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Genetic Analysis of Some Quantitative Traits in Cluster Bean (*Cyamopsis tetragonoloba* L.)

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Abstract: An experiment comprising of eight promising genotypes of cluster bean developed at Agricultural Research Station, Bahawalpur, Pakistan was conducted to study the genetic differences among the genotypes during Kharif season, 2014. The experiment was laid out in RCBD and data on five characters i.e. grain yield (kg ha^{-1}), plant height (cm), number of branches plant^{-1}, number of pods plant^{-1} and number of grains pod^{-1} were recorded. Analysis of variance showed highly significant differences among all the genotypes. A significant level of correlation was also noticed among quantitative traits. Number of branches plant^{-1} were negatively correlated with all characters while grain yield, plant height, number of pods plant^{-1} and number of grains pod^{-1} were positively correlated with each. The genotype S-5498 was found to be higher yielder which produced grain yield of 2093kg ha^{-1} followed by S-5488 which produced 2037 kg ha^{-1} respectively as compared to standard variety BR-99 (1533 kg ha^{-1}).While the genotypes S-5490 and S-5497 were the lowest yielders and yielded grain yield of 993 kg ha^{-1} each.

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1. Introduction

Guar [*Cyamopsis tetragonoloba* L. (Taub.)] also known as cluster bean, is a self-pollinated herb belongs to the family leguminosae and subfamily paplionaceae. It is a short duration crop with fast growth habit, therefore fits well as a summer crop into most of the prevailing cropping system (Ashraf et al., 2002) It is a drought tolerant, summer annual legume, well adapted to arid and semi-arid regions of Pakistan, usually grown in rainy season (Ali et al., 2004). Base temperature of guar is 14.6 ºC, but it can tolerate wide range of temperature i.e., 10-45 ºC and is considered high temperature tolerant, but susceptible to frost (Daisy, 1979; Angus et al., 1981; Ecocrop-FAO, 2007).

Although, guar is considered as a minor crop, it has a larger role among the domesticated plants that provides food for human beings and besides this it provides a good quality of nutritional quality protein. Guar beans are good source of different amino acids including glutamic, arginine, aspartic acid and leucine (Kobeasy et al., 2011). Guar is useful in weight management as it has role in lowering absorption of fat, enhanced lipolysis through increased activity of hormone sensitive lipase causing decreased adipose weight and increased mobilization of accumulated fat (Pande and Srinivasan, 2014). Guar seeds have been used in manufacturing of pharmaceuticals, nutraceuticals and industrial compounds. It serves as a better concentrate for both working and milch animals. It is also used as vegetable, green manuring, guar meal and fodder purposes (Arora and Pahuja, 2008).

Guar is a source of a very valuable polysaccharide i.e., galactomannan, commercially called guar gum, which is a, obtained from its endosperm (Hymowitz and Matlock, 1964; Reid, 1985). Galactomannon is highly soluble in cold water, contain high chemical reactivity and flexibility and possess peculiar rheological properties (Wang and Zhang, 2009). Guar gum has diversified industrial applications and can be used in every product where water is one of the components. e.g. food, pharmaceutical , textile industry, drugs, paper, cosmetic, tobacco, oil & gas well drilling, hydraulic fracking, fish farming, poultry and cattle feed, paint, leather, firefighting, explosive, beverages, confectionary, dairy products, baby pampers, photography, mining and construction (Whistler and Hymowitz, 1979; Tasneem and Subramanian, 1986; Pathak et al., 2010).

Recent rise in demand of guar gum is attributed to its use in petrochemical and mining industry, where its use as viscosifier has revolutionized the petrochemical industry and resulted in considerable increase in global natural gas production (Falasca et al., 2015). On account of industrial value, guar seed has great demand from foreign countries like USA, Britain, France, Germany, Italy, UAE, Lesotho, South

Africa, Hong Kong, China, Japan, Australia etc. (Singh et al., 2005; Gresta et al., 2013).

World's most of the guar is grown in tropical deserts of Indo-Pak Sub Continent. India and Pakistan share 95% of world production and only 5% is produced by all other countries like USA, South Africa, Sudan, Argentina and Australia (Kumar et al., 2013; Falasca et al., 2015). In Pakistan, 42% of guar is grown in Punjab, 38% in Sindh, 8% in KPK and 12% in Baluchistan (Zahoor, 2007; Anonymous, 2009). Thal and Tharparkar are the core areas for guar crop in Punjab and Sindh provinces because this crop is highly drought tolerant and grows well in water deficient areas of these regions (Pathak and Roy, 2015) and no other crop fits well in cropping patterns of these areas.

The yield of guar in Pakistan is very low as compared to other countries. The main reason lower yield of guar is that the existing varieties have lost their yield potential which results in low yield and causes significant losses to the growers. Therefore, development of new guar varieties having high yield potential should be the main objective of the breeding program. For this, information about patterns of genetic variability and interrelationship among quantitative traits of cluster bean is pre-requisite to develop new varieties. Therefore, the present studies were conducted to assess the extent of genetic variation and correlation among promising genotypes of guar crop.

2. Materials and Methods

The experimental material comprising of eight promising genotypes of cluster bean namely S-5488, S-5490, S-5497, S-5498, S-5499, S-5505, S-5509 and S--5490, which were developed at Agricultural Research Station, Bahawalpur, Pakistan. The sowing was conducted on 15th June and harvesting on 15th November, 2014 at the experimental area of Agricultural Research Station, Bahawalpur. The experiment was laid out in Randomized Complete Block Design with four replications. Each entry was planted in four rows plot^{-1} with row to row distance of 45cm @ 25kg ha^{-1} seed rate. The sowing was done with single row hand drill and after germination plant to plant distance of 15cm was maintained by manual thinning. For weed control Pendimathline @ 2.5L ha^{-1} was sprayed as weedicide at the time of land preparation. All recommended agronomic practices and crop protection measures were applied from sowing till harvesting of crop. Fertilizer N-P-K was applied @ 57-23-60 kg ha^{-1}. Three irrigations, first at the time of 35-40 days, 2nd irrigations at the time of flowering and last at the time of pod formation were applied. At maturity, the data concerning the quantitative traits were recorded on five randomly selected plants from each entry including grain yield (kg ha^{-1}), plant height (cm), number of branches plant^{-1}, number of pods plant^{-1} and number of grain pod^{-1}.

The data collected was subjected to the standard technique of analysis of variance (Steel et al., 1997) to establish the level of genotypic differences for plant traits under study. Duncan's multiple range test was used to compare the treatment means. Coefficients of correlations were established as suggested by Kwon and Torrie (1964). The significance of correlation coefficients was tested by Brooks and Harvey (1950).

3. Results and discussion

The analysis of variance revealed considerable level of variability among all the genotypes as shown in Table-1. A significant level of correlation in present study was noticed among quantitative traits (Table-2).

Table 1. Summary of Analysis of Variance of various characters studied in guar genotypes.

SOV	d.f.	Grain yield	Plant height	No. of branches plant^{-1}	No. of pods plant^{-1}	No. of grains pod^{-1}
Replications	3	0.10	3.70	1.81	1.82	1.04
Varieties	7	32.74**	34.58**	30.31**	125.20**	3.06**
Error	21	0.03	1.57	1.18	0.65	2.57

Table: 2 Coefficients of correlations among various traits of guar

	Grain yield (Kg ha^{-1})	Plant height (cm)	Branches plant^{-1}	Pods plant^{-1}	Grains pod^{-1}
Grain yield (Kg ha^{-1})	1.00	0.646*	-0.268	0.545	0.386
Plant height (cm)		1.00	-0.489	0.743*	0.405
Branches plant^{-1}			1.00	-0.832**	-0.414
Pods plant^{-1}				1.00	0.532*
Grains pod^{-1}					1.00

* and ** Significant at 5% and 1%.

Table: 3. Comparison of yield traits different accessions/varieties/ strains of guar.

Strain/Accession	Grain yield (kg ha^{-1})	Plant height (cm)	Branches plant^{-1}	Pods plant^{-1}	Grains pod^{-1}
S-5488	2037 A	197.8 AB	6.75 AB	58.75 B	7.00 BC
S-5490	993 D	115.3 E	5.75 B	28.00 D	6.50 C
S-5497	993 D	142.0 D	6.50 B	27.00 D	7.25 ABC
S-5498	2093 A	184.8 B	0.00 C	125.00 A	8.25 A
S-5499	1939 AB	152.3 CD	7.25 AB	48.50 C	7.25 ABC
S-5505	1089.8 D	148.3 CD	8.50 A	46.00 C	6.25 C
S-5509	1726.3 BC	158.8 C	7.00 AB	51.75 BC	6.75 BC
BR-99 (Check)	1533.3 C	201.8 A	0.00 C	118.80 A	7.75 AB
SE for comparison	6.973	5.046	0.324	2.746	0.299

Means sharing same letters in each column are non-significantly different from each other's.

Genotype S-5498 and S-5488 were the highest yielders with 2093 and 2037 kg ha^{-1} respectively and genotypes S-5490 and S-5497 were the lowest yielders with 993 kg ha^{-1} (Table-3).

Grain yield was found to be positively correlated with plant height, number of pods plant^{-1} and number of grains pod^{-1}, but negatively correlated with number of branches plant^{-1} (Table-2). Rai and Dharmatti (2014) determined significant and positive correlation of yield with plant height, pods plant^{-1} and branches plant^{-1} while negative correlation with number of grains pod^{-1}. Similar results were reported by Sultan et al. (2012).

BR-99 (check variety) proved to be the tallest one i.e. 201.8 cm and genotype S-5490 was the shortest genotype having height of 115.3 cm (Table-3). Plant height was found to be positively correlated with all characters except number of branches plant^{-1} (Table-2) while Sultan et al. (2012) found positive correlation of plant height with grain yield, branches plant^{-1} and pods plant^{-1} and negative correlation with grains pod^{-1}. Similarly Rai and Dharmatti (2014) reported significant positive correlation of plant height with grain yield and grain pod^{-1} and negative correlation with branches plant^{-1} which are in confirmation with our results.

Genotype S-5505 was a spreading type with 8.55 breaches plant^{-1} and genotypes S-5498 and BR-99 (check variety) were the compact genotypes with no branches. Number of branches plant^{-1} was negatively correlated with all other characters (Table-2). Rai and Dharmatti (2014) reported negative correlation of branches plant^{-1} with plant height and pods plant^{-1} but positive correlation with grain yield and grains pod^{-1}.

Number of pods plant^{-1} showed negative correlation with number of branches and positive correlation with all other traits (Table-2). S-5498 was the genotype having largest number of pods plant^{-1} (125 pods) while genotypes S-5497 and S-5490 produced lowest number of pods i.e. 27 and 28, respectively. Sultan et al. (2012) found significantly positive correlation of pods plant^{-1} with grain yield, plant height and branches plant^{-1}but negative correlation with grains pod^{-1}.

Genotype S-5498 produced highest number of grains pod^{-1} (8.25) while genotype S-5505 produced 6.25 grains pod^{-1} (Table-3). It was negatively correlated with number of branches plant^{-1} while positively correlated with all other characters (Table-2). However, Rai and Dharmatti (2014) reported that grains pod^{-1} was negatively correlated with grain yield, branches plant^{-1} and pods plant^{-1} but positively correlated with plant height. Similarly, Sultan et al. (2012) found negative correlation of grains pod^{-1} with grain yield, plant height, branches plant^{-1} and pods plant^{-1}.

4. Conclusion

It is concluded that genotype S-5498 was the best performer with regards to grain yield, plant height, number of pods plant^{-1} and number of grains pod^{-1} having single stem plant type. The correlation studies revealed that number of branches plant^{-1} was negatively correlated with grain yield, plant height, number of pods plant^{-1}and number of grains pod^{-1}, while all the other characters were positively correlated with one another. The use of the genotype S-5498 may result in improvement of yield potential and evolution of new cultivars of guar.

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Competing Interests

Authors declare that they have no competing interests.

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