STUDIES OF DIFFERENT IRRIGATION SCHEDULES AND VARIETIES ON GROWTH, YIELD AND ECONOMICS OF SUMMER SEASON GUAR OR CLUSTER BEAN (*CYAMOPSIS TETRAGONOLOBA* L.) IN MIDDLE GUJARAT AGRO-CLIMATIC ZONE CONDITIONS, INDIA

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ABSTRACT

A field experiment was conducted during summer season of 2012 at Gujarat to assess the impact of irrigation schedules and different varieties. The field experiment was laid out in strip plot design with four replications. Crop Irrigated with (I_2) 0.8 IW: CPE ratio was recorded significant and maximum plant height (32.63, 43.48 and 75.23 cm) at (30, 60 and 90 DAS) during the experiment, respectively. It also produced the significant the highest seed (1489.00 kg ha⁻¹) and gotar yield (4325.00 kg ha⁻¹) with treatment cost (₹2490.00) compare than other irrigation scheduling. The data indicated that the lowest soil moisture extracted 13.47% in treatment (I_1) 0.6 IW: CPE ratio at 45-60 cm of soil depth. Crop data indicated that cultivar Pusa Navbahar maximum plant height (30.95, 41.59 and 81.28 cm) at (30, 60 and 90 DAS), respectively. Further, Pusa Navbahar recorded the significantly higher seed yield (1429.00 kg ha⁻¹) but non significant and maximum gotar yield (4076.00 kg ha⁻¹) with increased treatment cost (₹4620.00), which was superior to rest cultivar treatments. The data noticed that the soil moisture minimum extracted from 45-60 cm of soil depth which was 13.29% observed under treatment in cultivar (V_3) Pusa Navbahar.

KEYWORDS: Irrigation Scheduling, Summer Clusterbean, Gujarat, Varieties & Moisture Extraction

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INTRODUCTION

It can be grown successfully on marginal lands and in areas of erratic rainfall. Amongst the legume crops, clusterbean is grown for fodder, vegetable, and cattle feed. It has now assumed great significance with increasing demand for high-quality gum, which is present in its seed endosperm. After extracting gum from the seed endosperm, the residual byproduct of clusterbean rich in protein serves as cattle feed. Despite poor fertility of soils, very little research efforts have gone into the agronomic aspects influencing its production. Therefore, the present investigation was undertaken to identify suitable variety and irrigation scheduling.

Clusterbean (*Cyamopsis tetragonoloba* L.) is an important crop locally known as 'Guar' grown for green tender pods and for extraction of gum from seeds. Due to more remunerative market prices for last few years, the farmers of Gujarat have shown more interest in this crop. Clusterbean (vegetable) crop requires irrigation for continuous flowering, ultimately, higher production of green pods. Its low productivity is mainly due to inadequate nutrition and management practices. In arid and semi-arid areas of Gujarat, the problem is more aggravated due to

very limited availability of irrigation water, particularly in the summer season (Patel *et al.*, 2014).

As water for irrigation is a scarce resource, its optimization is fundamental to water resource use. It permits better utilization of all other production factors and thus leads to increased yields per unit area and time. The objective of irrigation is to maintain the soil moisture at optimum levels in the plant root zone, so that root will have a constant supply of moisture with adequate aeration. Efficient water management requires a thorough study of the plant water relationship, climate, agronomic practices and economic assessment Anonymous, (2008).

When promising genotypes with higher yield potential identified, it is necessary to establish their appropriate agronomic manipulation or cultivation practices obtaining higher yield. A plant population is one of such factors that have direct influence on the yield of a particular genotype. In recent years, the cluster bean seeds are used in industries for its vegetable gum, which has a great demand. Cluster bean gum and its derivatives are widely used in several industries such as food processing, mining, paper, textiles, ceramics, paints, cosmetics, oil industries and pharmaceuticals. Cluster bean by product of gum industry is also used as concentrate feed for the animal. Seeds are used as a chemotherapeutic agent against smallpox and also used as laxative Anonymous, (2008).

Use of improved varieties of clusterbean in addition to adequate irrigation scheduling management has been reported effective in improving the productivity of clusterbean in arid zone. Though the cultivars have their own inherent ability for growth, development and yield, yet some genotypes of clusterbean have shown considerable variation in yield potentials under varying fertility levels (Rawat *et al.*, 2015). Keeping in view, the scanty information available on these aspects, present investigation entitled, studies on the performance of different irrigation schedules and varieties on growth, yield and economics of the summer season guar (*Cyamopsis tetragonoloba* L.) in middle Gujarat conditions, India has been planned to be carried out.

MATERIALS AND METHODS

Experimental Site, Climate and Soil

This field experiment was conducted during the summer season of the year 2012 in the plot No. 32 of the College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand, (Gujarat). The geographical coordinates of Anand are 22° 35' N latitude and 72° 55' E longitude, with an elevation of 45.1 m above the mean sea level. The climate of Anand is semi-arid and sub-tropical. In this area monsoon commences by the third week of June and retreats by the middle of September with an average rainfall of 864 to 870 mm received entirely from the southwest monsoon current. Uncertain and uneven distribution of rainfall in the monsoon in Anand district. All the facilities required for crop cultivation are available. The data regarding daily pan evaporation measured from USWB class "A" pan evaporimeter during the experimental period (Deewan, 2010). The soil was representative of the soil of the region, locally known as Goradu soil. The texture of the soil was loamy sand. It is alluvial in origin, light brown in color, well drained, fairly retentive of moisture, low in organic matter and responded well to manuring and irrigation. The experiment consisted four irrigation treatments in vertical strip as IW: CPE ratio (0.6, 0.8 and 1.0 kg ha⁻¹) and control (critical growth stage as branching, flowering and pod formation) and three varieties of clusterbean (Gujarat Guar - 1, Gujarat Guar - 2 and Pusa Navbahar in horizontal strip of strip plot design).

The soil moisture studies were started right from the sowing of the crop and continued up to its maturity. The soil moisture content of all the treatments in one replication was determined on the same day just before irrigation and 48 hours after irrigation at 0-15, 15-30, 30-45 and 45-60 cm soil depths were recorded. Soil samples were taken with the help of the screw auger from four different depths (0-15 cm, 15-30 cm, 30-45 cm and 45-60 cm). The soil samples were taken around fixed spot selected at random in net plot area of each treatment from one replication. The samples were transferred immediately to aluminum boxes and covered with a moist gunny bag to avoid moisture losses from the samples. The samples were shifted immediately to the laboratory. The value of table 'F at 5% level significance, where the treatment difference between were found significant the value of the CD and CV % were also worked out to compare the treatment mean Snedecor and Cochran (1967).

Table 1: Physico- Chemical Properties of the Experimental Plots

Particulars		Soil depth			Method of analysis
		0-15 cm	15-30 cm	Average	
A. Mechanical composition					
1.	Coarse sand (%)	0.54	0.53	0.54	International pipette method(Piper, 1980)
2.	Fine sand (%)	82.45	82.89	82.67	-do-
3.	Silt (%)	11.98	10.97	11.48	-do-
4.	Clay (%)	5.00	5.58	5.29	-do-
5.	Textural class	Loamy sand	Loamy sand	-	-do-
B. Chemical parameters					
1.	Soil pH(1:2.5Soil:Water)	8.60	8.65	8.63	pH meter (Jackson,1973)
2.	Electrical Conductivity (dsm ⁻¹)(1:2.5)	0.14	0.34	0.24	Conductivity meter (Jackson,1973)
3.	Organic carbon (%)	0.45	0.47	0.46	Walkley and Black method (Jackson,1973)
4.	Available N (kg ha ⁻¹)	242.32	221.54	231.93	Alkaline permanganate method, (Subbaiah & Asija,1956)
5.	Available P ₂ O ₅ (kg ha ⁻¹)	24.53	29.97	27.25	Olsen's method. (Olsen <i>et al.</i> , 1954)
6.	Available K ₂ O (kg ha ⁻¹)	188.28	187.54	187.91	Flame photometric method (Jackson,1973)

RESULTS AND DISCUSSION

EFFECT OF DIFFERENT IRRIGATION SCHEDULING

Data presented at (table-2) plant height (32.63 cm) at 30 DAS significantly higher in irrigation treatment (I₂) 0.8 IW: CPE ratio (Common irrigation + 7) = 8. However, at par with treatment (I₁) 0.6 IW: CPE ratio (Common irrigation + 6) = 7 and (I₃) 1.0 IW: CPE ratio (Common irrigation + 8) = 9. At 60 DAS, significant the highest value of plant height (43.48 cm) in irrigation treatment (I₂) 0.8 IW: CPE ratio (Common irrigation + 7) = 8. While plant height (75.23 cm) was observed value significantly higher at 90 DAS with at par with (I₃) 1.0 IW: CPE ratio (Common irrigation + 8) = 9. High values of growth parameters at higher moisture regimes might be due to the application of more irrigations as timely and early growth stages encourage better growth and development(Rajanna *et al.*, 2016).The second reason might be owing to increase in moisture regimes resulted in higher photosynthetic activity per unit area and more dry-matter production lead to increase in growth indices.

The results noticed that treatment (table2) the effect of different levels of irrigation scheduling and varieties on the significantly the highest value recorded in treatment (I₂) 0.8 IW: CPE ratio (Common irrigation + 7) = 8. viz., Grain yield (1489.00 kg ha⁻¹), Gotar yield (4325.00 kg ha⁻¹). The probable reason might be due to attributed to its beneficial effect on the better development of yield attributes at higher moisture regimes might be owing to increase in cell turgidity, a better

opening of stomata and finally helping in translocation of photosynthates to sink (Rajanna *et al.*, 2016) and Sewhaget *et al.*, (2008). The increase in gotar yield due to various treatments may be mainly due to increase in the vegetative growth characters (Deewan 2010).

Table 2: Effect of Irrigation Scheduling and Varieties on Plant Height, Seed Yield, Gotar Yield, Total Common Cost and Treatment Cost of (*Cyamopsis tetragonoloba* L.)

Treatment	Plant height (cm)			Seed Yield (kg ha ⁻¹)	GotarYield (kg ha ⁻¹)	Total Common Cost (₹ha ⁻¹)	Treatment Cost (₹ha ⁻¹)
	At 30 DAS	At 60 DAS	At 90 DAS				
Vertical strip (Irrigation IW:CPE ratio) (I-4)							
I ₀ : Control (critical growth stage as Branching, Flowering and Pod formation) (Common irrigation + 3) = 4	22.03	35.24	68.64	1370.00	3776.00	27732.00	1240.00
I ₁ : 0.6 IW: CPE ratio(Common irrigation + 6) = 7	30.79	37.73	69.50	1297.00	3858.00	27732.00	1990.00
I ₂ : 0.8 IW: CPE ratio(Common irrigation + 7) = 8	32.63	43.48	75.23	1489.00	4325.00	27732.00	2240.00
I ₃ : 1.0 IW: CPE ratio(Common irrigation + 8) = 9	30.38	37.79	73.70	1318.00	3725.00	27732.00	2490.00
S. Em±	0.93	1.67	1.40	37.57	70.82	-	-
C. D. at 5 %	2.98	5.35	4.47	118.00	227.00	-	-
C.V. (%)	11.15	15.02	6.75	9.51	6.26.00	-	-
Horizontal strip (Variety (V-3))							
V ₁ : Gujarat Guar - 1	25.62	36.08	66.90	1290.00	3731.00	27732.00	3870.00
V ₂ : Gujarat Guar - 2	30.30	38.00	67.12	1386.00	3956.00	27732.00	3870.00
V ₃ : PusaNavbahar	30.95	41.59	81.28	1429.00	4076.00	27732.00	4620.00
S.Em±	1.14	1.19	3.02	30.91	52.79	-	-
C. D. at 5 %	3.95	4.13	10.45	107.00	183.00	-	-
C.V. (%)	15.77	12.38	16.83	9.04	5.39	-	-
Interaction (I ×V)	NS	NS	NS	S	NS	-	-
C.V. (%)	11.14	9.88	6.66	6.53	5.26	-	-

The data pertaining to economics in (table - 2) indicated that the highest treatment cost (₹2490.00) was secured under treatment (I₁) 0.6 IW: CPE ratio (Common irrigation + 8) = 9, respectively. While the lowest (₹1240.00) was observed under irrigation scheduling (I₀) Control (critical growth stage as Branching, Flowering, and Pod formation) (Common irrigation + 3) = 4, respectively.

Figure 1: Effect of Irrigation Scheduling (IW: CPE Ratios) and Varieties on Moisture Extraction Pattern(%) of Clusterbean(*Cyamopsis tetragonoloba* L.)

The data indicated (figure -1) that the soil moisture extracted from 0-15, 15-30, 30-45, and 45-60 cm of soil depth were 24.25, 19.40, 17.59 and 15.43% under treatment (I₀) Control (critical growth stages as Branching, Flowering and Pod formation), 25.75, 19.00, 17.81 and 15.84% under treatment (I₁) 0.6 IW:CPE ratio, 28.48, 20.20, 16.12 and 15.23% under treatment (I₂) 0.8 IW:CPE ratio and 31.71, 21.50, 18.22 and 13.47% under treatment (I₃) 1.0 IW:CPE ratio. The maximum percent of soil moisture was extracted from 0-15 cm soil depth, followed by 15-30 cm soil depth for all the treatments of

irrigation. The moisture extraction increased with the increase in quantity of irrigation water from upper layers of soil (0-15 and 15-30 cm soil depth), whereas, the almost reverse trend was observed with respect to deeper layers of soil (30-45 and 45-60 cm soil depth) under the study.

EFFECT OF DIFFERENT VARIETIES

Among the clusterbean varieties (table-2) at 30 and 60 DAS recorded significantly the higher plant height (30.95 and 41.59 cm) in a variety (V_3) PusaNavbahar compared than other both varieties. It variety also have was observed significantly at par with (V_2) Gujarat Guar - 2. Further, the result growth parameter revealed that there was significant the highest plant height (81.28 cm) at 90 DAS, which was superior to rest of varieties. It might be due to the differential behavior of clusterbean varieties with respect to root-shoot growth characters could be explained solely by the variation in their genetic make-up and adaptability to soil and climatic conditions. The results are in close conformity with the findings of (Vyas 2002) whom reported that the late genotypes had better vegetative growth in terms of plant height (Deewan 2010).

The perusal of the data presented in (table- 2) revealed that the variety (V_3) PusaNavbahar recorded significantly the higher seed yield ($1429.00 \text{ kg ha}^{-1}$) but non significant the highest gotar yield ($4076.00 \text{ kg ha}^{-1}$). However, it significantly at par with variety (V_2) Gujarat Guar - 2 value seed ($1386.00 \text{ kg ha}^{-1}$). It might be due to the trend of increases in seed and gotar yields obtained due to these treatments was exactly in accordance with the similar increase in the yield attributing characters (Kalyani *et al.*, 2011) The second reason might be ascribed to their best vegetative growth in terms of plant height, number of pods, and bolder seeds.

The seed yield is the resultant of the coordinated interplay of growth and development characters. Thus, the productivity parameters are based on the cumulative effect of the genetic ability and production efficiency of the varieties, their fertility management and the agro-climatic conditions where these varieties are grown. The wide variations in productivity parameters among the clusterbean varieties have also been observed by (Singh *et al.*, 2013)

Economics data noticed (table-2) that the highest treatment cost (4620.00 ₹) was secured under treatment (V_3) (PusaNavbahar) and the lowest ($₹3870.00$) observed under (V_1) (Gujarat Guar-1). Further, exactly equal value of treatment cost ($₹3870$) was observed in treatment (V_2) (Gujarat Guar-2) during the experiment year.

The data indicated (figure - 1) that the moisture extracted from 0-15, 15-30, 30-45, and 45-60 cm of soil depth were 21.69, 19.46, 16.59 and 15.58 % observed under treatment V_1 (Gujarat Guar-1) and 21.25, 18.78, 16.46 and 14.98 % under treatment (V_2) (Gujarat Guar-2) and 19.84, 17.13, 15.21 and 13.29% in treatment (V_3) (PusaNavbahar). The maximum percent of moisture was extracted by treatment (V_1) (Gujarat Guar-1, followed by (V_2) (Gujarat Guar -2). Whereas lower soil moisture was observed deeper layers of soil (30 - 45 and 45-60 cm).

Plate 1: Bird Eye View of Experimental Field

CONCLUSION

From the present investigation, it may be concluded that adoption of irrigation at IW: CPE of 0.80 in clusterbean with either use of cv. PusaNavabharor Gujarat Guar-2 varieties leads to increase in growth parameters along with seed and gotaryieldscompared to others. Since varied weather conditions, the crop seasons of clusterbeanhave performed well productivity from irrigation scheduling and varieties.

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