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Research Article

Variation in Some *Guar Cyamopsis tetagonoloba* (L.) Parameters at Different Row Spacing under Rainfed Conditions

Muhammad Adeel Ahmed*, Muhammad Yaqoob, Noman Latif, Amanullah Khan and Muhammad Arshad Khan, Muhammad Ehsan Elahi

PARC, Arid Zone Research Centre, Dera Ismail Khan, Pakistan

*Corresponding Author E-mail: adeelahmad7773@gmail.com

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ABSTRACT

A field experiment was investigated to determine the Guar adaptability in rainfed areas of Lakki Marwat Pakistan. Their most appropriate row spacing in guar crop was conducted at newly established Adaptive-cum-Demonstration Research Station (PARC) Matora, Lakki Marwat, Pakistan. Two guar genotypes including one cultivar BR-99 and one local land race (LLR) were tested under 20, 30 and 40 cm row spacing in a Split Plot Design with three repeats. BR-99 and local land race belong to single and multiple branching habit respectively. The crop was maintained under rainfed conditions. Results revealed that all the parameters (except pod length and number of seed per pod) were significantly affected due to genotypes, row spacing treatment and interaction between genotypes and row spacing. The highest grain yield of 1041.70 and 417.7 kg ha^{-1} was produced by BR-99 and LLR at 30 and 40 cm row spacing respectively, suggesting that single stick guar should be planted at 30 cm while multiple branches variety at 40 cm row under rainfed conditions.BR-99 performed best under rainfed condition as compared with local variety so it is concluded from the study that BR-99 is consider under rainfed condition for higher yield production of Guar crop in rainfed condition.

Keywords: *Guar [Cyamopsis tetagonoloba (L.) genotypes, Row spacing, rainfed, Yield and yield components.*

INTRODUCTION

Guar or cluster bean [*Cyamopsis tetagonoloba* (L.) Tuab] *(2n = 14)* is an important commercial, industrial and a valued export commodity of Pakistan. It is cultivated for grain as well as fodder purpose. Being a nutritious commodity, guar dry fodder is exported to Middle East for feeding desert animal like Camels. Guar has worldwide uses for food stabilization, fiber source, food and multipurpose industry. Pakistan stands second in area and production after India. Total area of guar in Pakistan is about 0.20 million hectare with production of 0.15 million tone (Anonymous, 2016). Guar plant is extremely drought resistant, being able to absorb soil moisture efficiently for its growth and development.

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It is really a crop of rainfed region which is also cultivated in arid and semi-arid area, where other crop could not successfully grow. Guar seeds are mainly used for extraction of endospermic gum having good binding properties and high demand in food, petroleum, varnish, textile, explosive, pharmaceutical, telephone, electricity, juice, paper, dairy and coal industries (Girish et al., 2013).

Several studies have been conducted on plant density analysis of guar under various ecologies. Hashemabadi and Sedaghathoor (2006) in faba bean and Taleie et al. (2000) in pinto bean have found that the increase in plant density leads to the loss of pod number per plant. This loss of pod number per plant at higher densities can be related to the intensified competition of plants and the decrease in over-ground space for light interception and branch-bearing. So, lower density plants get better conditions for utilizing environmental amenities and produce more flowers. Consequently, pod number per plant increases. Habibzadeh et al. (2006) found that intensified inter-plant competition on environmental factors and the shading of lower parts of the canopy at higher densities are the reasons for the decrease in pods number per plant of pulses. Mahmood et al. (1988) observed the maximum plant height, number of pods and seed weight. at 60 cm row spacing while they recorded higher number of branches and grain yield at 45 cm row spacing in two guar varieties. Mohamed (2008) studied the effect of four spacing treatments (10, 20, 30 and 40 cm) on two guar (*Cyamopsis tetragonoloba*) varieties and reported that number of branches and grain yield were significantly affected. They noted similar performance of the two guar lines no significant different in all parameters studied except in number of branches. The spacing x lines interaction was not significant in all parameters studied, except number of branches per plant and number of plants per unit area.

Akhtar et al. (2012) determined the response of three guar strains under different row spacing and reported that seed yield was highest at 30 cm row spacing, suggesting that guar crop is highly sensitive to row spacing. They further detected that guar yield is specific to type of guar plant as far as the plant population is concerned. They concluded that different row spacing had significant effect of most of the plant traits including, plant height, pods, clusters, Maturity period, seed weight and grain yield, whereas other trait remained statistically similar at different spacing. Muhammad (2012) investigated three guar {Cyamposis tetragonoloba (L.) Taub} varieties (DPS, HF53 and CB) under three different spacing at five locations. The varieties DPS and HFG53 gave higher seed yield in contrast to variety CB. The former two varieties flowered and matured earlier than the latter one. The 10 cm spacing was found to be an optimum for attaining highest seed yield. Sultan et al. (2012) noted considerable dissimilarity level for a number of morphological traits in guar *Cyamopsis tetragonoloba* (L.) Taub. Highly variable traits were found for days to maturity, plant height, pods per plant and grain yield.

Ahmad et al. (2015) explore the row spacing impact on new guar genotype S-786. The optimum and suitable row to row spacing was recorded as 45 cm for obtaining maximum grain yield. Any increase or decrease in this optimum row distance might decrease the yield of this crop adversely. Spacing had also significant effect on other plant traits like; plant height, number of pods, clusters. Days to maturity, 1000 seed weight and grain yield. Deka et al. (2015) conducted field experiment to find out the optimum time of sowing and plant spacing of cluster bean. The results showed that all characters were markedly affected by sowing dates and spacing. Most of the characters studied except flowering period, decreased by delaying sowing date from early July to mid-August. Increasing spacing from 30 to 60 cm significantly increased pods/plant and leaf area, but decreased maturity date and plant height.

Mevada et al. (2017) reported that 30 cm row spacing with guar variety GG-2 recorded significantly higher seed yield which was found at par with treatment combination as compared to 60 cm row spacing. Similarly, other plant traits like days to maturity, number

of pods, plant height, 1000 seed weight were also affected due to different row spacing and varieties. Ramanjaneyulu et al. (2018) studied row spacing and sowing date on seed yield and quality traits in guar. The crop sown at 30 cm row spacing recorded significantly higher seed yield than that of 45 cm and 60 cm row spacing. They also noted higher galactomannan, protein and NKP uptake were significantly higher at 30 cm row spacing. Number of pods, cluster and 1000 seed weight were also significantly were higher at 30 cm row spacing as compared to 45 and 60 cm spacing. In present research two guar varieties were evaluated under different row spacing to work-out the most appropriate plant population for higher grain yield under rainfed conditions.

MATERIALS AND METHODS

The experiment was conducted at newly established Adaptive-cum-Demonstration Research Station (PARC) Matora, Lakki Marwat, Khyber Pakhtunkhwa, Pakistan. Two guar genotypes, (one approved variety "BR-99" and one local land race) were tested under three row spacing i.e. 20, 30 and 40 centimeters. The experiment was laid out in a split plot design with three replications. The varietal factor was kept in main plot while row spacing in sub-plot. The crop was seeded on 15th July, 2018 and was maintained under rainfed conditions. Uniform plot sizes (2.4 m X 4m) were maintained for each treatment. Each treatment was comprised of variable number of rows depending upon row width, with a common row length of 4 meters. The crop was protected from sucking pest though appropriate pesticide spray and field was kept clean through regular hand weeding. The crop had received enough rain about 200 mm at different intervals during growth period. Data were recorded on days to 50% flowering, plant height (cm), number of branches plant^{-1}, number of pods plant^{-1}, number of clusters plant^{-1}, pod length, number of seed pod^{-1}, days to Maturity, 1000 grain weight and grain yield. The analysis of variance and LSD at 0.05% probability level were done through statistical software STATISTIX 8.1 using technique proposed by Steel et al. (1997).

RESULTS AND DISCUSSION

The results of statistical analysis showed that all the traits (except pod length and seed per pod) were significantly affected due to varieties, row spacing and their interactions (Table-1).

Days to 50%Flowering

Analysis of variance into its components given in Table-1 revealed that days to 50% flowering was significantly different due to guar varieties and interaction between varieties and row spacing. However, effect of row spacing was found to be non-significant on number of days to 50% flowering. Mean data given in Table-2 showed that 50% flowering ranged from 57.33 to 68.33 days due to varieties. The Cultivar BR-99 remained early and took 57.33 days to complete 50% flowering while local land race was late availing 68.33 days. Similarly, significant variation was observed between interactions of varieties and row spacing. It was noted that wider row spacing had slightly enhanced the flower initiation in both the guar genotypes as compared to narrow spacing. The 50% flowering period was noted as 58 and 68.67 days in BR-99 and local land race due to 20 cm row spacing respectively, while this period was hasten in 30 and 40 cm row spacing. The days to 50% flowering was 57 and 68 in BR-99 and local land race under 40 cm row spacing. Deka et al. (2015) also found optimum time of sowing and plant spacing of cluster bean. All characters were markedly affected by sowing dates and row spacing. Similar findings have been reported by Mohamed (2008) Akhtar et al. (2012), Ahmad et al. (2015), Mevada et al. (2017) and Ramanjaneyulu et al. (2018). The finding of Deka et al. (2015) however do not harmonize with present results who noted non-significant variation in days to flowering due to different plant spacing in guar.

Plant height

Plant height being quantitative trait is highly influenced by environmental changes. In our study plant height was highly significantly affected due to varieties, row spacing and their interaction (Table-1). Mean data showed that guar variety BR-99 being single stick remained taller with height of 85.33 cm while LLR being branches line was comparatively

short with 51.67 cm height. Similarly, the effect of different row spacing showed that plant remained stunted in narrow row (20 and 30 cm) spacing while the height of guar increased under wider row spacing (40 cm). The interaction between guar varieties and row spacing revealed that wider row spacing i.e. 40 cm had increased the height of both the lines (Table-2). The growth of plant height due to different row spacing was however significant in BR-99 while non-significant in LLR. Similar results have also been reported by Muhammad (2008), Akhtar et al. (2012) Muhammad (2012), Ahmad et al. (2015), Deka et al. (2015), Mevada et al. (2017) and Ramanjaneyulu et al. (2018).

Number of branches plant^{-1}

The numbers of branches in guar were highly significantly affected due to varieties, row spacing and their interaction (Table-1). BR-99 being single stick variety had produced only one branch while LLR with multiple branching patterns had produced more branches (6.33 plant-^{1}). The effect of row spacing was only observed on LLR which showed that narrow spaced plants produced significantly low branches (5.33 plant^{-1}) while broader spacing produced more branches (7 branches plant^{-1}). The main effect of row spacing was not considered as the branching pattern of BR-99 is fixed i.e. genetically single *branched variety*. Muhammad (2008), Akhtar et al. (2012) Muhammad (2012). Ahmad et al. (2015), Deka et al. (2015), Mevada et al. (2017) and Ramanjaneyulu et al. (2018) reported similar results. The findings of Deka et al. (2015) are however do not correspond to present results who noted non-significant variation in branching pattern due to different plant spacing in guar.

Number of pods plant^{-1}

The number of pods plant^{-1} were significantly affected due all factors of variation i.e. varieties, row spacing and their interaction. The cultivar BR-99 remained at the top by producing highest pods (100 pods plant^{-1}) while LLR remained poor, producing 45.33 pods plant^{-1}. The inclusive effect of spacing showed that 30 cm row spacing was ideal as guar plant produced the maximum pods (79.58 plant^{-1}) at this spacing while rest of the row spacing i.e. 20 and 40 had respectively showed 64.13 and 74.28 pods plant^{-1}. Interaction between varieties and row spacing showed that BR-99 produced highest number of pods (117.03 plant^{-1}) at 30 cm row spacing, while LLR produced maximum pods (50.88 plant^{-1}) at 40 cm row spacing. Hashemabadi and Sedaghathoor (2006) in faba bean and Taleie et al. (2000) in pinto bean have found that increase in plant density leads to the loss of pod number per plant. This loss of pods at higher densities can be related to the intensified competition of plants and the decrease in over-ground space for light interception and branch-bearing. So, lower plant density get better conditions for utilizing environmental conditions and produce more flowers ultimately increase pod number per plant. (Hashemabadi & Sedaghathoor, 2006 & Taleie et al, 2000). An intensified inter-plant competition on environmental factors and the shading of lower parts of the canopy at higher densities are the reasons for the decrease in pod number per plant in pulses (Habibzadeh et al., 2006), Zabet et al. (2005) also reported similar results. Earlier studies of Muhammad (2008), Akhtar et al. (2012) Muhammad (2012), Ahmad et al. (2015), Deka et al. (2015), Mevada et al. (2017) and Ramanjaneyulu et al. (2018) show significant variation in number of pods in guar genotypes planted under different plant geometry.

Number of clusters plant^{-1}

The resulted presented inTable-1 revealed that number of cluster in guar were highly significantly affected by varieties and row spacing, while mere significant due to interaction between varieties and row spacing. The means number of cluster given in Table-2 showed that BR-99 has produced two fold more cluster plant^{-1} clusters as compared to LLR. The main effect of row spacing showed that 30 cm row spacing was the desirable producing 11.90 clusters plant^{-1}. It was however, statistically similar to the effect of 40 cm row spacing producing (11.43 clusters plant^{-1}). The interaction between varieties and row spacing showed that BR-99 produced significantly highest cluster at 30 cm row spacing while LLR produced highest pods at 40 cm row spacing. These results are in line

with the findings of Akhtar et al. (2012), Muhammad (2012), Ahmad et al. (2015), Deka et al. (2015), Mevada et al. (2017) and Ramanjaneyulu et al. (2018) who reported significant differences in number of clusters in guar genotypes under different plant densities.

Days to maturity

The information regarding analysis of variance for days to maturity in guar due to varieties and row spacing are given in Table-1. The data showed that merely varietal factor had significantly affected the time to maturity while rest of the variation factors had no significant effect on maturity period in gaur. The cultivar BR-99 remained early and matured within 118 days while LLR was found late taking 127.44 days to maturity. Deka et al. (2015) reported that increasing spacing from 30 to 60 cm significantly decreased maturity days and plant height. Taleie et al. (2000), Hashemabadi and Sedaghathoor (2006) in faba bean and Muhammad (2008), Muhammad (2012), Ahmad et al. (2015), Deka et al. (2015) and Mevada et al. (2017) reported significant differences in days to maturity due to variable plant spacing in guar.

1000 grain weight

The weight of grain in guar was highly significantly affected due to varieties and interaction between varieties and row spacing. While, it was non-significantly affected due to row spacing (Table-1). The maximum size of grain was produced by cultivar BR-99 with weight of 334.44 gram 1000^{-1} grain while LLR produced the seed with 281 gram 1000^{-1} grain. Patel et al. (2004) and Vishal et al. (2014), Taleie et al. (2000), Habibzadeh et al. (2006), Zabet et al. (2005) Akhtar et al. (2012) and Muhammad (2012) also reported statistically significant variability in grain size of varieties and effect of row spacing in guar.

Grain yield Kg ha^{-1}

Grain yield in present studies was highly significantly affected due to varieties, row spacing and interaction between varieties X row spacing (Table-1). The cultivar BR-99 produced the highest grain yield 928.44 kg ha^{-1} while LLR produced 366.78 kg ha^{-1}. The major effect of row spacing on guar revealed that 30 cm spacing between rows is more desirable as it had produced significantly highest yield of 708.83 kg ha^{-1}. The effect of 20 and 40 cm row spacing with grain yield of guar was not encouraging as compare 30 cm row spacing. Both the treatments were statistically uniform at 0.05% level of probability. These findings are substantiated with those reported by Patel et al. (2004) and Vishal et al. (2014), Habibzadeh et al. (2006) Zabet et al. (2005), Muhammad (2012). Ahmad et al. (2015), Ramanjaneyulu et al. (2018) who also reported statistically significant variability in grain yield among guar varieties and due to effect of row spacing.

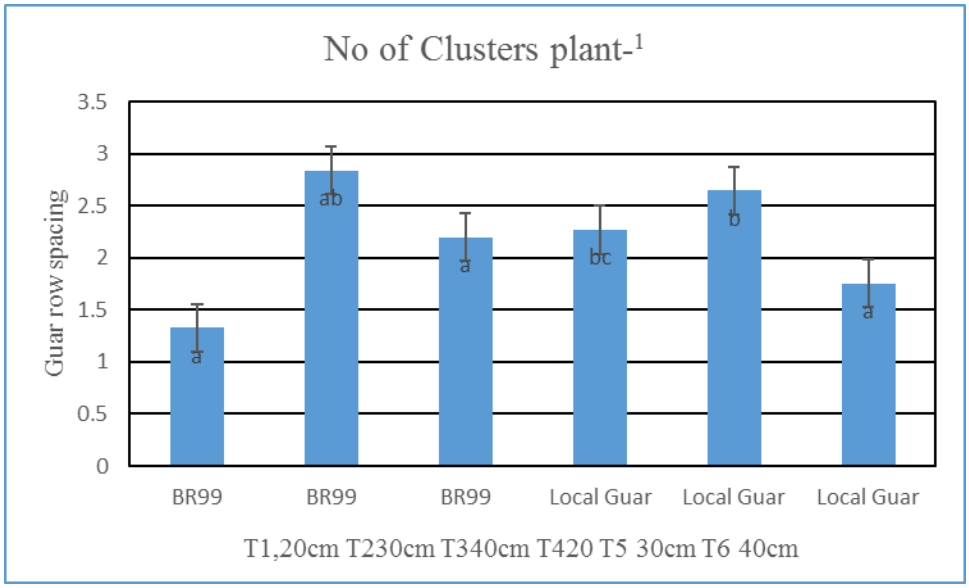

Fig. 1: Guar cluster as affected by row spacing under rainfed condition

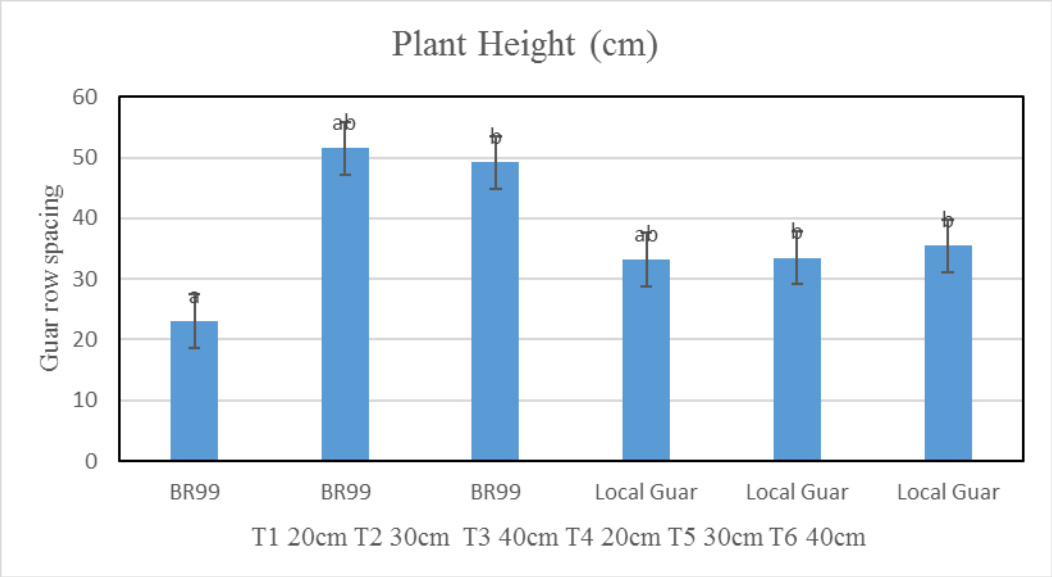

Fig. 2: Guar Plant height as affected by row spacing under rainfed condition

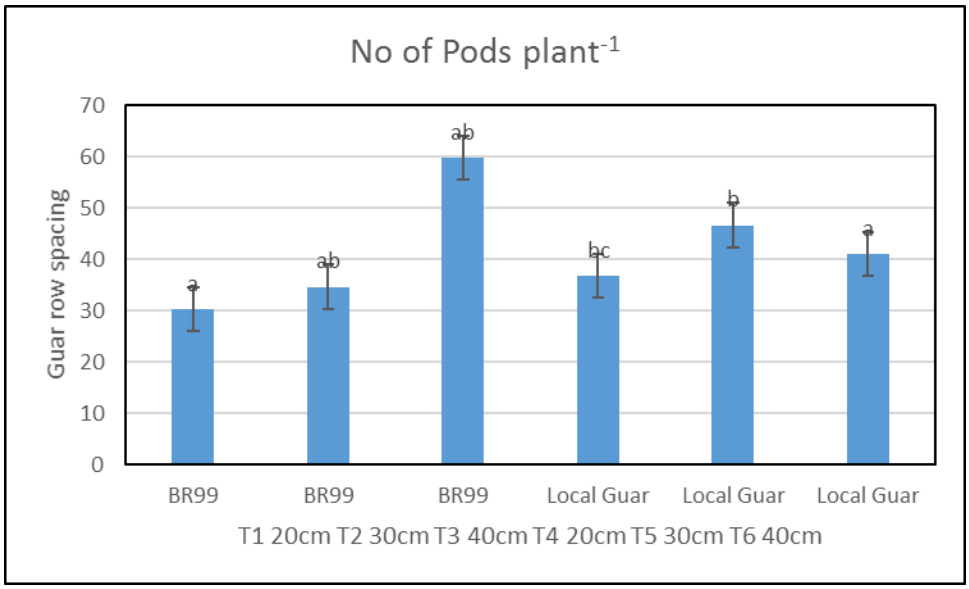

Fig. 3: Guar No of Pods per plant^{-1} as affected by row spacing under rainfed condition

Table 1: Main effect of varieties, row spacing and interaction of varieties X row spacing on various guar traits under rainfed conditions

Treatments	Days to 50% flowering			Plant height (cm)		
	BR-99	Local Guar	Means	BR-99	Local Guar	Means
Row spacing-1 (20 cm)	58 B	68.67 A	62.67 A	78.67 B	49.33 C	64.00 B
Row spacing-2 (30 cm)	57 B	68.33 A	62.50 A	86.00 AB	52.67 C	69.33 A
Row spacing-3 (40 cm)	57 B	68.00 A	63.33 A	91.33 A	53.00 C	72.17 A
Means	**57.33 B**	**68.33 A**	**62.83**	**85.33 A**	**51.67 B**	**68.50 A**
	Number of Branches			**Number of pods**		
Row spacing-1 (20 cm)	1.00 C	5.33 B	3.16 B	85.26 C	42.99 D	64.13 B
Row spacing-2 (30 cm)	1.00 C	6.67 A	3.83 A	117.03 A	42.12 D	79.58 A
Row spacing-3 (40 cm)	1.00 C	7.00 A	4.00 A	97.68 B	50.88 D	74.28 A
Means	**1.00 B**	**6.33 A**	**3.67**	**100 A**	**45.33 B**	**72.66**
	Number of Cluster			**Pod length (cm)**		
Row spacing-1 (20 cm)	11.96 BC	5.90 B	8.93 B	6.00 A	5.33 A	5.67 A
Row spacing-2 (30 cm)	16.86 A	6.93 DE	11.90 A	6.33 A	5.67 A	6.00 A
Row spacing-3 (40 cm)	14.20 B	8.67 CD	11.43 A	6.33 A	5.68 A	6.00 A
Means	**14.34 A**	**7.17 B**	**10.76**	**6.22 A**	**5.56 A**	**5.89**

	Number of seed per pod			Days to maturity		
Row spacing-1 (20 cm)	7.00 A	6.00 A	6.50 A	117.33 B	125.33 A	121.33 A
Row spacing-2 (30 cm)	7.33 A	6.33 A	6.83 A	118.33 B	126.67 A	122.50 A
Row spacing-3 (40 cm)	7.67 A	6.67 A	7.16 A	118.33 B	130.33 A	124.83 A
Means	**7.33 A**	**6.33 A**	**6.83**	**118. B**	**127.44 A**	**122.89**
	1000 Grain weight (g)			**Grain Yield Kg ha^{-1}**		
Row spacing-1 (20 cm)	333.33 A	290.00 B	311.67 A	901.30 B	306.70 C	604.00 B
Row spacing-2 (30 cm)	333.33 A	280.00 B	306.67 A	1041.70 A	376.00 C	708.83 A
Row spacing-3 (40 cm)	336.67 A	273.33 B	305.00 A	842.30 B	417.7 C	630.00 B
Means	**334.44 A**	**281.11 B**	**307.71**	**928.44 A**	**366.78 B**	**647.61**

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