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Adaptability and stability of elite greengram (*Vigna radiata* L. Wilczek) genotypes for high seed yield

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Abstract
Since the genotype-environment (G × E) interaction has such a significant impact on crop yield performance, researchers are investing a lot into developing stable cultivars. The objective of this research is to find stable, high-yielding elite greengram genotypes that may be suited to specific locations or in a wide range of environments. During the *Rabi* 2019-20 season, six elite greengram genotypes were tested in six different locations in Telangana, India. Seed yield data was subjected to a genotype-environment interaction analysis. Because there was a strong G × E interaction, genotypes performed differently in various environments. Based on stability analysis, the genotypes 1, 2, 3 and 5 exhibited stable to below average stable for higher seed yields in most of the locations tested.

Keywords: Greengram, adaptability, stability and G × E interaction

1. Introduction

Greengram (*Vigna radiata* L. Wilczek) is an important short grain legume that is commonly planted in Southeast Asia. In Asia, it is regarded as an economically significant legume crop. South Asia produces more than 80% of the greengram. It's planted in crop rotation and relayed cropping with cereals to take advantage of the soil's residual moisture. Drought and heat stress may become more unpredictable as a result of climate change. The genotype environment is the key bottleneck that can undermine a plant breeder's efforts to increase production.

Plant breeders must identify genotypes that are both adaptable and stable to the environment(s) before releasing them as cultivars, allowing for rapid genetic gain (Showemimo *et al*., 2000, Mustapha *et al*., 2001, Yan and Kang 2003) [13, 9, 14]. To understand G × E interaction, appropriate biometrical or statistical techniques must be used. The analysis of variance aids in determining the existence, significance, and degree of the G × E interaction, but it does not explain its significance or ramifications. As a result, statistical models were developed to characterize the amount of G × E interactions, their patterns, and plant breeding implications.

When tested in various environments, there are several methods for determining genotype adaptability and stability. The number of environments available, the significance level required, and the type of information required all play a role in deciding which analysis to use for experimental data. In general, the evaluation process should be dependable, simple to comprehend, include minimal statistics, and be relevant to both small and big groups of environments (Schmildt *et al*., 2011) [12].

Yates and Cochran (1938) [15] provided one of the most simple and simplest ways of stability evaluation, which was later modified by Finlay and Wilkinson (1963) [4] and Eberhart & Russell (1966) [3] and is now a widely used method. The trait mean (M), the slope of the regression line (bi), and the sum of squares for deviation from regression are used to assess stability in this model (s^2d_i). Keep in mind that a high mean yield is a prerequisite for stability. The slope (b_i) of regression indicates a genotype's response to the environmental index, which is determined from the average performance of all genotypes in each environment. It does not, however, take into account stability, crop performance, or stability extension (Eberhart and Russell 1966, Yue *et al*., 1997) [3, 16]. If b_i is nearly identical to unity, the genotype is adaptive to any environment. Genotypes with a bi greater than unity are more sensitive to environmental change (below average stability) and more specialized to high yielding environments. A b_i value smaller than one suggests more resilience to environmental change (above average stability), increasing adaptive specificity to low yielding conditions. According to the Eberhart and Russell model, genotypes are grouped based on the variance of the regression deviation (s^2d_i) (either equal to zero or not). A genotype with a regression deviation variance of zero has a highly predictable response, whereas a genotype with a regression deviation greater than zero has a less predictable response (Scapim *et al*. 2010) [11].

Earlier, many stability analyses have been carried out for greengram yield in India (e.g. Mahalingam *et al*., 2018 [8], Anandi *et al*., 2019, and Nath *et al*., 2013) [10]. However, there is a scarcity of information on greengram genotype adaptation and stability. Hence, the objective of the present study is to identify new elite genotypes in greengram with high and stable yields suitable for specific locations or a wide range of locations.

2. Material and Methods

2.1 Experimental design and trial management

Six elite greengram genotypes were evaluated in six diverse environments at PJTSAU research stations (Table 1) in Telangana state, India during *Rabi*, 2019-20 using a Randomized Block Design (RBD) with three replications. The experimental plot in each location consisted of 7.2 m^2 size with 30 cm inter-row spacing and 10 cm intra-row spacing. The recommended fertilizers doses per acre were 8:20: kg N:P were used. Data was recorded on seed yield (kg/ha) in each environment and subjected to data analysis.

2.2 Statistical analysis methods

Windostat software was used to analyse all collected data, with environments treated as random effects and genotypes treated as fixed effects. According to Ding *et al*., 2008, the following linear model was employed for combined ANOVA estimation.

$$Y_{ijr} = \mu + \alpha_i + \beta_j + \alpha\beta_{ij} + b_j + \varepsilon_{ijr}$$

where y_{ijr}, is the value of the dependent variable of genotype i in environment j average over block r, μ is overall mean, α_i is the effect of the i^{th} genotype in the j^{th} environment, β_j is the effect of the j^{th} environment for all genotypes, $\alpha\beta_{ij}$ is the effect of the i^{th} genotype by the j^{th} environment, b_j is the block effect at the j^{th} environment and ε_{ijr} is the residual error term.

The stability analysis was carried out using Eberhart and Russell's model (1966) [3]. The statistical formulas for the model are explained in the literature (Eberhart and Russell 1966, Lin *et al*., 1986) [3, 7]. The stable genotypes in six environments were found using a regression coefficient of one (b_i =1), a deviation from regression of zero (s^2d_i = 0), and a genotype yielding above the general mean.

3. Results and Discussion

In Table 2, the mean squares due to different sources of variation for mean seed yield (pooled over six locations) are represented using a combined analysis of variance. When compared to the pooled error and pooled deviation, the joint ANOVA indicated highly significant differences in seed yield between genotypes. The differences in seed yield between the environments were also shown to be highly significant. When evaluated against pooled error and pooled deviation, there were significant G × E as well as G × E (linear) interactions for seed yield per plot, indicating that genotypes exhibited distinct yield responses to the environments tested, and there may even be genotypes with specific adaptability.

According to Eberhart and Russell (1966) [3], a stable genotype should have a high yield, a non-significant squared deviation from regression, and an average response to the environment. In the present study, the seed yield response of six genotypes in all the environments ranged from 365 kg (genotype 5 at Madhira) to 1754 kg (genotype 6 at Tandur). Tandur had the highest mean seed yields, followed by Palem (Table 4).

Stability parameters of six genotypes were computed for each environment tested to identify the location specific stable genotypes. At Warangal, four genotypes had a higher mean yield than the average yield of six genotypes. The highest yielding genotype 2 (972 kg/ha) was found to be below average stable in this location (bi=1.550) with a better prediction since there is no significant deviation from regression (s^2d_i = -18534.392). However, genotypes 1, 3 and 5 showed regression coefficients (b_i) nearer one with a minimum significant deviation from regression (s^2d_i) indicating that these genotypes were stable under all conditions. The regression coefficients of genotypes in the Karimnagar location revealed that genotype 1 showed a higher mean yield than the average yield of all genotypes with a b_i value of 1.391 and was found to be stable with moderate prediction as there was a minimum significant deviation from the regression value, whereas genotypes 2, 3, and 5 were observed to be stable with an acceptable yield and a b_i value of almost equal to unity (Table 3). In location Tornala, genotype 3 showed a higher yield than the average yield of the location with a b_i value of 1.269, and there was no significant deviation from regression, which was found to be stable, whereas genotypes 1 and 5 were found to be below average stable with increasing specificity towards high yielding environments. Genotypic mean yields were found to be higher in location Palem than in any other location, and none of the high yielding genotypes specifically showed stable performance. However, genotype 3 showed a b_i value of 1.259 with a minimum deviation from regression and could be considered a stable genotype. Genotypes 2 and 4 were found to be adapted to high yielding environments. In Madhira, genotypes 1 and 3 exhibited higher mean yields with b_i values greater than unity, and were found to be below average stable, showing specificity towards the high yielding environments, whereas genotype 2 was found to be stable with a b_i value (1.264) almost equal to one with minimum deviation from regression. Regression coefficients of genotypes in location Tandur revealed that none of the genotypes were found to be towards stability as there were minimum deviations from regression values. However, genotypes 1, 4, and 6 were observed to be on average stable with adaptation to all environments (Table 3 and 4).

The aim of selection in a breeding program is to produce a population that has a mean value greater than the average mean value of all the genotypes evaluated. This difference should be due to differences in genotype and not to the environment (House 1985) [6]. Analysis of variance from the present study revealed that genotypes showed significant differences in seed yield over the locations, demonstrating that the observed differences in yield performances had genetic causes and, thereby, offered the possibility of selection and genetic gains for seed yield. The magnitude of variation due to environment (linear) was higher than G × E (linear) for seed yield, which revealed that most of the total variation was contributed by environment only. Significant pooled deviation indicates that genotypic performance varies in response to the environment. The predominance of linear components would aid in predicting genotype performance across environments. Similar findings were reported for significant effects of genotype, genotype × environment (interaction effect) and G × E (linear) on greengram seed yield by Mahalingam *et al*., 2018 [8], Anandi *et al*., 2019 and Gomashe *et al*. (2008) [5].

The adaptability and stability of genotypes revealed that genotypes' responses were distinct in each environment tested. Based on the regression coefficients recorded by genotypes, it was suggested that genotype 1 was stable in almost all the locations, with below average stability in Tornala and Madhira. Genotype 2 was found to be stable in Krimnagar and Madhira but below average stable in Warangal and Palem. In almost all the locations, genotype 3 was found to be a stable yielder, except for Tandur and Madhira. Genotype 4 did not show acceptable seed yields in most of the locations, but it showed stability for high seed yields in Tandur. Genotype 5 was found to be stable in Warangal and Karimnagar, whereas below-average stable in Tornala. In contrast, genotype 6 did not exhibit significantly higher seed yields in all the locations except Tandur, where it showed stability for higher grain yields.

Table 1: Description of three test locations and mean seed yield performance of the evaluated sorghum genotypes during *Rabi*, 2019-20

Location	Latitude	Longitude	Soil type
Regional Agricultural Research Station (RARS) Palem	16˚35' N	78˚ 01' E	Alfisol
Agricultural Research Station (ARS), Tandur	17˚ 17' N	77˚ 30' E	Vertisol
Regional Agricultural Research Station (RARS) Warangal	17° 58' N	79°40' E	Alfisol
Agricultural Research Station (ARS), Madhira	17°58' N	78°44' E	Vertisol
Agricultural Research Station (ARS), Tornala	18°11' N	78°74' E	Alfisol
Agricultural Research Station (ARS), Karimnagar	18°30' N	79°15' E	Alfisol

Table 2: Combined Analysis of Variance of seed yield (kg/ha) evaluated in *Rabi*, 2019-20

Source of variation	DF	Warangal	Karimnagar	Tornala	Palem	Madhira	Tandur
Replication	12	86.48**	1252.89**	109.14**	241.75**	952.65**	1091.05**
Genotype	5	4160.47**	2970.40**	4361.20**	11617.95**	4447.67**	2443.27**
Env.+ (Var.* Env.)	30	97731.65	78537.89	58866.35**	251551.9	61156.31	428910.2
Environment	5	565587.60**	456375.30**	331392.10**	1451222.00***	344699.40**	2561245.00**
G × E	25	4160.47	2970.407	4361.19	11617.94	4447.68	2443.3
Environmentc (lin.)	1	2827938.00**	2281877.00**	1656961.00**	7256109.00***	1723497.00***	12806220.00***
G × E (linear)	5	138080.30**	109097.50**	92445.62**	359952.00**	95625.98**	526908.70**
Pooled Deviation	24	-24432.91**	-9634.47**	-14716.59**	-62887.98**	-15289.08**	-107227.50**
Pooled Error	60	1142.28	503.36	727.282	971.05	255.30	535.80
Total	35	84364.34	67742.53	51079.9	217275.6	53055.07	367986.3

** Significant at 1% level of significance

Table 3: Estimates of stability parameters for seed yield in elite greengram genotypes evaluated in *Rabi*, 2019-20 at Warangal, Karimnagar and Tornala

Genotype	Warangal			Karimnagar			Tornala		
	Mean (kg/ha)	b_i	S^2d_i	Mean (kg/ha)	b_i	S^2d_i	Mean (kg/ha)	b_i	S^2d_i
1	764	1.219	-25265.767	783	1.391	-26173.662	783	1.631	-26147.889
2	972	1.550	-40305.323	725	1.288	-22549.472	470	0.980	-9828.426
3	767	1.223	-25457.059	750	1.333	-24086.625	609	1.269	-16077.634
4	514	0.820	-11974.485	608	1.080	-16030.954	401	0.836	-7324.301
5	847	1.351	-30858.360	754	1.339	-24295.514	745	1.552	-23729.611
6	649	1.036	-18534.392	433	0.769	-8440.329	447	0.931	-8937.222
Aver yield (kg/ha)	752			676			576		
CV %	19.67			14.090			19.875		
CD 5%	260.870			173.172			208.155		
SE ±	371.052			77.720			296.073		

Table 4: Estimates of stability parameters for seed yield in elite greengram genotypes evaluated in *Rabi*, 2019-20 at Palem, Madhira and Tandur.

Genotype	Palem			Madhira			Tandur		
	Mean (kg/ha)	b_i	S^2d_i	Mean (kg/ha)	b_i	S^2d_i	Mean (kg/ha)	b_i	S^2d_i
1	1322	1.317	-73665.170	764	1.562	-24710.091	1736	1.302	-1262447.242
2	1429	1.423	-85890.355	618	1.264	-16398.869	1542	1.156	-99659.020
3	1264	1.259	-67415.670	776	1.584	-25458.864	1480	1.110	-91895.015
4	1452	1.447	-88731.341	519	1.061	-1151.573	1604	1.203	-107873.576
5	811	0.808	-28272.577	365	0.747	-5929.383	1486	1.114	-92595.242
6	950	0.946	-38422.785	480	0.980	-9954.869	1754	1.315	-128865.242
Aver yield (kg/ha)	1205			587			1600		
CV %	10.975			11.546			6.136		
CD 5%	240.524			123.330			178.665		
SE ±	342.114			55.351			80.185		

4. Conclusion
Based on the foregoing discussion, it was concluded that genotypes 1, 2, 3 and 5 exhibited stable to below average stable for higher seed yields in most of the locations tested. Genotypes 4 and 6 did not show acceptable seed yields in most of the locations, but were found to be stable towards high seed yields in Tandur.

5. Declaration
All the authors declare no conflicts of interest regarding the publication of this paper.

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7. References
1. Anandhi K, Anand G, Juliet Hepziba S. Genotype × environment interactions in rainfed grown greengram (*Vigna radiata*). Electronic Journal of Plant Breeding. 2019;10(3):1234-1239.
2. Ding M, Tier B, Yan W. Application of GGE Biplot Analysis to Evaluate Genotype, Environment and G × E Interaction on *P. radiata*: A Case Study. New Zealand Journal of Forestry Science. 2008; 38:132-142.
3. Eberhart SA, Russell WA. Stability parameters for comparing varieties. Crop Science. 1966;6:36-40.
4. Finlay KW, Wilkinson GN. The analysis of adaptation in a plant-breeding programme. Australian Journal of Agricultural Research. 1963;14:742-754.
5. Gomashe SS, Patil JV, Deshmukh SB, Sarode SB, Pise PP. Stability for seed yield and its components in mungbean. [*Vigna radiata* (L.) Wilczek]. Asian Journal of Bio Science. 2008;3:111-114.
6. House LR. A Guide to Sorghum Breeding. Second Edition, ICRISAT, India, 1985, 245p.
7. Lin CS, Bains MR, Lefkovitch LP. Stability analysis: where do we stand? Crop Science. 1986;26:894-900.
8. Mahalingam A, Manivannan N, Lakshmi Narayanan S, Indhu SM. Genetic analysis on genotype × environment interaction for seed yield in greengram (*Vigna radiata* (L.) Wilczek). Electronic Journal of Plant Breeding. 2018;9(1):332-335.
9. Mustapha AA, Showemimo FA, Aminu-kano A. Yield stability analysis of promising Triticale cultivars in Nigeria. Journal of Arid Agriculture. 2001;11:1-4.
10. Nath A, Harer PN, Utpal Dey. Stability analysis and G × E interaction in Mungbean (*Vigna radiate* L. Wilczek): A review. African Journal of Agricultural Research. 2013;8(26):3340-3347.
11. Scapim CA, Pacheco CAP, Amaral AT. Correlations between the stability and adaptability statistics of popcorn cultivars. Euphytica. 2010;174:209-218.
12. Schmildt ER, Nascimento AL, Cruz CD, Oliveira JAR. Avaliação de metodologias de adaptabilidade e estabilidade de cultivares milho. Acta Scientiarum Agronomy. 2011;33:51-58.
13. Showemimo FA, Echekwu CA, Yeye MY. Genotype × environment interaction in Sorghum trials and their implication for future variety evaluation in Sorghum growing areas of northern Nigeria. The Plant Scientist. 2000;1:24-31.
14. Yan W, Kang MS. GGE Biplot Analysis: A Graphical tool for geneticists, breeders and agronomists. CRC Press, Boca Raton, FL, 2003, 286p.
15. Yates F, Cochran WG. The analysis of groups of experiments. Journal of Agricultural Science. 1938;28:556-580.
16. Yue GL, Roozeboom KL, Schapaugh WT. Evaluation of soybean genotypes using parametric and nonparametric stability estimates. Plant Breeding. 1997;116:271-275.