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Effect of Planting Density and Different Genotypes on Growth, Yield and Quality of Guar

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ABSTRACT

A field trial was conducted to standardize row spacing and suitable genotype at College of Agriculture, Shivamogga. Three guar genotypes viz., RGC-1003, RGC-936 and HG-365 were grown at four different spacing viz., 45 cm x 15 cm, 30 cm x 15 cm, 45 cm x 10 cm and 30 cm x 10 cm. Experiment was laid out in factorial Randomized complete block design with three replications. Among the genotypes, RGC-1003 recorded significantly higher growth parameters viz., plant height (53.06 cm), number of leaves (17.38), number of branches (8.28), number of clusters plant^{-1} (7.94), number of pods plant^{-1} (29.31), number of seeds pod^{-1} (7.07), 100 grain weight (3.33 g), pod length (4.62 cm) and grain yield (898.18 kg ha^{-1}), stover yield (1931.39 kg ha^{-1}) with a harvest index (0.32) and quality parameters viz., Endosperm (33.96 %), Protein (31.68 %), Gum (31.09 %), Viscosity (245.75 cps^{-1}) as compared to other genotypes. Among the spacing, plants grown at 30 cm x 10 cm recorded significantly higher plant height (49.51 cm), number of leaves (16.39), number of branches (8.07), number of clusters plant^{-1} (7.18), number of pods plant^{-1} (23.48), number of seeds pod^{-1} (6.76), 100 grain weight (3.22 g), pod length (4.47 cm) and grain yield (743.89 kg ha^{-1}), stover yield (1629.94 kg ha^{-1}) with a harvest index (0.34) and quality parameters viz., Endosperm (33.49 %), Protein (30.94 %), Gum (30.36 %), Viscosity (236.47 cps^{-1}) as compared to other planting density.

Key words: *Genotypes, Guar, Spacing, Yield, and Quality.*

INTRODUCTION

Cluster bean (*Cyamopsis tetragonoloba* (L.) Taub.), commonly known as guar, belonging to the family *Leguminosae* is an indigenous, annual and self-pollinated legume crop grown for feed, green fodder, vegetable, green manuring and gum extraction from seed. Being drought hardy, it is grown mainly under rainfed conditions in India since ancient times. It is primarily grown for its tender green pods in arid and semi arid regions of our country and is a good source of carbohydrates, protein, fiber and minerals like calcium, phosphorous, iron and contains appreciable amount of vitamin C[2]. Cluster bean has medicinal value for curing various diseases. The leaves of guar are used to cure night blindness, seeds as chemo-therapeutic agent against small pox and also used as laxative.

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The green pods and gum has the anti-diabetic qualities, hence, diabetic patient can use its powder. The matured seeds are also used as an emergency pulse in times of drought[17]. Of late, the crop has assumed great industrial importance because of presence of 'guar-gum' in its endosperm.

Guar seed is mainly composed of three parts; hull/seed coat (14-17%), endosperm (35-42%) and the germ (43-47%). The germ and hull of the guar seeds are known as guar meal which is rich in protein hence used for cattle feed. The endosperm is commercially important from which gum is extracted. This gum is a source of natural polysaccharide (galactomannan) which is an excellent thickener, emulsifier and stabilizer thus it is extensively used in number of industries *viz.*, petroleum, textile, paper, food, bakery, dairy, meat, dressing and sausages, beverages, cosmetics, paints and varnishes, pharmaceuticals, explosives etc., It also has greater utility in pollution control as well as in waste water purification. Recently, it is also been used as a substitute for fat in human food to decrease total caloric content. The productivity of Guar in Southern states found to be very low as compared to that of Haryana, Gujarat and Rajasthan due to the lack of suitable genotypes, as well as production packages. Hence efforts are needed to develop sound agronomic packages for profitable cultivation of Guar in Southern India.

MATERIALS AND METHODS

The experiment was conducted to evaluate the performance of Guar (*Cyamopsis tetragonoloba* L.) genotypes with different spacing at ZAHRS, University of Agricultural and Horticultural Science, Shivamogga, during *kharif* 2014. The soil of experiment site was on a red sandy clay soil with clay (35.8 %), silt (7.1 %), fine sand (57.1 %). Experiment was laid out in factorial Randomized Complete Block Design (RCBD) with replicated thrice. The plot size of 3.6 m x 3.0 m was used. The sowing was carried out in respective plots in second week of September 2014 according to the treatments. Recommended fertilizer was applied in the seed furrows open manually and it was mixed thoroughly in to the soil before sowing. Recommended dose of fertilizer NPK kg ha^{-1} was added to the well prepared area. Urea, Super phosphate and Murate of potash were used as source of nutrients. Optimum plant population was maintained by thinning after 15 days of sowing. All other agronomic practices were kept normal and uniform. Biometric observations like plant height was measured from base of the stem at ground level to the tip of the main shoot having fully opened top leaf and number of fully opened green leaves and number of branches were recorded from the five healthy plants in each plot at 15, 30, 45, 60, 75, 90 days after sowing.

Yield parameters like number of clusters, pods $plant^{-1}$ and seeds pod^{-1} was recorded from the five randomly selected plants at the time of harvest. Pod length was measured from the base of the pod to tip of the pod and expressed as pod length in centimeters (cm). A grain yield and stover yield of Guar obtained from net plot is computed for hectare and expressed in kilogram $hectare^{-1}$. Harvest index was determined by dividing the total grain yield by the total biological yield and expressed as % following Donald and Humbalin[5].

$$\text{Harvest index} = \frac{\text{Total economic yield}}{\text{Total biological yield}} \times 100$$

Quality parameters

Crude protein content of grain

Nitrogen content in the grain was determined by Kjeldal Method as described by Jackson (1973). The % crude protein in grain was calculated as under:

Crude protein (%) = N content in grain (%) X 6.25.

Protein yield was estimated by multiplying protein % of grain with grain yield *i.e.* Protein yield (kg ha^{-1}) = crude protein of grain (%) X grain yield (kg ha^{-1}).

Estimation of endosperm Content

For estimation of endosperm % from the guar seed was done by the method as described by Das *et al.*[3]. About 30 gm of guar seeds were subjected to wet processing (2% NaOH) with

vigorous boiling at 98°C for 5 minutes. The solution was sieved through coarse sieve to remove excess NaOH. After the leachate was discarded and wet de husked seeds were acidified slightly for 10 minutes in 0.1 N HCL and washed with water. The de husked seeds were then air dried for 2-3 days. Later, the dried de husked seeds were pulverized to get endosperm splits and germ meal. Further, the germ meal was discarded using 1 mm sieve.

Estimation of gum Content

For estimation of gum content also, the procedure given by Das *et al.*[3] was used. Endosperm splits obtained from the above procedure were soaked in distilled water in 1:5 proportions and kept for 4-5 hours. The soaked splits were then ground in a blender to get viscous solution of thick consistency and it was kept overnight. Later, the thick solution was disturbed using glass rod and then 50-100 ml of isopropanol was added leading to precipitation of gum on the top. Further, excess isopropanol was removed from the lumps (gum) with the help of strainer and the lumps were then vacuum dried. Dried lumps were further powdered in a blender and the gum content was calculated.

Gum yield (kg ha^{-1})

Gum yield was estimated by multiplying gum % of grain with grain yield *i.e.* Gum yield (kg ha^{-1}) = gum content in grain (%) X grain yield (kg ha^{-1}).

Estimation of viscosity of guar gum

Viscosity of guar gum was estimated by BROOKEFIELD DV-E Viscometer. One gram of guar gum powder was added to 10 ml isopropyl alcohol. Guar gum was dispersed by glass rod after one litre of boiled distilled water was added then keep it for one hour. After cooling, the solution was mixed uniformly with the help of glass rod and viscosity was measured by using BROOKEFIELD DV-E Viscometer. Viscosity was expressed in cps^{-1} of 1% solution of guar gum.

The data recorded were tabulated and analysed statistically using Fisher's analysis of variance technique at 5% probability level was applied to compare the differences among treatments' means.

RESULTS AND DISCUSSION

The results revealed that genotypes exhibited significant difference with respect to plant height from 15 DAS to harvest. Significantly higher plant height (53.06 cm) was recorded with RGC-1003 as compared to HG-365 (47.23 cm) and RGC-963 (43.29 cm) (Table. 1) this might be due to genetic make-up of genotypes. Significantly taller plants were recorded when plants grown at 30 cm x 10 cm spacing (49.51 cm) as compare to spacing of 30 cm x 15 cm (48.23 cm), 45 cm x 10 cm (47.10 cm) and 45 cm x 15 cm (46.60 cm). The increase in plant height was might be due to competitions for light up to certain limit with higher plant density at 30 cm x 10 cm spacing. The above results are in agreement with the findings of Hussain *et al.*[6] and Singh *et al.*[16].

Significantly higher number of leaves (17.38) and branches (8.28) were recorded with genotype RGC-1003 as compared to HG-365 and RGC-963 (Table.1). Among planting density significantly more number of leaves plant^{-1} (16.39) and branches (8.07) were observed with 30 cm x 10 cm of spacing compared to other planting density. Narrow plant spacing which intercepted more photosynthetically active radiation owing to better geometric situation that might have resulted in vigorous plant growth and more number of branches and leaves as compared to wider spacing. These results are confirmation with findings of Murade *et al.*[11] and Hussain *et al.*[6].

The grain yield of a crop is the integrated results of a number of physiological processes. In the present study genotypes significantly influenced the grain yield of guar.

RGC-1003 recorded significantly higher grain yield (898.18 kg ha^{-1}) as compared to HG-365 (635.26 kg ha^{-1}) and RGC-936 (448.36 kg ha^{-1}) (Table. 3). The increase in grain yield of RGC-1003 may be due to increase in yield parameters *viz.,* number pods $plant^{-1}$ (29.31), number of clusters $plant^{-1}$ (7.94), number of seeds pod^{-1} (7.07), pod length (4.62 cm) and 100 seed weight (3.33 g) (Table. 2). The results of this present investigation are in conformation with the findings of Jain *et al.*[8] in cluster bean. The low yield in other varieties is due to decreased yield attributes. Among the planting density 30 cm x 10 cm spacing recorded significantly higher grain yield (743.89 kg ha^{-1}) as compared to 30 cm x 15 cm (721.24 kg ha^{-1}) and 45 cm x 10 cm (652.77 kg ha^{-1}). Significantly lower grain yield was observed in 45 cm x 15 cm (524.50 kg ha^{-1}) (Table. 3). The higher grain yield may be attributed to higher yield components *viz.,* pod number (23.48), number of clusters $plant^{-1}$ (7.18), number of seeds pod^{-1} (6.76), pod length (4.47 cm), 100 seed weight (3.22 g) (Table. 2) and results were in conformity with the findings of Akhtare *et al.*[1]. He also reported a functional relationship in grain yield with various yield attributes of cluster bean. The interaction effect did not differed significantly between the genotype and spacing levels with respect to grain yield.

Significantly higher stover yield (1931.39 kg ha^{-1}) was recorded with RGC-1003 as compared to HG-365 (1467.77 kg ha^{-1}) and RGC-936 (980.54 kg ha^{-1}). This higher stover yield of RGC-1003 may be attributed to higher dry matter accumulation in vegetative parts. Lower stover yield may be due to reduced size of photosynthesising surface which might have caused reduction in growth. These results are in confirmatory with the work of Sanghi and Sharma[12] in guar. The closer spacing of 30 cmx 10 cm produced significantly higher stover yield (1629.94 kg ha^{-1}) compared to other planting density. The increase in stover yield with closer spacing was mainly due to vertically expansion of plants with higher growth and dry matter production resulted in higher stover yield.

Harvest index is a measure of physiological productivity potential of a crop. The significant differences in harvest index were observed due to spacing and genotype levels are presented in Table.3. In the present study RGC-1003 has recorded higher (0.32) harvesting index as compared to HG-365 (0.31) and RGC-936 (0.30). This may be due higher partitioning and translocation of photosynthates from source to sink because of higher vegetative growth and higher interception and utilisation of solar radiation this may produce higher above ground dry matter. Similar results were also reported by Daulay and Henry[4] as well as Siddaraju *et al.*[14] in cluster bean. Plants grown at spacing of 30 cm x 10 cm recorded significantly higher HI (0.34) as compared to wider spacing of 30 cm x 15 cm (0.32), 45 cm x 10 cm (0.31) and low HI was observed in 45 cm x 15 cm (0.28) (Table. 3). Higher HI at closer spacing due to higher economic yield contributing from the higher plant population per unit area as compared with lesser population per unit area of wider spacing. These findings are in agreement with those recorded by Malik *et al.*[10], Taleei *et al.*[18] and also Jan *et al.*[9].

Significantly higher quality parameters *viz.,* Endosperm % (33.96), Protein % (31.68), Gum % (31.09), Viscosity (245.75 cps^{-1}) was recorded with RGC-1003 as compared to HG-365 and RGC-936 (Table.4). Among spacing 30 cm x 10 cm was recorded significantly higher quality parameters *viz.,* Endosperm (33.49%), Protein (30.94%), Gum (30.36%), Viscosity (236.47 cps^{-1}) as compared with other spacing (Table.4). These results are in confirmatory with the work of Sanghi and Sharma[12] in guar. Veena Jain *et al.*[19], Sharma *et al.*[13] and also Singh and Singh[15] in cluster bean.

Table 1: Growth parameters of guar genotypes as influenced by different planting density

Treatments			
Spacing (S)	Plant height (cm)	Number of leaves	Number of branches
45 cm x15 cm	46.60	14.97	7.81
30 cm x15 cm	48.23	15.92	7.98
45 cm x10 cm	47.10	15.46	7.9
30 cm x10 cm	49.51	16.39	8.07
F-test	*	*	*
S.Em ±	0.4	0.27	0.03
C.D. at 5%	1.17	0.8	0.07
Genotypes (G)			
RGC-1003	53.06	17.38	8.28
RGC-936	43.29	14.06	7.54
HG-365	47.23	15.61	8
F-test	*	*	*
S.Em ±	0.34	0.24	0.02
C.D. at 5%	1.01	0.7	0.06
Interaction (S X G)			
45 cm x 15 cm + RGC-1003	51.75	16.6	8.18
45 cm x 15 cm + RGC-936	42.11	13.43	7.4
45 cm x 15 cm + HG-365	45.93	14.87	7.83
30 cm x 15 cm + RGC-1003	53.27	17.73	8.3
30 cm x 15 cm + RGC-936	43.85	14.23	7.58
30 cm x 15 cm + HG-365	47.57	15.8	8.06
45 cm x 10 cm + RGC-1003	52.54	16.87	8.25
45 cm x 10 cm + RGC-936	42.39	14.08	7.47
45 cm x 10 cm + HG-365	46.37	15.43	7.97
30 cm x 10 cm + RGC-1003	54.67	18.33	8.37
30 cm x 10 cm + RGC-936	44.83	14.5	7.72
30 cm x 10 cm + HG-365	49.03	16.33	8.12
F-test	NS	NS	NS
S.Em ±	0.69	0.47	0.04
C.D. at 5%	-	-	-

Table 2: Yield components of guar genotypes as influenced by different planting density

Treatments					
Spacing (S)	Number of pods	Number of clusters	Number of seeds	Pod length (cm)	100 seed weight(g)
45 cm x15 cm	16.33	5.26	5.99	3.97	3.04
30 cm x15 cm	21.15	5.82	6.66	4.27	3.17
45 cm x10 cm	19.22	5.63	6.50	4.21	3.10
30 cm x10 cm	23.48	7.18	6.76	4.47	3.22
F-test	*	*	*	*	*
S.Em ±	0.73	0.32	0.08	0.05	0.03
C.D. at 5%	2.15	0.95	0.25	0.15	0.08
Genotypes (G)					
RGC-1003	29.31	7.94	7.07	4.62	3.33
RGC-936	11.36	4.36	5.82	3.83	2.91
HG-365	19.47	5.61	6.55	4.23	3.17
F-test	*	*	*	*	*
S.Em ±	0.63	0.28	0.07	0.04	0.02
C.D. at 5%	1.87	0.82	0.21	0.13	0.07
Interaction (S X G)					
45 cm x 15 cm + RGC-1003	25.44	6.33	6.87	4.40	3.27
45 cm x 15 cm + RGC-936	7.11	4.55	4.93	3.41	2.73
45 cm x 15 cm + HG-365	16.44	4.89	6.18	4.09	3.13
30 cm x 15 cm + RGC-1003	30.67	7.45	7.13	4.55	3.37
30 cm x 15 cm + RGC-936	12.11	4.22	6.13	3.99	2.97
30 cm x 15 cm + HG-365	20.67	5.78	6.71	4.26	3.17
45 cm x 10 cm + RGC-1003	27.34	7.44	6.96	4.50	3.27
45 cm x 10 cm + RGC-936	11.11	3.89	6.05	3.88	2.90
45 cm x 10 cm + HG-365	19.22	5.55	6.51	4.24	3.13
30 cm x 10 cm + RGC-1003	33.78	10.55	7.31	5.04	3.40
30 cm x 10 cm + RGC-936	15.11	4.78	6.18	4.04	3.03
30 cm x 10 cm + HG-365	21.56	6.22	6.80	4.34	3.23
F-test	NS	NS	NS	NS	NS
S.Em ±	1.26	2.08	0.82	0.56	0.05
C.D. at 5%	-	-	-	-	-

Table 3: Grain yield (kg ha^{-1}), Stover yield (kg ha^{-1}) and Harvest index of guar as influenced by spacing, genotypes and their interactions

Treatments			
Spacing (S)	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index
45 cm x15 cm	524.50	1299.31	0.28
30 cm x15 cm	721.24	1496.50	0.32
45 cm x10 cm	652.77	1413.84	0.31
30 cm x10 cm	743.89	1629.94	0.34
F-test	*	*	*
S.Em ±	25.78	54.94	0.01
C.D. at 5%	76.10	162.18	0.03
Genotypes (G)			
RGC-1003	898.18	1931.39	0.32
RGC-936	448.36	980.54	0.30
HG-365	635.26	1467.77	0.31
F-test	*	*	NS
S.Em ±	22.33	47.58	0.01
C.D. at 5%	65.90	140.45	-
Interaction (S X G)			
45 cm x 15 cm + RGC-1003	778.85	1755.79	0.31
45 cm x 15 cm + RGC-936	290.21	769.52	0.28
45 cm x 15 cm + HG-365	504.44	1372.61	0.27
30 cm x 15 cm + RGC-1003	933.69	1979.17	0.32
30 cm x 15 cm + RGC-936	625.43	1001.85	0.39
30 cm x 15 cm + HG-365	672.55	1508.49	0.31
45 cm x 10 cm + RGC-1003	874.87	1901.00	0.31
45 cm x 10 cm + RGC-936	433.45	924.61	0.32
45 cm x 10 cm + HG-365	649.99	1415.90	0.32
30 cm x 10 cm + RGC-1003	1005.31	2089.58	0.32
30 cm x 10 cm + RGC-936	444.36	1226.16	0.28
30 cm x 10 cm + HG-365	714.05	1574.07	0.31
F-test	NS	NS	NS
S.Em ±	44.65	95.16	0.016
C.D. at 5%	-	-	-

Table 4: Quality parameters of guar as influenced by spacing and genotypes and their interactions

Treatments	Quality parameters			
Spacing (S)	Endosperm (%)	Protein (%)	Gum (%)	Viscosity (cps^{-1})
45x15 cm	32.68	29.75	29.71	226.12
30x15 cm	33.04	30.75	30.24	231.07
45x10 cm	32.83	30.29	30.19	229.26
30x10 cm	33.49	30.94	30.36	236.47
F-test	NS	NS	NS	NS
S.Em ±	0.41	0.33	0.33	2.68
C.D. at 5%	-	-	-	-
Genotypes (G)				
RGC-1003	33.96	31.68	31.09	245.75
RGC-936	32.13	29.08	29.39	219.01
HG-365	32.95	30.53	29.89	227.43
F-test	*	*	*	*
S.Em ±	0.35	0.28	0.29	2.32
C.D. at 5%	1.04	0.84	0.85	6.84
Interactions (S X G)				
45 x 15 cm + RGC-1003	33.48	31.20	30.25	238.10
45 x 15 cm + RGC-936	32.00	28.07	29.38	219.17
45 x 15 cm + HG-365	32.56	29.98	29.50	221.10
30 x 15 cm + RGC-1003	33.91	31.90	31.34	246.30
30 x 15 cm + RGC-936	32.11	29.57	29.37	218.00
30 x 15 cm + HG-365	33.10	30.78	30.00	228.90
45 x 10 cm + RGC-1003	33.57	31.48	31.25	241.10
45 x 10 cm + RGC-936	31.95	29.13	29.35	219.96
45 x 10 cm + HG-365	32.98	30.25	29.96	226.70
30 x 10 cm + RGC-1003	34.82	32.15	31.53	257.50
30 x 10 cm + RGC-936	32.45	29.56	29.45	218.90
30 x 10 cm + HG-365	33.21	31.12	30.09	233.00
F-test	NS	NS	NS	NS
S.Em ±	0.71	0.57	0.58	4.64
C.D. at 5%	-	-	-	-

REFERENCES

1. Akhtare, L. H., Bukhari. S., Salah-Ud-Din, S., Minhas, R., Response of new guar strains to various row spacings. *Pakistan Journal of Agricultural Science* **49(4):** 469-471 (2012).
2. Aykroyd, U.R., 1963, Indian Council of Medical Research,Special Report, Series, No.42, Vegetables, National Book Trust India (4thEdn.), New Delhi, pp. 188-191.
3. Das, B., Arora, S.K., Luthra, Y.P., A rapid method for determination of gum in guar (*Cyamopsis tetragonoloba* (L.) Taub.). Proceedings of Ist ICAR Guar Research Workshop, Jodhpur, pp : 117–123 (1977).
4. Daulay, H.S., Henry, A., Response of cluster bean varieties to different *Rhizobial* strains in dry land of western Rajasthan. Forage Legumes **23(1):** 105-107 (1997).
5. Donald, C. M., Humblin, T., The biological yield and HI of cereals as agronomic and plant breeding criteria. *Advances in Agronomy* **28:** 361-405 (1976).
6. Hussain, F., Malik, A.U., Haji, M.A., Malghani, A.L., Growth and yield response

of two cultivars of mungbean (*Vigna radiata* L.) to different potassium levels. *Journal of Animal and Plant Science* **21(3):** 622-625 (2011).

7. Jackson, M.L. 1973, Soil Chemical Analysis (Ed.). Prentice Hall of India (Pvt.) Ltd., New Delhi.
8. Jain, V., Yadav, B.D., Sharma, B.D., Taneja, K.D., Effect of dates of sowing, row spacing and varieties on yield and quality of cluster bean (*Cyamopsis tetragonoloba* (L.) Taub). *Indian Journal of Agronomy* **32(4):** 378-382 (1987).
9. Jan, A., Kaleem, S.A., Taj, F.H., Khan, H., Response of mungbean cultivars to different seeding densities at dry land condition. *Pakistan Journal of Biological Science* **3(12):** 2030-2032 (2000).
10. Malik, B.A., Tahir, M., Hussain S.A., Chaudhry, A.H., Identification of physiologically efficient genotypes in mungbean. *Pakistan Journal of Agricultural Research* **7(1):** 41-44 (1986).
11. Murade, N.B., Patil, D.B., Jagtap, H.D., More, S.M., Effect of spacing and fertilizer levels on growth and yield of urd bean. *International Quarterly Journal of Life Sciences* **9(4):** 1545-1547 (2014).
12. Sanghi, A.K., Sharma, S.K., Correlation studies in guar. *Indian Journal of Genetics and Plant Breeding* **24(3):** 282-285 (1964).
13. Sharma, B. D., Taneja, K. D., Kairon, M. S., Veena Jain, Effect of dates of sowing, row spacing and varieties on yield and quality of clusterbean (*Cyamopsis tetragonoloba* (L.) Taub.). *Indian Journal of Agronomy* **29(4):** 557-558 (1984).
14. Siddaraju, R., Narayanaswamy, S., Ramegowda, S., Siddaraju, R., Prasad, R., Puttaraju, T.B., Studies on growth, seed yield and yield attributes as influenced by varieties and row spacing in cluster bean. *Mysore Journal of Agricultural Science* **44(1):** 16-21 (2010).
15. Singh, R. V., Singh, R. R., Effect of nitrogen phosphorous and seeding rates on growth, yield and quality of guar under rainfed conditions. *Indian Journal of Agronomy* **34(1):** 53-56 (1989).
16. Singh, S.P., Sandhu, S.K., Dhaliwal, L.K., Inderjeet Singh, Effect of Planting Geometry on Microclimate, Growth and Yield of Mungbean (*Vigna radiata* L.). *Journal of Agricultural Physiology* **12(1):** 70-73 (2012).
17. Singh, U.P., Tripathi, S.N., Natarajan, S., 2007, Crop profile-Guar. *www.igfri.ernet.in*.
18. Taleei, A. R., Bandeh, N. K., Gholamie, B., Effect of sowing date on grain yield, yield components and percentage of protein in green gram cultivars. *Iranian Journal of Agricultural Science* **29(4):** 7510758 (1999).
19. Veena Jain, Yadav, B. D., Sharma, B. D., Taneja, K. D., Effect of dates of sowing, row spacing and varieties on yield and quality of clusterbean (*Cyamopsis tetragonoloba* (L.) Taub.). *Indian Journal of Agronomy* **32(4):** 378-382 (1987).