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PHYSIOLOGICAL AND GROWTH RESPONSE OF CLUSTERBEAN [*CYAMOPSIS TETRAGONOLOBA* (L.) TAUB.] VARIETIES TO DIFFERENT GROWING SEASONS

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ABSTRACT

An experiment was conducted during 2014 - 2015 to find out physiological and growth responses of cluster bean varieties to different growing seasons. Fifteen treatment combinations i.e. seasons (*kharif*, *rabi* and summer) and varieties (Ankur rani, Milan-51, Sarada, Malav - 51 and Nylon-55) was laid out in Factorial Completely Randomized Design with three replications. Maximum plant height at vegetative phase (22.44 cm) and flower initiation (46.46 cm) was reported in *kharif* while during pod initiation (64.11 cm) and maturity (77.42 cm) in summer. Similarly the maximum number leaves in vegetative phase (6.33), flower initiation (8.73) and pod initiation (13.33), leaf angle (61.45), leaf area per plant at 45 DAS (188.60 cm²) and 90 DAS (21.95 cm²) and seed yield per plant (6.49 g) was also reported in *kharif*. Among various varieties maximum plant height at flower initiation (33.00 cm), pod initiation (53.08 cm) and maturity (59.43 m), number of leaves at flower initiation (10.00), leaf angle (51.42), leaf area at 45 DAS (149.86 cm²) and crude seed gum (26.34 %) was reported in Milan-51. From the present studies it can be concluded that *kharif* season and variety Milan-51 is found suitable for vegetative growth and seed gum production.

INTRODUCTION

Cluster bean also known as guar, is a legume crop that is cultivated mostly in the arid and semi arid areas. The long deep taproot system enables the plant to grasp all the water in the soil making it an ultimate drought resistant crop (Kalyani, 2012). Cluster bean seed is used as a concentrate for animal and for extraction of gum chemically 'galactomannas' which are functionally belong to the category of reserve polysaccharides of seed cells (Reid, 1985), good solubility in cold water, high chemical reactivity and flexibility, and peculiar rheological properties (Wang and Zhang, 2009). India occupied top position in the world trade for guar gum. Gum is extensively used as sizing agent in paper and textile industries, as an effective flocculent and filtering in mining and metallurgical processes, as water blocking agents in explosives and as a thickener etc., Protein rich guar meal (42 % protein), is a byproduct used as an animal feed concentrate.

Guar production is greatly affected by climatic factors (rainfall and temperature), soil factors and cultural practices (e.g. sowing date, seed rate, plant spacing, sowing methods, weeding and harvesting methods). Although guar is grown under wide range of annual precipitation, the amount and distribution of rainfall is the limiting factor for guar production under sub humid and semi arid regions. However, the time of sowing varies according to the cultivar selected for cultivation and there is need to find out the best time of sowing for high yielding varieties evolved recently and also to find out their growth, yield and quality behavior under late sown conditions, if sowing is delayed due to reasons beyond control (Kalyani, 2012). Despite of its importance, very little attention has been paid to study the physiological effect of dates of sowing and varieties on yield and quality of cluster bean for gum yield. Hence, the study on morpho-physiological behavior of cluster bean [*Cyamopsis tetragonoloba* (L.) Taub] was conducted in *Kharif*, *Rabi* and Summer seasons to adjudge impact of seasonal variation on growth yield parameter and seed gum yield with the objectives to identify the morpho-physiological traits linking to high yield and impact of seasonal variation on phenological phases and yield.

MATERIALS AND METHODS

Pot experiment was conducted up to harvest stage in the Department of Plant Physiology, IGKV, Raipur, during the *kharif* (2014) *rabi* (2014-15) and summer (2015). The site is situated in central part of Chhattisgarh at latitude 21.6' N and longitude 81.36' E with an altitude of 289.56' meters above the mean sea level. Fifteen treatment combinations i.e. seasons (*kharif*, *rabi* and summer) and varieties (Ankur rani, Milan-51, Sarada, Malav-51 and Nylon-55) was laid out in Factorial Completely Randomized Design with three replications. The experimental soil was sandy loam and processed to good physical condition, ideal for cluster bean growth. This soil was filled in cement pots @ 8 kg per pot. About 24 hours before sowing, all the pots were irrigated by unsterilized water. Ten holes (2 to 3 cm deep) per pot were made with the help of sterilized glass rod maintaining equal distance

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from hole to hole. Sowing of 10 seeds was done by placing one seed in each hole. Observation on vegetative growth and seed quality parameters were recorded. Leaf angle was measured as the angle between the zenith direction and normal of the leaf surface. Chlorophyll content of leaves was measured using SPAD-502 Plus (Konica Minolta). The protein content was determined by Microkjeldhal method using Gerhart digestion and distillation model (VAO-30). For estimation gum content, the procedure given by Das *et al.* (1997) was used.

RESULTS AND DISCUSSION

Plant height

Among the different varieties, significantly maximum plant height at vegetative phase and flower initiation were recorded in *kharif* season (S_1). While significantly maximum height at pod initiation and maturity were recorded in summer season (S_3). They found that July sowing produced significantly taller plants. High rainfall and soil moisture content favors longer vegetative period. Height is related with the vegetative growth of the plant i.e. more leaf number and canopy coverage which helps in more light harvesting and better yield (Deka *et al.*, 2015). Significantly maximum plant height at vegetative phase was observed in Nylon-55 (V_3), whereas Milan-51 (V_2) reported maximum plant height at flower initiation, pod initiation and maturity. The results corroborates the findings of Kelechukwu *et al.* (2007) who reported that cowpea height is dependent on the type of variety as certain varieties are genetically taller than others.

Number of leaves

In respect of number of leaves per plant, the maximum leaves was recorded in Summer season for vegetative, flower initiation and pod initiation phases while it was found at par with *kharif* season for flower initiation and pod initiation phases. The minimum number of leaves was reported in *rabi* season (S_2) for all phenological phases. Acosta *et al.* (1996) indicated that delayed sowing of common bean reduced its

dry matter production, leaf area index, leaf area duration, crop growth rate, net assimilation rate and hence, yield. Maximum performance of *kharif* sowing plants might be due to longer growth period allows the plants to have enough opportunity for better vegetative growth (Deka *et al.*, 2015). Similar information revealed by (Kalyani, 2012) in response to vegetative growth. Significantly highest number of leaves during vegetative phase was reported in varieties Ankur rani and Sarada, whereas during flower initiation Milan-51 recorded maximum leaves. At pod initiation maximum leaves was observed in Sarada which was at par with Ankur rani. The differential behaviour among the varieties could be explained solely by the variation in their genetic make up and their differential behaviour under different conditions. This may be because of the long duration and fast later growth of these cultivars and it was also evident by significantly higher crop growth rate at later stages of growth (Meena *et al.*, 2014).

Leaf angle

As figures presented in Table 1, significantly maximum leaf angle was reported in *kharif* season whereas minimum in summer. More leaf angle in *kharif* is due to di-heliotropic movement for more light interception requirement and in summer it was less due to paraheliotropic movement to reduce high light intensity and ultimately reduce water loss. Leaf angle plays very important role in light interception and further maintaining the plant efficient for physiological and metabolic process. Particularly the change in leaf angle according to climatic situation is stress avoiding phenomenon. Among various varieties of guar maximum leaf angle was reported in Milan-51 which was found at par with Malav-51. The minimum leaf angle was observed in Nylon-55. Thus Nylon-55 could be economical variety under summer season.

Leaf area per plant

Significantly maximum leaf area per plant was reported in *kharif* season during whole experimental period. This is probably due to early sown crop may enjoy favorable climatic conditions in term of temperature and other climatic parameter during various crop growth stages, which reflected into better growth

Table 1: Effect of growing season and varieties on growth of cluster bean

Treatments Growing seasons	Plant height (cm)				Number of leaves/plant			Leaf angle at flowering phase
	Vegetative phase	Flower initiation	Pod initiation	Maturity	Vegetative phase	Flower initiation	Pod initiation	
S1 : <i>Kharif</i>	22.44	46.76	55.38	55.16	6.33	8.73	13.33	61.65
S2: <i>Rabi</i>	9.70	15.99	26.84	28.71	4.33	6.93	9.46	44.63
S3 : Summer	14.02	26.21	64.11	77.42	5.73	8.66	12.46	40.59
SE(m) ±	0.25	0.25	0.25	0.26	0.18	0.17	0.44	0.72
C.D. (0.05)	0.74	0.94	0.72	0.77	0.52	0.51	1.28	2.08
Varieties								
V1: Ankur rani	16.44	28.52	50.57	54.83	6.33	8.88	13.22	48.10
V2 : Milan-51	14.42	33.00	53.08	59.48	4.88	10.00	11.55	51.42
V3 : Sarada	14.98	30.98	48.44	56.24	6.33	7.55	13.00	48.66
V4 : Malav-51	13.53	25.99	44.90	48.52	3.55	5.77	10.33	50.34
V5 : Nylon-55	17.56	29.77	46.89	49.73	6.22	8.33	10.66	46.29
SE(m) ±	0.33	0.32	0.32	0.34	0.23	0.22	0.57	0.92
C.D. (0.05)	0.96	0.46	0.94	1.00	0.67	0.66	1.65	2.69
Interaction effect								
SE(m) ±	0.57	0.56	0.56	0.60	0.40	0.39	0.98	1.60
C.D. (0.05)	1.66	0.8	1.63	1.74	NS	NS	NS	4.67

Table 2: Effect of growing season and varieties on leaf area, chlorophyll, seed yield, protein content and gum yield of cluster bean

Treatments Growing seasons	Leaf area /plant (cm ²)						Chlorophyll (SPAD)			Seed yield / plant(g)	Protein content %	Crude seed gum yield (%)
	15 DAS	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS	Vegetative phase	Flower initiation	Pod initiation			
S ₁ : <i>Kharif</i>	44.67	89.04	188.6	92.43	54.57	21.95	35.51	44.74	42.86	6.49	32.45	25.17
S ₂ : <i>Rabi</i>	10.02	17.29	38.17	19.30	10.45	5.48	49.61	47.00	49.45	2.32	32.29	25.31
S ₃ : Summer	11.11	36.89	84.92	50.65	32.46	12.22	50.28	45.68	48.68	4.86	31.84	25.51
SE(m)±	0.31	0.33	0.38	0.40	0.30	0.26	0.30	30.00	2.42	0.07	0.23	0.22
C.D. (0.05)	0.91	0.98	1.12	1.16	0.89	0.76	0.87	0.88	NS	0.21	NS	NS
Varieties												
V ₁ : Ankur rani	29.13	44.83	105.37	55.06	29.84	14.47	47.62	48.26	52.84	4.25	32.04	24.52
V ₂ : Milan-51	21.01	36.95	149.86	65.96	42.16	13.27	43.08	41.69	40.92	5.20	31.79	26.34
V ₃ : Sarada	21.76	65.83	69.62	35.53	19.36	10.76	45.05	47.30	47.03	4.10	34.05	24.84
V ₄ : Malav-51	10.33	41.78	105.93	57.40	32.75	10.94	42.99	44.95	48.61	3.20	33.02	25.39
V ₅ : Nylon-55	27.45	49.31	96.35	56.67	38.35	16.65	46.93	46.85	45.57	6.03	30.07	25.55
SE(m)±	0.40	0.43	0.50	0.51	0.39	0.34	0.38	0.39	5.43	0.09	0.3	0.29
C.D. (0.05)	1.18	1.26	1.45	1.50	1.15	0.99	1.12	1.14	NS	0.28	0.87	0.84
Interaction effect												
SE(m)±	0.70	0.75	0.86	0.89	0.68	0.59	0.67	0.68	5.43	0.16	0.52	0.50
C.D. (0.05)	2.05	2.19	2.51	2.6	1.99	1.71	1.95	1.98	NS	0.48	NS	1.46

(Desai *et al.*, 2015).

Varieties showed significant differences in leaf area (Table 2). The maximum leaf area at 15 DAS was reported in Ankur rani followed by Nylon-55. Leaf area at 30 DAS was reported significantly maximum in Sarada variety, whereas Milan-51 showed significantly maximum leaf area at 45, 60 and 75 DAS. The maximum leaf area at 90 DAS was observed in Nylon-55. The minimum leaf area at 15 and 30 DAS were reported in Malav-51 and Milan-51 respectively whereas, least leaf area at late vegetative and flowering phase was observed in variety Sarada. The higher leaf area under Milan-51 might be due to higher plant height of genotype.

Leaf Chlorophyll content

The maximum chlorophyll content in vegetative phase of guar was reported in summer season followed by *rabi* whereas minimum chlorophyll in *kharif* season. However at flower initiation stage maximum chlorophyll was observed in *rabi* season. The results are in line with the findings of Goldman (1980) who reported increase in chlorophyll and photosynthetic activity at high temperature. In this experiment positive correlation was observed between temperature and chlorophyll contents.

Among guar varieties maximum leaf chlorophyll content was reported in Ankur rani (V₁). The cultivar factor can influence the chlorophyll content of the plant, as the leaves of a given cultivar tend to have certain characteristics, such as thickness, pigment content and internal structure are functions of morphological and physiological differences between cultivars, which may influence the spectral properties of the sheets (SPAD index) (Minotti *et al.*, 1994). Leaf chlorophyll content was found to be non significant in respect of seasons and varieties for pod initiation stage.

Seed yield per plant

Significantly maximum seed yield per plant was reported in *kharif* season followed by summer season, while minimum in *rabi* season. Saini *et al.* (1999) reported that cluster bean was a photosensitive crop for flowers and fruits, when sown in *kharif* season. The decrease in harvest index at delayed sowings

could have been caused by the shortening of growing season and its impact on reproductive phase which brought about a decrease in the number of flowers and pods per plant. Board and Modali (2005) point out that the accumulation of dry matter from the reproductive stage is a major component to estimate the productivity of, mainly due to higher solar radiation interception and carbon partitioning to the reproductive organs, which assists in optimizing productivity which is available to the plants during September and October of *kharif* season. From the Table 2 it was evident that Nylon-55 performed significantly best in respect of seed yield per plant. The minimum seed yield was reported in Sarada variety. Strong variations among cultivars in respect to seed yield may be due to inherent genotypic characteristics as well as variation in weather patterns.

Protein content

Growing season had no significant effect on protein content of guar. These results are in agreement with the finding of Sharma *et al.* (1984) and Naik *et al.* (2013). It was observed that protein content was significantly highest in Sarada variety while minimum in Nylon-55. The variation in protein content of the genotypes in this study may be attributed to genetic factors and environmental conditions.

Crude seed gum yield (%)

The results (Table 4) revealed that crude seed gum yield (%) was non significantly affected by growing seasons. These results are in agreement with the finding of Sharma *et al.* (1984) and Naik *et al.* (2013). The maximum crude seed gum yield was reported in variety Mila-51 which was at par with Nylon-55. The variation in the crude fibre content among genotypes might be attributed to genetic variation and environmental conditions.

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