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G x E Interaction for Grain Yield and it's Contributing Traits in Rabi Sorghum [*Sorghum bicolor* (L.) Moench] under Medium Soil of Western Maharashtra

R.S. Bagate[1], J.M. Patil[2*], U.S. Dalvi[3] and S.D. Deokar[4]

[1]Student, Department of Agricultural Botany, College of Agriculture, M.P.K.V., Rahuri (Maharashtra), India.
[2]Assistant Professor, Department of Agricultural Botany, College of Agriculture, M.P.K.V., Dhule (Maharashtra), India.
[3]Assistant Professor, Department of Biochemistry, Sorghum Improvement Project, M.P.K.V., Rahuri (Maharashtra), India.
[4]Assistant Professor, Department Agricultural Botany, College of Agriculture, M.P.K.V., Kashti (Malegaon) (Maharashtra), India.

(Corresponding author: J.M. Patil)*
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ABSTRACT: In the present study, 14 sorghum genotypes comprising 12 advanced lines and two check varieties were evaluated for stability parameters over three locations during *rabi* 2022-23. Based on the six morphological and yield traits, pooled ANOVA showed significant differences for the quantitative traits. Meansum of squares due to E+ (G x E) was significant for all of the traits. Environment component showed significant values for all traits. The G x E (linear) showed significant interaction for all the traits in this study except days to 50% flowering. RSV-2657, RSV-2589 and RSV 2596 genotypes had mean value more than population mean, coefficient of regression near to unity and non-significant deviation from regression, hence adapted to all situations.

Keywords: Rabi Sorghum, G x E, grain yield, dry fodder yield.

INTRODUCTION

A sorghum (*Sorghum bicolor* L. Moench) prominent cereal crop grown as a staple food in semi-arid regions of Asia and Africa as Compared to most other cereals, it is more resistant to heat and drought. It is the source of food, fodder and predominantly cultivated in states of Maharashtra, Karnataka and Tamil Nadu. Rabi sorghum is cultivated over 4.24mha in India with an annual production of 4.78 mt. In Maharashtra, *rabi* sorghum are being cultivated over 16.6 lakh ha with an annual production of 20.36 lakh ton (Anonymous, 2022). In Maharashtra rabi sorghum is cultivated on variations in soil types *viz.*, 23 % shallow, 48 % medium and 29 % deep soil. It is mainly cultivated under rainfed conditions and predominantly dominated by varieties and local landraces (Badigannavar *et al.*, 2015).

It can be emphasised that the G x E interaction is the driving force behind the scientific crop research efforts that are related to genotype stability. Before releasing improved strains for commercial cultivation, they undergo adaptive evaluation (Sharma, 2006). Genetic improvement of rabi sorghum was hindered by narrow genetic base and lack of phenotypic variability and stability present in the breeding lines (Prabhakar, 2002). The stable genotype is the one, which has the buffering capacity against the change in environmental conditions. This can be identified by assessing the genotype environment interaction (G x E) by growing the genotypes in stratified environments.

MATERIAL AND METHODS

A field study was conducted in randomized block design with two replications at three locations *viz.,* Sorghum Improvement Project, Rahuri, Agricultural Research Station, Chas and ARS, Mohol during Rabi-2022-23 .The experiment was conducted on medium soil, consists of 4 rows of 4.5 m row length with 45 cm row spacing and 15 cm in between plant. Recommended agronomic cultural practices were followed for raising healthy crop. The study was based on six quantitative characters *viz.,* days to 50 per cent flowering, days to maturity, plant height (cm), 1000-grain weight (g), grain yield (q /ha) and dry fodder yield day(q/ha) Data from the three environments and pooled data are subjected to Analysis of Variance (Panse and Sukhatme 1967). The traits which showed the significant G x E interactions were subjected to stability analysis usingthe Eberhart and Russell (1966) model. As per the model, three parameters *viz.,* overall mean performance of each genotype across the environments, the regression of each genotype on the environmental index (bi) and squared deviation from the regression (S^2di) were estimated. The significance of stability parameters and deviations from unity were tested by student's 't' test.

RESULTS AND DISCUSSION

Mean Performance: Mean performance is presented in Table 1. The three environments *viz.,* Rahuri, Chas and Mohol, showed significant differences for all characters. This implies that there is a scope or possibility of selection of better genotypes in each location for all characters. Rahuri (E1) was most favorable for yield and yield contributing characters as it indicated maximum positive value of environmental indices than Chas (E2) and Mohol (E3) locations.

Stability analysis: The analysis of variance for stability analysis (Table 2) revealed that the differences among the genotypes were significant for *viz.*, days to 50 per cent flowering, days to maturity, 1000 grain weight, plant height (cm) grain yield (q/ha) and dry fodder yield (q/ha) indicating sufficient variability among the genotypes for these characters. Difference among the environments were found highly significant for all the indicating variation in environment for those characters. Significant Environment + (G x E) interaction variances are observed for all traits. Significant variance due to environment (linear) for all the characters suggesting that prediction of performance of these characters in different environments. Anarase *et al*. (2016) indicated importance of both linear and non-linear components in determining genotype x environment interactions for days to 50% flowering. Girish *et al*. (2020) observed significant interaction of G x E for plant height. Karad and Kusalkar (2005) also observed significant G x E interactions for grain yield and dry fodder.

Finlay and Wilkinson (1963) considered linear regression slope as a measurement of stability. However, Eberhart and Russell (1966) emphasized the need of considering both linear (bi) and nonlinear (S^2di) components of G x E interaction in judging the stability of genotype.

An ideal genotype is defined as, one possessing high mean performance, with regression coefficient around unity (bi=1) and deviation from regression (S2di) close to zero. Stability parameters of rabi sorghum genotypes for yield and yield contributing characters is presented in Table 3.In present investigation on the basis of grain yield q/ha parameters only three genotypes RSV 2589, RSV2657and RSV 2596 exhibited better grain yield as compared to the mean over the environments (1978 q / ha) and the order of genotypes became as RSV 2589 (23.40 q/ ha)) followed by RSV 2657 (22.75q/ ha) and then RSV 2596 (20.36 q/ ha) similarly those three genotypes exhibited regression coefficient values as RSV 2589 (bi= 149), RSV 2657 (bi=1.99) and RSV 2596 (bi=1.26) in that order which are being non-significant and further the deviation from regression values are also non-significant. There by indicating the highly stable performance of those genotypes for grain yield over the environments tested. Similar results were also reported by Saxena and Dabholkar (1982); Desai *et al*. (1983); Prabhakar (2002); Karad and Kusalkar (2005) in Sorghum.

First high yielding genotype RSV 2657 showed average stability for the all charecters indicating that it may perform well in different environments for these characters. Second high yielding genotype RSV 2589 also showed above average stable performance dry fodder yield (q/ha).Third high yielding genotype RSV 2596 above average stability performance for grain yield(q/ha) only. Such kind of differential performances of various yield contributing characters by the stable genotypes were also reported by Saikiran *et al.* (2022) ; Yahaya *et al*. (2023).

Table 1: Estimates of mean, range and environmental index (EI) for six quantitative traits in rabi sorghum.

Sr. No.	Character	Rahuri (E_1)			Chas (E_2)			Mohol (E_3)		
		Mean	Range	EI	Mean	Range	EI	Mean	Range	EI
1.	Days to 50% Flowering	87.11	82-92.50	3.41	85.75	82-87.50	2.05	78.25	76 - 80.50	-5.45
2.	Days to maturity	129.11	124 - 134.50	4.09	125.75	122 – 127.50	0.74	120.18	118 - 122.50	-4.83
3.	Plant height (cm)	219.64	190-235	12.50	210.18	195- 232.50	3.03	191.61	167.50 -210	-15.53
4.	1000-grain weight (g)	33.00	28.50– 41	1.84	29.50	27.5 – 30	-1.23	30.50	27.2 - 33.70	-0.60
5.	Grain yield (q/ha)	26.71	20.37 - 36.60	6.92	15.01	9.63- 20.84	-4.27	17.59	15.98- 22.69	-2.19
6.	Dry fodder yield (q/ha)	77.44	61.13 – 94.08	22.71	40.70	26.48 – 53.81	- 14.04	46.07	39.69 – 49.91	-8.66

Table 2: Analysis of Variance of yield and yield contributing traits under different environments.

Source of Variation	d.f.	Mean sum of squares					
		DFF	DM	PLH	TW	GY	DFY
Rep within Env.	3	1.195	1.875	63.988	1.195	0.935	16.739
Varieties	13	5.529**	7.07**	342.857**	5.529**	14.988**@@	75.817**
Env. + (Var x Env)	28	8.011**	23.369**++	388.839**	8.011**	49.095**++	456.259**++
Environments	2	36.798**++	284.738**++	2847.768**++	36.798**++	525.66**++	5514.297**++
Var. x Env.	26	5.797*+	3.264**	199.691**	5.797*+	12.436**	67.179**
Env. (Linear)	1	73.595**++	569.476**++	5695.537**++	73.595**++	1051.32**++	11028.59**++
Var. x Env. (Lin)	13	9.082**++	2.135**	195.612**	9.082**++	17.2**	85.575**
Pooled Deviation	14	2.333**	4.078**	189.215**	2.333**	7.124**	45.298**
Pooled Error	39	0.844	1.111	5.417	0.844	0.965	51.809
Total	41	7.224	38.281	335.631	7.224	18.201	374.26

DFF- Days to 50% Flowering, DM- Days to maturity, PLH-Plant height (cm), TW-1000-grain weight, GY- Grain yield and DFY- Dry fodder yield

+,++ and *,** significant at 5 and 1 % level of significance when tested at pooled deviation and pooled error respectively.

Table 3: Stability parameters of rabi sorghum genotypes for yield and yield contributing characters.

Sr. No.	Genotypes	Days to 50% flowering			Days to maturity			Plant height (cm)			1000-grain weight (g)			Grain yield (q/ha)			Dry fodder yield (q/ha)		
		Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di
1.	MSV 175	82.2	0.68	14.37*	123.2	0.86	11.5*	205.8	0.18	494.8*	31.0	1.10	-0.82	22.62	0.95	18.82*	59.57	0.76	193.94*
2.	RSV 2408	84.8	0.82*	1.16	126.2	0.97	1.60	222.5	0.62	49	30.3	0.43	-0.75	18.50	0.43	3.01	53.56	1.38	5.49
3.	RSV 2589	82.5	1.11	12.18*	123.8	1.35	12.20*	196.7	0.72	351.9*	28.3	0.28	-0.14	23.40	1.49	3.09	60.52	1.42	7.05
4.	RSV 2515	86.7	1.27	4.82*	128.0	1.40*	2.40	227.5	2.01	138.8	29.4	-0.49*	-0.86	21.41	1.15	3.94*	57.99	0.67	-4.53
5.	RSV 2576	85.0	1.38*	-0.44	126.3	1.18	-1.00	200.8	0.24	-48.8	31.2	1.52	7.57*	16.67	0.74	-0.69	46.72	1.18	47.56*
6.	RSV 2596	83.7	1.093*	5.66*	125.0	0.94	4.30*	202.5	1.20	141	32.5	4.36	8.62*	20.36	1.26	0.93	59.45	1.22	-5.26
7.	RSV 2371	83.8	1.02*	3.62*	125.2	0.77	3.10	191.7	1.99	582.3*	30.8	1.99	-0.79	19.29	1.50	16.51*	50.48	0.78	105.71*
8.	RSV 2622	84.3	0.79*	-0.64	125.7	0.97	-0.90	208.3	1.10	128.7	30.0	0.23	-0.65	18.96	0.40*	-1.09	54.91	0.71	12.92
9.	RSV 2620	84.8	0.92*	1.94	126.2	0.67	1.90	205.0	0.68	-7.2	30.2	2.43	3.80	16.08	0.69	8.03*	46.69	0.69	121.68*
10.	RSV 2628	83.7	0.79	7.84*	125.0	0.99	5.10*	201.7	1.99	198.4	29.9	-0.13	-0.01	18.70	1.07	0.75	49.24	0.70	-4.97
11.	RSV 2636	84.8	0.98	-0.42	126.2	0.99	-0.80	217.5	1.20	-29.7	27.6	-0.66	0.19	18.69	0.58	2.19	54.56	1.41*	-2.59
12.	RSV 2657	81.3	0.98	-0.42	122.7	1.21	-0.80	210.8	0.82	0.2	30.5	0.81	-0.86	22.75	1.99*	-0.92	62.01	1.41	-5.92
13.	**P. Suchitra**	82.3	1.18	0.35	123.7	1.01	-0.50	215.8	1.37	-42.4	32.6	1.27	4.93*	21.15	1.27	30.02*	57.13	0.57	1.79
14.	**M-35-1**	81.8	0.936	4.68*	123.2	0.86	4.6*	193.3	-0.15	-45.6	30.2	0.81*	0.26	18.41	0.43*	-1.05	53.51	0.76	11.16
	Popl. Mean	**83.70**			**125.0**			**207.1**			**30.31**			**19.78**			**54.74**		

CONCLUSIONS

It is concluded that the genotype RSV 2657, RSV 2598 and RSV 2596 could be included in the hybridization program to converge the stability characteristics of grain yield for the development of stable cultivar adapted to a wide range of environments. These genotypes after further multilocation testing may be released as varieties for medium soil type of Maharashtra. Thus, any generalization regarding stability of genotypes for all characters it is too difficult since the genotypes may not simultaneously exhibit uniform responsiveness and stability for all the characters.

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