm row spacing + HG 365 variety.	19594.6	50171.39	30576.79	2.56
30 cm row spacing + RGC 1002 variety.	19552.5	30883.95	11331.44	1.57
45 cm row spacing + HG 2-20 variety.	19399.0	57150.39	37751.44	2.94
45 cm row spacing + HG 365 variety.	19305.4	69703.41	50398.01	3.61
45 cm row spacing + RGC 1002 variety.	19275.3	36176.94	16901.63	1.87
60 cm row spacing + HG 2-20 variety.	19230.3	62724.39	43494.09	3.26
60 cm row spacing + HG 365 variety.	19159.6	61872.20	42712.60	3.22
60 cm row spacing + RGC 1002 variety.	19137.3	44315.33	25177.99	2.31

CONCLUSION

The variety HG 365 along with 45 cm row line up achieved higher plant height, figure of branches per plant, leaves per plant, anhydrous basis, pods for each plant, seed mass per hectare & stalk yield per hectare followed by variety HG 2-20 sown with 60 cm row line up. But, variety RGC 1002 found superior in both harvest index and test weight. There is no significant difference in test weight due to row arrangements. Among the results we concluded that, variety HG 365 gave significant production with 45 cm row space arranging and variety HG 2-20 shows notably result under 60 cm row line up sowing.

FUTURE SCOPE

Further scope for experiment can be carried on the basis of availability of land and varieties to see how spacing and different genotype affect crop growth and yield.

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Conflict of Interest. There is no conflict of interest among the four authors.

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