The Pharma Innovation Journal 2022; SP-11(7): 1887-1890

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(7): 1887-1890

www.thepharmajournal.com
Received: 18-05-2022
Accepted: 22-06-2022

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Growth, productivity and nutrient uptake in clusterbean varieties at varied crop geometry in semi-arid region of Andhra Pradesh

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Abstract
A field experiment was conducted at Professor Jayashankar Telangana State Agricultural University, Hyderabad in rainy season of 2013-14 to study the "Performance of clusterbean varieties at varied crop geometry" The experiment was laid out in factorial randomized block design with three replications to evaluate the performance of promising varieties of clusterbean (V_1- RGC 1025, V_2- HGS 365, V_3- RGC 936 and V_4- RGC 1017) and to standardize the crop geometry levels (S_1- 30 x 7.5 cm, S_2- 30 x 10 cm, S_3- 37.5 x 10 cm and S_4- 45 x 10 cm) under rainfed semi-arid conditions of Andhra Pradesh. The results indicated that among the four varieties tested plant height, dry matter accumulation, leaf area, number of branches/plant, crop growth rate (CGR) and pods plant^{-1} of RGC 1025 variety was significantly higher as compared to other varieties followed by RGC 936, HGS 365 respectively, RGC 1017 showed inferior performance with respect to growth. Variety RGC 936 recorded earlier 50 per cent flowering and maturity followed by RGC 1025 and Similarly, Seed, stalk, gum and protein yield were significantly higher with variety RGC 1025 which was distinctly superior over other varieties and followed by RGC 936, HGS 365 and RGC 1017 respectively, However, RGC 936 found to be higher gum producing variety while protein content was higher with HGS 365. NPK uptake was significantly higher with variety RGC 1025 compared to rest. Clusterbean performed well under closer crop geometry i e. 30 x 7.5 cm and almost similar results were obtained under 30 x 10 cm compared to wider crop geometry 45 x10 cm regarding growth and yield, Therefore it can be concluded that RGC 1025 and RGC 936 planting at closer geometry (30 x 10 cm) are best suited and can be recommended to rainfed semi-arid area of Andhra Pradesh.

Keywords: Growth, utrient uptake, clusterbean varieties, varied crop geometry

Introduction
Clusterbean or guar botanically called as *Cyamopsis tetragonoloba* (L.) Taub is widely grown in north western India and Pakistan and in the semi-arid areas of the high plains of Texas in the USA, Australia and Africa to a smaller extent. India is the largest producer of guar seed and accounts for around 75-80 per cent of the total guar production in the world. In India, it is grown in an area of 3.88 million hectares with a production of 2.80 million tonnes and productivity of 698 kg ha^{-1} and is annually contributing to around 80% share to the world's total production enabling its export to more than 65 countries. (Directorate of economics and statistics, 2021). Today Guar is one of the significant foreign exchange earners of the country. The importance of guar has increased considerably in recent years due to the general ecological trend of utilizing polysaccharides of renewable plant origin in different industrial applications. Recently, galactomannan have also been used in the production of water proof biocide films (Das *et al*., 2011) [3]. It is used in textile, paper manufacture, stamps, cosmetics, pharmaceuticals, food products, e.g. bakery products, ice cream, stabilizer in cheeses making and meat binder. Recently it is also used in oil wells, mining industries, explosives, and other industrial applications .On the other hand, guar is considered as an excellent soil improvement crop, like other legumes, with respect to available nitrogen, which improve yield of succeeding crops. Clusterbean is best adapted to tropical and subtropical regions. Rajasthan state accounts for 65-70 per cent of India's production. The other producers are Gujarat, Haryana, Punjab, Uttar Pradesh and Madhya Pradesh. Clusterbean is a photosensitive crop. It cannot withstand water logging conditions and grows well in hot climates, can tolerate extended periods of drought and high salinity (Ashraf *et al*., 2005) [1]. Hence, the cultivation of guar can be extended to arid and semi-arid areas of Andhra Pradesh and Telangana where the rainfall is low and erratic in distribution, coupled with high temperatures and low fertility status of soils.

Guar is not prominently grown in this region hence there was a need to evaluate and standardize variety which can achieve high yield potential under optimum crop geometry. The agro climatic conditions that prevail in this area are favorable for growth and development for guar crop. Hence, keeping in view the present study was planned to evaluate "suitability of clusterbean varieties at varied crop geometry"

Method and Materials

A field experiment was conducted at Professor Jayashankar Telangana State Agricultural University, Hyderabad in rainy season of 2013-14. Performance of promising varieties (V_1- RGC 1025, V2- HGS 365, V_3- RGC 936 and V_4- RGC 1017) at different crop geometries (S_1- 30 x 7.5 cm, S_2- 30 x 10 cm, S_3- 37.5 x 10 cm and S_4- 45 x 10 cm) were analyzed in a factorial randomized block design with three replications under rainfed semi-arid climate. The weekly mean maximum and minimum temperature during crop growth period was 30.8 °C, and 22.0 °C respectively and total rainfall received was 475.3 mm in 33 rainy days. Crop was sown on 26, June 2013 at varied geometry levels and each variety was harvested according to their duration as variety RGC 1025, HGS 365, were harvested at 98 DAS while RGC 936 and RGC 1017 was harvested at 90 and 105 DAS respectively, The experimental soil was sandy clay loam in texture, slightly alkaline in reaction and the fertility status of soil was low in organic matter, available nitrogen, phosphorus and medium in available potassium. The observations on growth attributes *viz.* plant height, dry matter accumulation, leaf area, number of branches, number of pods plant^{-1}, seed yield and stalk yield of the clusterbean were taken. The nutrient uptake was calculated on the basis of seed yield and stalk yield of the crop.

Results and Discussion

Plant height of variety RGC 1025 was significantly higher as compared to other varieties followed by RGC 936. Shorter plants were found with RGC 1017. The number of branches/ plant produced with RGC 1025 variety was significantly higher compared to the rest of varieties at flowering stage. The dry matter accumulation of clusterbean increased progressively with advancement in age of the crop up to harvest. Variety RGC 1025 led to highest dry matter accumulation which was on par with RGC 936 due to more plant height and leaf area. Leaf area (cm^2 plant^{-1}) gradually increased with increase in age of the crop and reached its peak at 70 DAS and thereafter shown declined trend towards maturity due to senescence of foliage. Leaf area of variety RGC 1025 showed superiority over the other three varieties at all the growth stages and was at par with variety RGC 936 at 25, 45 DAS and at harvest. Results were corroborated with the findings of (Kalyani *et al*., 2006) [5]. Variety RGC 1025 and RGC 936 maintained more crop growth rate (CGR) throughout the crop growth period. The variety RGC 936 provided earliest 50 per cent flowering and maturity followed by RGC 1025, HGS 365 and RGC 1017 (86, 96, 96, and 105 days to maturity) respectively, The variety RGC 1017 taken maximum number of days to reach 50 per cent flowering and maturity due to long duration. Among the varieties tested, highest number of pods plant^{-1} was produced by RGC 1025 variety. Variety RGC 936 resulted in higher gum and protein content, whereas lowest gum and protein producing variety was RGC 1017. NPK content was found non-significant due to varieties and crop geometry in seed and stalk but NPK uptake was significantly higher in variety RGC 1025. Seed and stalk yield was significantly influenced by varieties. The maximum Seed and stalk yield was recorded with variety RGC 1025 which was distinctly superior over other varieties and followed by RGC 936, HGS 365 and RGC 1017. The superiority of variety RGC 1025 over other varieties with respect to yield may be due to its genetic potentiality to utilize the growth resources and translocate photosynthates from source to sink. Rahman *et al*. (2013) [7] also reported similar results.

Plant height decreased with every increase in crop geometry from 30 x 7.5 cm to 45 x 10 cm. However, maximum plant height was observed under 30 x 10 cm crop geometry which was significantly higher compared to other crop geometries. Highest dry matter accumulation and leaf area was recorded at closer crop geometry 30 x 7.5 cm and was closely followed by 30 x 10 cm and both were significantly superior over rest of the crop geometries due to higher plant density per unit area. Crop geometry did not show significant impact with respect to number of branches/ plant at flowering stage. Siddraju *et al*. (2010) [9] corroborated with the above findings. CGR under narrow crop geometry (30 x 7.5 cm) was significantly higher rather than wider crop geometry at both 45 -70 DAS and 70 - Harvest period of crop growth. Among the geometry levels, minimum and maximum number of days taken to flowering and maturity were noticed with narrow spacing 30 x 7.5 cm and wider spacing of 45 x 10 cm respectively. With every increase in crop geometry from 30 x 7.5 to 45 x 10 cm, the number pods plant^{-1} significantly differed and produced highest at wider spacing (45 x 10 cm) which was significantly superior compared to closer spacing (30 x 7.5 and 30 x 10 cm). This might be due to sufficient space available for individual plants without competition at lower plant density was grown more vigorously and produced more number of branches and inturn more number of pods plant^{-1}. Seed and stalk yield of clusterbean was decreased as widening the crop geometry. Bhadoria and Chauhan (1994) [2] Siddaraju *et al*. (2010) Malliswara Reddy and Sahadeva Reddy. (2011) [6] reported similar findings. Gum and protein content was found non-significant due to crop geometry and interaction of varieties and crop geometry but their yield was higher under closer spacing 30 x 10 cm which was on par to another narrow spacing (30 x 7.5 cm). NPK uptake was significantly higher under narrow spacing 30 x 10 compared to wider spacing 45 x10 cm. Highest seed yield was obtained under 30 x 7.5 cm which was at par with 30 x 10 cm and lowest at 45 x 10 cm. (Reddy and Reddy 2011) also reported the similar findings. Therefore it can be concluded that RGC 1025 and RGC 936 planting at closer geometry (30 x 10 cm) are best suited and can be recommended to rainfed semi-arid area of Andhra Pradesh and Telangana.

Table 1: Crop growth performance of clusterbean varieties at different crop geometries

Treatments	Plant height (cm)	Total dry matter (g m^{-2}) at harvest	Leaf area (cm^2 $plant^{-1}$) at 70 DAS	Number of branches/plant
Varieties				
RGC 1025	74.1	480.8	508	6.5 (8.4)
HGS 365	66.3	392.3	423	0.0 (0.7)
RGC 936	65.4	463.4	479	5.2 (7.2)
RGC 1017	58.9	384.7	390	5.5 (7.1)
SEm±	0.5	6.9	5.0	0.2
CD (P=0.05)	1.4	20.0	14.2	0.6
Crop geometry (cm)				
S_1 : 30 × 7.5	69.3	491.5	513	4.0 (5.3)
S_2 : 30 × 10	70.4	456.1	479	4.1 (5.4)
S_3 : 37.5 × 10	64.0	385.9	405	5.2 (7.2)
S_4 : 45 × 10	60.9	387.7	404	5.5 (7.1)
S.Em ±	0.5	6.9	5.0	0.2
CD (P=0.05)	1.4	20.0	14	NS

* Original values of number of branches/plant given in parenthesis were transformed through square-root [$\sqrt{(x+0.5)}$] method

Table 2: Yield and yield attributing characters of clusterbean as influenced by varieties and crop geometry

Treatments	Yield attributes			Yield (kg/ha)	
	Days to 50 % flowering	Days to maturity	Number of pods $plant^{-1}$	Seed Yield	Stalk yield
Varieties					
RGC 1025	34	97	87.1	575	4192
HGS 365	35	96	71.6	456	3234
RGC 936	32	86	74.5	492	3582
RGC 1017	38	105	62.1	321	2640
SEm±	0.2	0.2	1.3	5.5	100
CD (P=0.05)	0.5	0.5	3.7	16	280
Crop geometry (cm)					
S_1 : 30 × 7.5	34	96	70.1	490	3999
S_2 : 30 × 10	34	96	69.6	477	3406
S_3 : 37.5 × 10	35	97	74.7	437	3180
S_4 : 45 × 10	36	97	80.9	439	3063
S.Em ±	0.2	0.2	1.3	5.5	98
CD (P=0.05)	0.5	0.5	3.7	16	284

Table 3: Nutrient uptake and quality of clusterbean as influenced by varieties and crop geometry

Treatments	N uptake (kg/ha)	P uptake (kg/ha)	K uptake (kg/ha)	Protein content (%)	Gum content (%)
Varieties					
RGC 1025	23.5	1.71	24.0	25.4	30.2
HGS 365	20.0	1.41	18.9	27.4	31.9
RGC 936	21.3	1.54	20.6	27.1	32.4
RGC 1017	12.8	1.00	13.4	24.9	28.6
SEm±	0.4	0.03	0.4	0.5	0.6
CD (P=0.05)	1.1	0.11	1.1	1.3	1.6
Crop geometry (cm)					
S_1 : 30 × 7.5	20.5	1.51	14.6	25.8	30.2
S_2 : 30 × 10	20.1	1.44	12.3	26.3	30.5
S_3 : 37.5 × 10	18.5	1.40	13.5	26.2	31.4
S_4 : 45 × 10	18.6	1.34	13.1	26.3	31.3
S.Em ±	0.4	0.03	0.4	0.5	0.6
CD (P=0.05)	1.1	0.11	1.1	NS	NS

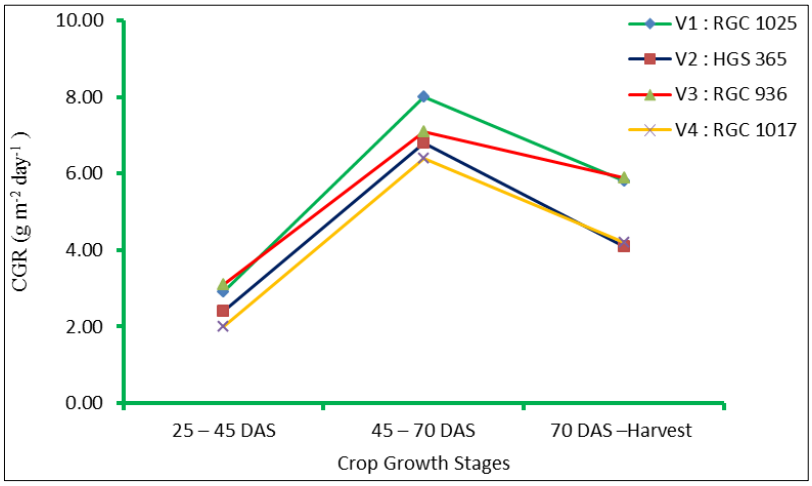

Fig 1: Crop Growth Rate (CGR) g m^{-2} day^{-1} of clusterbean at different stages of crop growth as influenced by varieties

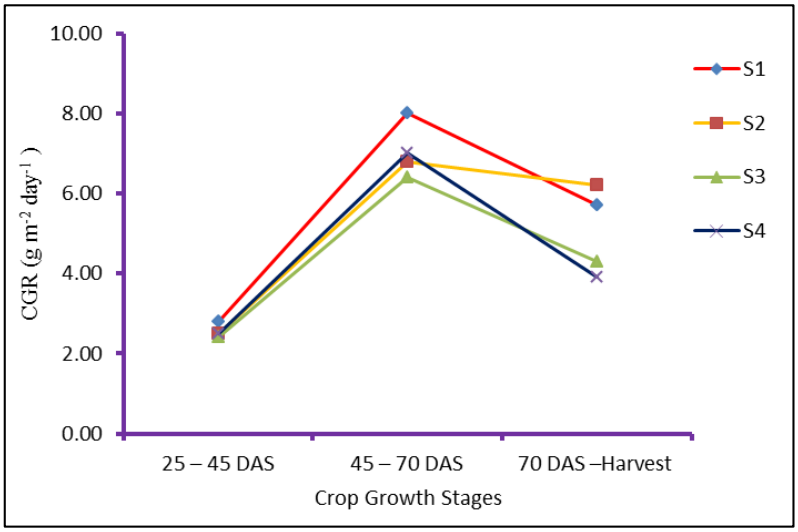

Fig 2: Crop Growth Rate (CGR) g m^{-2} day^{-1} of clusterbean at different stages of crop growth as influenced by crop geometry

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