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Genetic Variability Studies for Seed Yield, Physiological and Quality Attributes in Guar (*Cyamopsis tetragonaloba* (L.) Taub.)

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ABSTRACT

Study of genetic parameters in fifty genotypes of Guar collected from Rajasthan, Gujarat, Haryana and Karnataka revealed high estimates of variation for number of pods per plant, harvest index, seed yield per plant, leaf area index at 50 days after sowing, number of branches per plant and number of clusters per plant. High heritability coupled with genetic advance as percent of mean was observed for the characters viz., number of pods per plant, seed yield per plant, leaf area index at 50 days after sowing, number of branches per plant, harvest index, number of clusters per plant, plant height, number of pods per cluster, days to maturity, specific leaf area at 40 days after sowing and viscosity indicating that simple selection program would be effective for genetic improvement of Guar.

Keywords: additive gene action, GCV, genetic advance, gum content, heritability, PCV, selection

INTRODUCTION

Guar or cluster bean [*Cyamopsis tetragonaloba* (L.) Taub] has turned out to be a commercial crop due to its export quality galactomannon gum and protein-rich nutritious feed. It is an important arid legume crop whose cultivation is mainly concentrated in marginal and submarginal soils receiving low rainfall (300-400 mm) India, being the chief Guar-growing country accounts for 80% of world's production and 70-80% of which is being cultivated in Rajasthan thereby playing a vital role in Indian economy. Global scenario indicates that Pakistan, Sudan and Parts of USA are other Guar growing countries. It is grown in an area of 2.955 million ha with a production of 1.05 million tonnes and productivity of 350 kg ha^{-1} in India (Indiastat 2005-2006).

About 75% of the Guar gums or their derivatives are exported mainly to USA and European countries. Its total output was valued at 1002.83 crores by 2003-2004 (including churi, korma and splits; Indiastat, 2005-2006). Churi and korma are the byproducts of Guar which account for 30 to 41% of the total seed, respectively depending on the variety (Karvy Comtrade Ltd. 2008). Guar provides nutritious fodder, fibreless green pods for vegetable, guar gum having several diversified uses and guar meal (concentrate) to the livestock, adds fertility to soil by fixing a considerable amount of atmospheric nitrogen and adding organic matter. It has assumed a great industrial importance in recent years in Indian Arid Zone mainly due to the presence of gum (galactomannan) in its endosperm, which constitutes about 30-32% of the whole seed.

Guar was not known for its industrial application until World War II, when there was a shortage of locust bean crop and the paper and textile industry of the world was searching for a substitute. They found as efficient alternative in the form of guar gum and since then, this derivative of guar ruled out locust bean from the scene and was readily accepted for application in many other industries (Kumar 2002). The refined gum powder has a wide variety of uses in various fields like textiles, confectionaries, cosmetics, explosives and oil industries because of its unique characteristics such as grease resistance, thickening agent, capacity to bind water and high viscosity and the capability to function at low temperatures.

Price per quintal of guar seeds were around Rs. 1700-1800 and the prices are expected to increase to about Rs. 3000 with the demand as the supply of this crop is less due to the limited area of cultivation and erratic climatic factors (Karvy Comtrade Ltd. 2008). It would help to augment the country's foreign exchange if elite genotypes are evolved. Information on the nature and extent of variability present in genetic stocks, heritability and genetic advance as percent of mean for different characters is a prerequisite for formulating selection criterion in any crop improvement program. The present study includes the results obtained on these aspects.

MATERIALS AND METHODS

Source of germplasm

Fifty genotypes of Guar collected from Rajasthan, Gujarat, Haryana and Karnataka were evaluated in a randomized block design with three replications, during Kharif, 2005 at Dryland Farm, RARS, Tirupati. Each genotype was sown in three rows of 4 m length with a spacing of 30 cm between rows and 10 cm between plants.

Genetic variability analysis using morphological, physiological and quality traits

Ten competitive plants were tagged in each genotype in each replication and observations were recorded for 21 characters (**Table 1**) viz., days to 50% flowering, days to maturity, plant height (cm), number of branches per plant, number of clusters per plant, number of pods per cluster, number of pods per plant, number of seeds per pod, 100 seed weight (g), harvest index, SPAD (soil plant analytical development) chlorophyll meter reading at 40 days after sowing (using Minolta chlorophyll meter SPAD-502), SPAD chlorophyll meter reading at 60 days after sowing, leaf area index at 50 days after sowing, specific leaf area at 40 days after sowing (cm^2/g)(using LI-COR model-3000), specific leaf area at 60 days after sowing (cm^2/g), protein content (%) (Lowry *et al.* 1951), carbohydrate content (%) (Dubois *et al.* 1956) endosperm percentage

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Short Communication

Table 1 Mean performance of the genotypes for various characters.

Character	Mean	Range	
		Minimum	Maximum
Days to 50% flowering	30.94	28.67	36.67
Days to maturity	99.84	84.67	128.33
Plant height (cm)	69.95	53.22	117.46
Number of branches/plant	4.50	0.00	8.33
Number of clusters/plant	16.99	4.10	27.50
Number of pods/cluster	3.31	2.23	4.96
Number of pods/plant	44.92	17.67	87.87
Number of seeds per pod	7.77	6.53	8.53
100-seed weight (g)	3.65	2.89	4.45
Harvest index	0.36	0.15	0.57
SCMR at 40 DAS	58.93	50.63	65.23
SCMR at 60 DAS	57.74	46.67	65.13
LAI at 50 DAS	3.81	1.46	8.36
SLA at 40 DAS (cm^2/g)	121.73	78.57	168.67
SLA at 60 DAS (cm^2/g)	139.61	109.11	169.43
Protein content (%)	31.19	27.43	34.27
Carbohydrate content (%)	36.12	32.16	44.29
Endosperm (%)	33.08	31.16	35.36
Gum content (%)	30.84	28.55	33.22
Viscosity (c.pa.s^{-1})	243.54	202.03	323.36
Seed yield per plant (g)	7.92	2.86	14.65

(%), gum content (%), viscosity (cPa/s) (using Haake Rotoviscometer RV-20 model, Germany) and seed yield per plant (g) were used for statistical analysis. Procedures for extraction of gum (including endosperm percentage) were developed by Das *et al.* (1977). Observations on days to 50% flowering and days to maturity were recorded on per plot basis.

The data were pooled and standard statistical procedures were followed for estimating genetic parameters, phenotypic and genotypic coefficient of variation (Burton, 1952), heritability and genetic advance (Johnson *et al.* 1955).

Statistics

Analysis of variance for the above 21 quantitative characters revealed significant differences among the genotypes for all the characters (both at 1% and 5% significant levels). Average of three replication mean values was taken for each genotype for all the characters and the data was analysed using INDOSTAT software.

RESULTS AND DISCUSSION

A wide range of variability was observed for all the characters under study (**Table 1**). The analysis of variance revealed significant difference among genotypes for all the characters indicating considerable amount of variability in guar germplasm. The variability estimates in general revealed higher estimates of PCV than the corresponding estimates of GCV indicating a little influence of the environment on the phenotype for different traits, though the difference between them was relatively low (**Table 2**).

The characters viz., number of branches per plant, leaf area index at 50 DAS, number of pods per plant, seed yield per plant, number of clusters per plant, harvest index, number of pods per cluster and plant height showed higher estimates of GCV and PCV. Similar kinds of high estimates of variability were reported for the number of branches per plant (Choudhary *et al.* 1991), for the number of pods per plant (Shekhawat and Choudhary 2004), for seed yield per plant (Hanchimani Nagaraj *et al.* 2004) and for the number of clusters per plant (Singh *et al.* 2004).

Though seed yield per plant is a primary trait depending on number of variables high GCV values reported for this trait indicate that direct selection for seed yield is one approach for its genetic improvement.

Higher estimates of variability observed in the above characters show that there is ample scope for selection to improve the aforesaid traits.

Days to maturity and 100-seed weight showed moderate PCV values whereas specific leaf area at 40 days after sowing and viscosity showed moderate values at both phenotypic and genotypic levels.

Low estimates of variability were observed for number of seeds per pod, SPAD chlorophyll meter reading at 40 and 60 days after sowing, protein content, carbohydrate content, days to 50% flowering, endosperm percentage and gum content.

In general, high heritability was observed for almost all the characters except number of seeds per pod. High heritability coupled with genetic advance as per cent of mean was recorded for viscosity, number of pods per plant, harvest index, days to maturity, seed yield per plant, plant height, leaf area index at 50 days after sowing, specific leaf area at 40 days after sowing, number of clusters per plant, number of branches per plant and number of pods per cluster, which might be attributed to additive gene effects regulating their expression. Similar kinds of additive gene effects were reported for number of pods per plant, number of branches per plant and number of clusters per plant by Reddy and Gupta 1984 and for plant height and days to maturity by Saini *et al.* (2004) and Singh *et al.* (2004). Hence, simple selection would be effective for the improve-

Table 2 Variability and genetic parameters for seed yield and yield attributes in guar.

Phenotypic variance	Genotypic variance	Phenotypic covariance	Genotypic covariance	Heritability (broad sense) percentage	Genetic advance	Genetic advance as % of mean
2.97	2.31	5.56	4.92	78.10	2.77	8.95
131.53	123.31	11.48	11.12	93.75	22.14	22.18
223.63	202.54	21.37	20.34	90.57	27.90	39.88
3.88	3.15	43.76	39.40	81.07	3.29	73.09
27.48	23.22	30.85	28.36	84.52	9.12	53.72
0.75	0.55	26.18	22.42	73.33	1.31	39.55
230.19	220.89	33.77	33.08	95.96	29.99	66.75
0.43	0.13	8.46	4.64	30.13	0.40	5.25
0.14	0.13	10.35	9.95	92.47	0.72	19.72
0.01	0.01	29.91	29.07	94.48	0.21	58.21
23.62	17.83	8.24	7.16	75.48	7.55	12.82
22.28	18.00	8.17	7.34	80.82	7.85	13.60
2.70	2.43	43.09	40.86	89.89	3.04	79.80
469.45	403.90	17.79	16.50	86.04	38.40	31.54
235.98	153.07	11.00	8.86	64.87	20.52	14.70
3.75	2.51	6.20	5.07	66.93	2.67	8.56
12.20	10.55	9.66	8.99	86.51	6.22	17.22
1.03	1.01	3.07	3.04	97.69	2.05	6.19
1.20	1.16	3.56	3.50	96.52	2.18	7.08
639.81	635.51	10.38	10.35	99.33	51.75	21.25
6.09	5.61	31.17	29.92	92.13	4.68	59.16

ment of these traits.

High estimates of heritability coupled with moderate genetic advance as per cent of mean was recorded for 100 seed weight, carbohydrate content, specific leaf area at 60 days after sowing, SPAD chlorophyll meter reading at 40 days after sowing. High heritability coupled with low genetic advance as per cent of mean was recorded for days to 50% flowering, protein content, gum content, endosperm percentage and number of seeds per pod. Moderate heritability with low genetic advance was recorded for number of seeds per pod. This might be due to non-additive gene effects such as epistasis and dominance type of gene interactions and selection would be ineffective for such characters. Hence a crossing program can be taken up which might result in recovery of novel recombinants for improvement of these traits and results also suggests that simultaneous selection for seed yield and quality traits to be of dubious worth.

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