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GENETIC COMPONENTS OF VARIANCE OF GUAR AND ITS RESPONSE TO SOWING DATES IN SEMI ARID REGION OF MAHARASHTRA, INDIA

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Abstract

Eight guar genotypes were sown in two different sowing dates and tested in split plot design with four replications. Genetic components like phenotypic, genotypic and error variances were estimated and studied effect of genotypes, sowing dates, genotypes x sowing dates interaction. The magnitude of mean performance for all traits was decreased in delayed of sowing. Combined analysis of variance in eighteen yield and yield contributing characters indicated the significant difference in genotypes and sowing dates. The phenotypic variance was higher than genotypic variance for all characters. The G × SD variance effect signifies relative performance of various genotypes is affected by the environment. Though, phenotypic variance was higher, but traits like branches plant^{-1}, number of clusters plant^{-1}, number of pods cluster^{-1}, seeds pod^{-1}, pod length, pod width, 100-seed weight and dry pod husk weight had less magnitude of error variance indicates low influence of environment on expression of above traits. In contrast, traits like days to flower initiation, days to 50% flowering, days to maturity and dry biomass weight plant^{-1} had much higher error variance indicating the strongest effect of environment on phenotypic expression. In case of G × SD effect, the magnitude of environmental variance was low in seed yield plant^{-1} and pod width indicating the strongest effect of genotypes. Genotypes have good adaptation and maintained optimum seed yield level. Genotypes RGC-1031, RGC-1038, RGC-1017, RGC–471 and RGC-986 performance was equal for seed yield plant^{-1} in SD_1 and SD_2 indicated that these genotypes are not sensitive to given environment and adapted to local condition with mean seed yield level of RGC-1031 = 29.62g plant^{-1}, RGC-1038 = 29.09g plant^{-1}, RGC-1017 = 28.28g plant^{-1}, RGC- 471 = 27.02g plant^{-1} and RGC-986 = 24.16g plant^{-1} suitable either for early or late sowing. Genotypes RGC-1033 and RGC-197 performed better in SD_1, but highly sensitive to SD_2 with seed yield level of 27.16g plant^{-1} and 24.97g plant^{-1}, respectively. Hence, timely sowing of genotypes RGC-1033 and RGC-197 can be done till second week of August during *Kharif* season. Only one genotype RGC-1055 performed better in SD_2 with seed yield level of 28.69g plant^{-1} indicated that RGC-1055 is preferable for late sowing (end of August).

Key words : *Cyamopsis tetragonoloba*, guar, sowing dates effect, genetic components of variance.

Introduction

Guar [*Cyamopsis tetragonoloba* L., Taub; 2n = 14] called as cluster bean is a leguminous self pollinated crop (*Fabaceae* family). It is one of the most important and potential vegetable cum industrial crop grown for its tender pods and endospermic gum. There are different genotypes used for vegetables and extraction of guar gum (galactomannan). The high commercial value of guar seeds are mainly for extraction of endospermic gum having binding, thickening, gelling properties. Guar gum has high demand in food industry as an ingredient in products like sauces and ice creams. A major share of guar gum goes to petroleum industry for gelling and thickening called as franking. Despite the commercial and export importance, crop was confined to semi arid region of agro-climatic zone. Western Ghats often called as Deccan plateau of Maharashtra received rainfall ranged from 250 to 560 mm with semi-arid tract of the plains. Mostly this area is rainfed and drought-prone, representing several kinds of abiotic stresses. The farmers are not in position to cultivate other crop because most of lands are in rainfed areas and depends upon Nira cannel water. Due to climatic changes total rainfall shifted from normal rainy season gives an erratic precipitation and only 20–25% of total rainfall is available during critical stages of plant growth. To enhance productivity of per unit land area, new crop introduction is necessary where information on genotypes response to given environment and study genetic components of variance is a pre-requisite that helps for assessing relatedness among crop genetic resources. Though researchers Dabas *et al*. (1982), Dass *et al*. (1972), Morris (2010), Pathak *et al*. (2009) and Saini *et al*. (2010) studied guar crop but information on sowing effects and genotypes response are scanty. The guar crop seems to be low temperature sensitive and delayed in sowing affects on crop yield. Rajasthan, Haryana and Gujarat are major seed guar producing states mainly grown crop in Kharif during 2nd week of July. Irregular monsoon chances schedule of sowing resulted poor performance of genotypes and affect directly on seed yield. Hence the present investigation was conducted to study the suitability of genotypes to climatic changes that helping in reducing risk of delaying in sowing.

Materials and Methods

An investigation was conducted in the experimental field of School of Drought Stress Management, National Institute of Abiotic Stress Management, Indian Council of Agricultural Research (ICAR), Malegaon Khurd (18°09"30.62'N by 74°30"03.08E; altitude=570m amsl), Baramati, Pune district, Maharashtra in the semi-arid tract of the plains of Western Ghats. The crop was grown during Kharif season with two different sowing dates (2nd and 4th week of August, 2012) in split plot design with four replications. Genetic stock of eight genotypes (RGC–986, RGC–1055, RGC–1038, RGC–1033, RGC–471, RGC–1071, RGC–1031 and RGC–197) were collected from Rajasthan Agricultural University, Agriculture Research Station, Durgapur, Jaipur, Rajasthan state. Each experimental unit area was consisted of six rows of 4 m length with row to row distance of 0.45 m in width. Dibbling was carried in and maintained single plant per hill with plant x plant spacing of 0.20 m. The soil texture at the experimental site is light black soil. Two split doses of NPK (19:19:19) at the rate of 50 kg ha^{-1} were applied by broadcasting method. Inter cultural practices were followed as per the recommended package and practices. Eighteen quantitative traits namely, germination (%), days to flower initiation, days to 50% flowering, days to maturity, plant height (cm), branches plant^{-1}, leaf area (cm^2), number of clusters plant^{-1}, number of pods cluster^{-1}, seeds pod^{-1}, pod length (cm), pod width (cm), test weight of 100 seeds (g), dry pod yield plant^{-1} (g), dry pod husk weight plant^{-1} (g), seed recovery (%), dry biomass plant^{-1} (g) and seed yield plant^{-1} (g) were recorded. The effect of two different sowing dates, genotypic effect and their interaction was studied using combined analysis of variance. The genetic components of variance (σ^2p = phenotypic, σ^2g = genotypic and σ^2e = environmental variance) were estimated (Johnson *et al*., 1955 and Hanson *et al*., 1956). OPSTAT on line statistical programme developed by CCS Haryana Agricultural University, Hisar, Haryana were used for two factor analysis and genetic components of variance (Snedecor and Cochran, 1980; Fisher, 1954; Gomez and Gomez (1984).

Results and Discussion

Effect on morphological traits and percentage decrease under different sowing dates

Decrease mean performance of 18 yield and yield contributing characters of 8 genotypes tested in two sowing dates revealed the presence of genetic variation (table 1, fig. 1). The magnitude of mean performance for all traits decreased when data was compared and analyzed with 't' test. The highest decreased performance was recorded in number of clusters plant^{-1} (144.66%) followed by number of branches plant^{-1} (116.96%), leaf area (107.21%), dry pod husk weight (59.28%), dry pod yield plant^{-1} (56.33%), plant height (54.40%), number of pods cluster^{-1} (52.31%), seed yield plant^{-1} (51.46%) and number of seeds pod^{-1} (48.87%) corresponding to high coefficient of variation, probably due to sowing dates interval. Below 10 per cent decreased was recorded in pod width. Delaying in sowing changed phenotypic performance of plant vigour as found in increased in number of days for flower initiation, days to 50% flowering and period of maturity. Apart from genetic set up, possible reason for decrease of mean performance of traits can be deficiency of moisture during crop standing phase in trial plots and other abiotic factors like temperature and humidity differences between sowing dates that hampered plant physiological processes. It is evident that date of sowing and irrigation played major role even though genotypes were grown in Kharif season. In support of present findings interaction of G x SD were studied using combined analysis of variances.

Analysis of variance for split plot design

The combined two factor analysis of variance indicated significant difference among genotypes, sowing dates and their interaction (tables 2, 2a, 2b). This suggested that seasonal effect played major role on expression of high degree of genetic variability because G and SD differ significantly. The G x SD interaction was non-significant for pod width and test weight of 100 seed weight. Sowing effect was non-significant for dry

Table 1: Mean performance of guar genotypes tested in two sowing dates

Phenotypic traits	Sowing dates	Mean ± SD	Decrease performance in two environments
Germination (%)	SD_1	87.59 ± 4.65	
	SD_2	74.55± 5.52	17.49
Days to flower initiation(40DAS)	SD_1	39.84 ± 5.46	
	SD_2	48.59 ± 3.64	-18.00
Days to 50 % flowering (60DAS)	SD_1	55.15 ± 10.58	
	SD_2	64.68 ± 7.17	-14.73
Days to maturity (120DAS)	SD_1	97.06 ± 10.40	
	SD_2	106.71 ± 9.96	-9.04
Plant height (cm)	SD_1	74.58 ± 9.36	
	SD_2	48.30 ± 10.97	54.40
No. of branches plant^{-1}	SD_1	10.74 ± 2.64	
	SD_2	4.95 ± 1.90	116.96
Leaf area (cm^2)	SD_1	25.57 ± 5.17	
	SD_2	12.34 ± 2.19	107.21
No. of clusters plant^{-1}	SD_1	12.60 ± 1.90	
	SD_2	5.15 ± 0.98	144.66
No. of pods cluster^{-1}	SD_1	9.87 ± 9.87	
	SD_2	6.48 ± 1.48	52.31
Pod length (cm)	SD_1	6.79 ± 0.53	
	SD_2	5.45 ± 0.57	24.58
Pod width (cm)	SD_1	0.45 ± 0.08	
	SD_2	0.42 ± 0.09	7.14
Dry biomass plant^{-1} (g)	SD_1	178.30 ± 11.85	
	SD_2	127.25 ± 23.61	40.11
No. of seeds pod^{-1}	SD_1	8.46 ± 0.49	
	SD_2	5.76 ± 0.78	48.87
Test weight of 100 seeds (g)	SD_1	3.90 ± 0.12	
	SD_2	3.17 ± 0.27	23.02
Seed recovery (%)	SD_1	74.52 ± 3.67	
	SD_2	61.77 ± 4.35	20.64
Dry pod yield plant^{-1} (g)	SD_1	43.43 ± 3.50	
	SD_2	27.78 ± 5.48	56.33
Dry pod husk weight plant^{-1} (g)	SD_1	14.79 ± 1.36	
	SD_2	9.29 ± 1.03	59.20
Seed yield plant^{-1} (g)	SD_1	26.98 ± 3.29	
	SD_2	17.12 ± 4.26	57.59

Sowing dates (SD_1 = 2nd & SD_2 = 4th) week of August 2012.

pod husk weight, seeds pod^{-1}, number of pods cluster^{-1}, pod length, pod width and dry biomass indicated less influence of environment. Study was further extended and estimated genetic components of variance.

Estimates of genetic components of variance

The estimates of genetic components of variance for genotype, sowing dates and G x SD were studied. It was observed that phenotypic variance was higher than genotypic variance for all characters studied (table 3). The G x SD interaction signifies relative performance of genotypes which is affected by environment. The relative performance of genotypes would change if environment is changed. The reminder mean square or composite error included differences in plot within a replication and sampling error. The errors in measurement takes care of sources of variation studied. Though phenotypic variance was higher but traits like branches plant^{-1} (0.31), number

Table 2 : Mean squares values of guar genotypes over two tested dates of sowing.

Source of variation	df	Germination (%)	Days to flower initiation	Days to 50% flowering	flower to maturity	Plant height (cm)	No. of branches plant^{-1}
Replications	3	2.25	6.39	6.64	9.85	1.44	0.21
Genotypes (G)	7	172.03**	171.45**	350.83**	409.56**	1175.00**	31.04**
Error (a)	21	6.17	8.24	15.86	8.33	4.90	0.31
Sowing dates (SD)	1	138.62**	20.25**	66.01**	105.06**	6.94*	44.55**
G x SD	7	113.81**	134.00**	582.98**	596.42**	314.53**	25.67**
Error (b)	24	10.21	9.36	5.85	10.45	6.50	0.25

*Significant at 0.05, ** significant at 0.01 probability, df : degree of freedom.

Table 2a : Mean squares values of guar genotypes over two tested dates of sowing.

Source of variation	df	Leaf area (cm^2)	No. of clusters plant^{-1}	No. of pods cluster $^{-1}$	Pod length (cm)	Pod width (cm)	Dry biomass plant^{-1} (g)
Replications	3	1.45	0.15	0.19	0.27	0.04	11.23
Genotypes (G)	7	140.64**	43.84**	18.54**	1.26**	1.91NS	4176.75**
Error (a)	21	1.13	0.09	0.29	0.19	2.10	16.17
Sowing dates (SD)	1	83.33**	0.88**	0.06NS	0.40NS	0.09NS	3.91NS
G x SD	7	40.99**	16.22**	5.23**	0.47**	0.96NS	791.97**
Error (b)	24	1.40	0.09	0.12	0.14	0.02	21.85

*Significant at 0.05 and **significant at 0.01 probability, df : degree of freedom.

Table 2b: Mean squares values of guar genotypes over two tested dates of sowing

Source of variation	df	Seeds pod^{-1}	Test weight of 100 seeds (g)	Seed recovery (%)	Dry pod yield plant^{-1} (g)	Dry pod husk weight plant^{-1} (g)	Seed yield plant $^{-1}$ (g)
Replications	3	0.37	0.09	1.09	1.55	0.01	0.95
Genotypes (G)	7	1.65**	0.57**	74.94**	335.39**	22.52**	230.96**
Error (a)	21	0.06	0.10	1.55	1.69	0.26	1.02
Sowing dates (SD)	1	0.49NS	0.41**	40.86**	12.69**	0.04NS	41.50**
G x SD	7	2.42**	0.06NS	60.56**	81.41**	5.67**	61.25**
Error (b)	24	0.12	0.08	1.74	2.69	0.38	0.72

*Significant at 0.05 and **significant at 0.01 probability, df : degree of freedom.

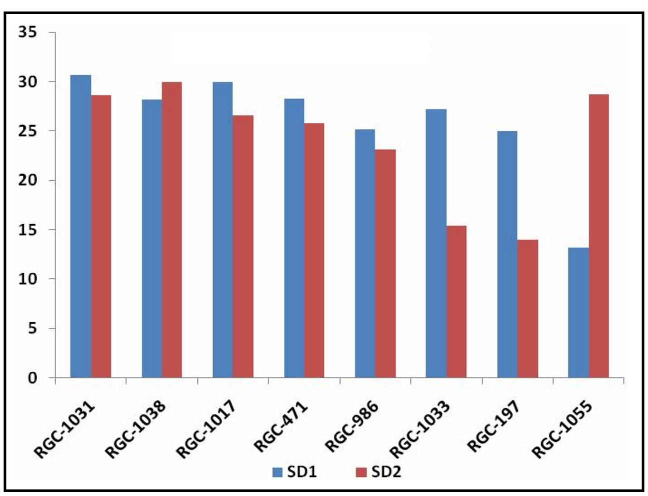

Fig. 1 : Seed yield / plant (g).

of clusters plant^{-1} (0.09), number of pods cluster^{-1} (0.29), seeds pod^{-1} (0.06), pod length (0.19), pod width (0.08), test weight of 100 seeds (0.11) and dry pod husk weight (0.26) had less magnitude of error variance. The low difference in extent of genotypic and phenotypic variance indicates low influence of environment on expression of above traits. In contrast, traits like days to flower initiation, days to 50% flowering, days to maturity and dry biomass plant^{-1} had much higher error variance indicating the strongest effect of environment on phenotypic expression. In case of G x SD, magnitude of environmental variance was low in seed yield plant^{-1}, branches plant^{-1}, clusters plant^{-1}, pods cluster^{-1}, seed pod^{-1}, pod length, pod width, test weight of 100 seeds and dry pod husk weight indicating strongest effect of genotypes. For all studied

Table 3: Estimates of genetic components of variance.

	Genotypes			Sowing dates		G x SD		
	σ^2g	σ^2p	σ^2e	σ^2g	σ^2p	σ^2g	σ^2p	σ^2e
Germination (%)	41.46	47.63	6.17	32.10	42.31	25.90	36.11	10.21
Days to flower initiation	3.31	13.67	10.36	19.59	29.09	19.82	29.32	9.50
Days to 50% flowering	39.91	52.05	12.14	5.99	13.67	119.38	127.06	7.68
Days to maturity	53.46	65.22	11.76	-5.38	16.92	139.33	161.63	22.30
Plant height (cm)	292.52	297.42	4.90	-0.26	6.24	77.00	83.50	6.50
Branches plant^{-1}	7.62	7.99	0.31	11.07	11.32	6.35	6.60	0.25
Leaf area (cm^2)	34.87	36.00	1.13	20.48	21.88	9.89	11.29	1.40
No. of clusters plant^{-1}	10.93	11.02	0.09	0.19	0.28	4.03	4.12	0.09
No. of pods cluster^{-1}	4.56	4.85	0.29	0.02	0.11	1.27	1.39	0.12
Seeds pod^{-1}	0.39	0.45	0.06	0.09	0.21	0.57	0.69	0.12
Pod length (cm)	0.26	0.45	0.19	0.06	0.21	0.08	0.22	0.14
Pod width (cm)	0.01	0.09	0.08	0.01	0.04	0.02	0.06	0.04
Test weight of 100 seeds (g)	0.12	0.22	0.11	0.08	0.17	-0.01	0.08	0.09
Dry pod yield plant^{-1} (g)	83.42	85.11	1.69	2.50	5.19	19.68	22.37	2.69
Dry pod husk weight plant^{-1} (g)	5.56	5.82	0.26	-0.08	0.30	1.32	1.70	0.38
Seed recovery (%)	18.34	19.89	1.55	9.78	11.52	14.70	16.44	1.74
Dry biomass plant^{-1} (g)	1040.14	1056.31	16.17	-4.48	17.37	192.53	214.38	21.85
Seed yield plant^{-1} (g)	57.48	58.50	1.02	10.19	10.91	15.13	15.85	0.72

σ^2g = genotypic, σ^2p = phenotypic, σ^2e = error variances of mean square.

traits genotypic and phenotypic estimated variance appeared large in comparison with estimated values of error variance. This type of result indicated that number of replicates used in experiments of these genotypes were adequate to give a better estimation for error variance. The phenotypic variance was higher than genotypic variance for all characters was in support of earlier report on guar crop (Rai *et al.*, 2012). Additive effect for days to 50% flowering was reported by Patil *et al.* (2003) in rice. Changes in sowing dates influenced morphological traits as evidence by significant differences in G, SD and G x SD for traits studied. These partitions were able to quantify genotypic and phenotypic effect due to G x SD variance effect. Based on phenotypic response in different date of sowing, genotypes were grouped *viz.*, equal response in SD_1 and SD_2 environment, genotypes performed better in SD_1 and genotypes performed better in SD_2 are given in table 4.

Performance of genotypes in different sowing dates

Genotypes RGC-1031, RGC-1038, RGC-1017, RGC – 471 and RGC-986 performance was equal for seed yield plant^{-1} in SD_1 and SD_2 indicated that these genotypes are not sensitive to given environment and adapted to local condition with mean seed yield level of RGC-1031=29.62g plant^{-1}, RGC-1038=29.09g plant^{-1}, RGC-1017=28.28g plant^{-1}, RGC-471= 27.02g plant^{-1} and RGC-986=24.16g plant^{-1} suitable either for early or late sowing. Genotypes RGC-1033 and RGC-197 performed better in SD_1 but highly sensitive to SD_2 with seed yield level of 27.16g plant^{-1} and 24.97g plant^{-1} respectively. Hence timely sowing of genotypes RGC-1033 and RGC-197 can be done till second week of August during Kharif season. Only one genotype RGC-1055 performed better in SD_2 with seed yield level of 28.69g plant^{-1} indicated that RGC-1055 is preferable for late sowing during end of August. Rao and Shahid (2011) evaluated 10 accessions of guar over a growing period of 120 days during summer in 2009 (late February) at International Centre for Biosaline Agriculture (ICBA), Dubai, UAE indicated environmental and location effect. They reported seed yield varied between 2.5 t ha^{-1} (India origin accession PI 263891) and 1.4 t ha^{-1} (India origin accession PI 263877) with mean of 2.2 t ha^{-1}. Other India origin accessions *viz.*, PI 158129 (2.39 t ha^{-1}), PI 263882 (2.31 t ha^{-1}), PI 263896 (2.46 t ha^{-1}), PI 323083 (2.44 t ha^{-1}) also performed well in terms of seed yield. In the present study estimated seed yield varied between 1.64 t ha^{-1} and 2.57 t ha^{-1} with mean of 2.09 t ha^{-1} in SD_1 environment (2nd week of August sowing) and in SD_2 (4th week of August sowing) seed yield varied between 0.89 t ha^{-1} and 2.09 t ha^{-1} and with mean of 1.39 t ha^{-1} indicated high potential in genotypes to be grown across wide locations are in support with findings of Rao and Shahid (2011). Studies conducted on guar crop at Wad Medani, Sudan showed that crop

Table 4 : Genotypic responses in different sowing dates.

Phenotypic traits	Equal response of genotypes in SD_1 and SD_2	Genotypes performed better in SD_1	Genotypes performed better in SD_2
Germination	RGC-986, **RGC-1038**, RGC-1033, **RGC-1031**	RGC-197	**RGC-1017**, **RGC-471**, RGC-1055
Days to flower initiation	RGC-197, **RGC-1031**, **RGC-1017**, RGC-1055	**RGC-471**, **RGC-1038**, RGC-986	RGC-1033
Days to 50% flowering	**RGC-1017**, **RGC-471**, RGC-1055	**RGC-1031**, **RGC-1038**, RGC-986	RGC-197, RGC-1033
Days to maturity	**RGC-1017**, **RGC-1038**, RGC-1055	**RGC-1031**, **RGC-471**, RGC-986	RGC-197, RGC-1033
Plant height (cm)	**RGC-1031**, **RGC-1017**, RGC-1055, **RGC-1038**	**RGC-471**,RGC-986	RGC-197, RGC-1033
Number of branches $plant^{-1}$	**RGC-471**, **RGC-1038**, RGC-1055, RGC-986	RGC-197, RGC-1033	**RGC-1031**, **RGC-1017**
Leaf area (cm^2)	RGC-197, **RGC-1017**, **RGC-471**, RGC-986, RGC-1055	RGC-1033,**RGC-1038**	**RGC-1031**
Number of clusters $plant^{-1}$	RGC-197, **RGC-471, RGC-1017**	**RGC-1038**, RGC-1055	**RGC-1031**, RGC-1033, RGC-986
Number of pod cluster $^{-1}$	RGC-1033, **RGC-1038**, RGC-986, **RGC-1017**	RGC-197, **RGC-471**	**RGC-1031**
Pod length (cm)	RGC-986, RGC-1055, **RGC-1038**, RGC-1033, **RGC-471**, **RGC-1031**	**RGC-1017**	RGC-197
Pod width (cm)	RGC-986, RGC-1055, RGC-1033, **RGC-471**, **RGC-1017**, **RGC-1031**	RGC-197, **RGC-1038**	-
Dry biomass $plant^{-1}$	RGC-986, **RGC-1017**	**RGC-1038**,**RGC-471**, **RGC-1031**	RGC-1055, RGC-197, RGC-1033
Number of seeds pod^{-1}	**RGC-1017**, **RGC-471**, RGC-1033,RGC-1055	RGC-197, RGC-986	**RGC-1031**,**RGC-1038**
Test weight of 100 seeds (g)	**RGC-1031**, **RGC-1017**,RGC-1055	RGC-197,**RGC-471**, RGC-1033, **RGC-1038**, RGC-986	-
Seed recovery (%)	**RGC-1017**,RGC-1055, RGC-986	RGC-197,**RGC-471**	**RGC-1031**, **RGC-1038**
Dry pod yield $plant^{-1}$	**RGC-471**, **RGC-1038**, RGC-986	RGC-197, RGC-1033	**RGC-1031**, **RGC-1017**, RGC-1055
Dry pod husk weight $plant^{-1}$(g)	RGC-1033, **RGC-471**, RGC-986	**RGC-1031**,**RGC-1038**	RGC-197, **RGC-1017**
Seed yield $plant^{-1}$	RGC-986, RGC-1038, **RGC-471**, **RGC-1017**, **RGC-1031**	RGC-197, RGC-1033	RGC-1055

Sowing dates ($SD_1 = 2^{nd}$ and $SD_2 = 4^{th}$) week of August 2012

water requirement was about 682mm with mean seed yield of about 1000 kg ha^{-1} (Abbas *et al*., 2008). Trails carried in southern great-plains of USA with precipitation between 184 and 485 mm during growing season, seed yield ranging from 877 to 2330 kg ha^{-1} (Rao and Northup, 2009b). The present findings are in support the findings of (Rao and Northup, 2009b) as the precipitation was received during crop grown cycle was 217.10mm. Guar is known for its drought tolerance and grows without irrigation even in areas with as little as 250mm of annual rainfall and reported seed yield varies from 340-2250 kg ha^{-1} (Undersander *et al*., 1991). Seed yield obtained in our study are closed to reported yields from the USA, Sudan and UAE indicating that guar has excellent promise also as a grain legume for the Deccan tract of Maharashtra. The optimum seed yield level in the present study is in support research findings of Rao and Shahid (2011) and Undersander *et al*. (1991).

Conclusion

Possibility of introduction of seed guar in semi arid region of Deccan plateau of Maharashtra region to be explored and identified genotypes can be grown across wide locations. Selected genotypes could be excellent alternatives to increase income per unit area land. The seed yields reported in these research findings have been obtained under minimal management. The mechanism behind genotype response to specific environment as found in genotype RGC-1055 are to be studied critically. Data further is to be analyzed for genetic variability, correlation and path analysis to understand variability and relationship between yield and yield contributing traits that helps to formulate crop improvement programme in guar crop.

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