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Research Article

STABILITY ANALYSIS IN ROSELLE (Hibiscus sabdariffa L.) BY EBERHART-RUSSELL MODEL

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ABSTRACT

Thirty genotypes of roselle (*Hibiscus sabdariffa* L) were raised in three environments (dates of sowing) during *kharif*, 2013 to study the environment and genotype × environment (G × E) linear interaction components. The study revealed significant differences for all the characters, indicating wide differences between environments and differential behavior of genotypes in different environments. The linear and non-linear G × E components were non-significant for all the characters except fibre yield per plant. The genotypes R-78, JRR-9 and AHS-162 were found to be stable for favourable environmental conditions for plant height; basal stem diameter, green plant weight and fibre yield per plant, whereas HS-4288 and AR-12 were stable for poor environmental conditions for all the characters under study. The genotypes HS-4288 and CRIJAFR-2 were considered to be stable for fibre yield per plant in poor environmental conditions. The genotypes HS-4288, AMV-4, CRIJAFR-2, AS-80-29, JRR-9, R-83 and R-78 were found to be stable over environments. These genotypes can be used as parents in future breeding programmes to generate desirable seggregants with wider adaptability over environments.

Keywords: *Roselle (Hibiscus sabdariffa L), Genotype × Environment (G × E) Linear, Stability and Fibre Yield*

INTRODUCTION

Roselle (*Hibiscus sabdariffa* L.) is a second most important fibre crop next to jute. It is an annual or perennial tropical plant. As it is a short day plant and sensitive to photoperiod, temperature and prolonged moisture stress, the yield of roselle is not stable and varies widely (Guptaji, 1993). The variability in environment namely location effect, seasonal fluctuations and their interaction highly influence the performance of genotypes in relation to yield potential. Studies on individual components can lead to simplification in genetic explanation of yield stability. These studies are reliable to plant breeders in the prediction and determination of the effects of the environments. The present investigation was undertaken to study the stability of the component traits in relation to the fibre yield.

MATERIALS AND METHODS

The experimental material, comprising of thirty genotypes of roselle, were grown in three environments (different dates of sowing with twenty one days interval) during *Kharif*, 2013 at the Agricultural Research Station Farm, Amadalavalasa, Andhra Pradesh, India. The design adopted was RBD with three replications. Each plot consisted of three rows of 3 meters length with a spacing of 30 x 10 cm. Observations were recorded on plant height(cm), basal stem diameter(cm), green plant weight(g) and fibre yield per plant (g). The data were analyzed for stability parameters following Eberhart and Russell (1966) model. A genotype having unit regression coefficient (b_i=1) and non-significant deviation from regression ($s^2d_i = 0$) was considered as stable.

RESULTS AND DISCUSSION

Successful evaluation of stable genotypes is possible through genotype × environment interaction studies. Earlier, Finlay and Wilkinson (1963) considered the linear regression (b_i) as a measure of stability, but later, Eberhart and Russell (1966) emphasized the need of both b_i and s^2d_i in judging the stability of a genotype. Breese (1969) and Paroda and Hayes (1971) advocated that the b_i could simply be regarded as a measure of responsiveness and s^2d_i as a measure of stability. A genotype having unit regression coefficient (b_i=1) and non-significant deviation from regression (s^2d_i = 0) was considered as stable. However, if a genotype possessed high mean with less than unity regression, the genotype should be suitable for poor environmental conditions.

Mean squares due to genotypes were significant for fibre per plant indicating sufficient variability among genotypes (Table 1). The environment interaction components exhibited significance for all the characters, indicating wide differences between environments. Significance of environment (linear) component for all the characters confirms to the observations of widely differing environments, in the analysis of variance. The genotype × environment (linear) interaction component was non-significant for all the characters except fibre yield per plant. Pooled deviation component was highly significant for plant height, basal stem diameter and green plant weight indicating the importance of non-linear component in the genotype-environment interaction. Similar results are reported in cotton by Kavithamani *et al.*, (2011) and Patel *et al.*, (2013).

The mean performance (X), the regression coefficient (b) and the deviation mean square (s^2d_i) for plant height, basal stem diameter, green plant weight and fibre yield per plant (g) are presented in Table 2 and Table 3. The genotypes ER-1, CRIJAFR-8 and AMV-4 for plant height; ER-1 and R-93 for basal stem diameter; AS-80-29 and AS-80-19 for green plant weight and HS-4288 for fibre yield per plant could perform well under average environmental conditions as they exhibited high mean performance with near to unity regression and least deviation from regression. The genotypes AS-80-19, AHS-162 and R-78 for plant height; R-78, CRIJAFR-8, JRR-9 and AMV-4 for basal stem diameter ; ER-1, AR-71, R-78 and JRRM-9-1 for green plant weight and R-78, R-83 and AHS-162 for fibre yield per plant, were considered to be stable for, favourable environmental condition as they exhibited high means with greater than unity regression.

Table 1: Pooled analysis of variance (mean sum of squares) for stability performance (Eberhart and Russell (1966) model) of four characters in roselle (*Hibiscus sabdariffa* L.).

Source	d.f.	Plant height	Basal stem diameter	Green plant weight	Fibre yield / plant
Genotypes	29	645.183	1.322	2077.7	12.564**
Environments	2	59973.430**	427.335**	64792.100**	1790.240**
Genotype × Environment	58	590.002	2.493	3529.363	13.285**
Environment + (Genotype × Environment)	60	2569.449**	16.654**	24988.120**	72.517**
Environment (linear)	1	19946.900**	854.670**	1294584.000**	3580.481**
Genotype × Environment (linear)	29	535.6	2.275	3561.844	22.319**
Pooled deviation	30	622.924**	2.620**	3380.319**	4.11
Pooled error	174	181.342	1.186	950.988	2.789

**Significant at 5% level*
***Significant at 1% level*

The genotypes AHS-152, HS-4288 and R-28 for plant height; AR-12, AS-80-29 and JRRM-9-1 for basal stem diameter; R-83, AMV-4 and HS-4288 for green plant weight and CRIJAFR-2 and HS-4288 for fibre yield per plant, which showed high means with less than unity regression could perform well even under poor environmental conditions. Twenty eight genotypes were found to be stable for fibre yield as b_i and s^2d_i values were non-significant. The genotypes AMV-4 showed average response (non-significant b_i)

with high mean performance i.e., greater the population mean in case of plant height (272.90) and basal stem diameter (16.49) and with low mean performance i.e., less than population mean in case of green plant weight (311) and fiber yield per plant (15.72), thus they possessed wide/general adaptability to be suited equally to all kinds of environments.

Table 2: Mean performance and stability parameters for plant height and basal stem diameter in roselle (*Hibiscus sabdariffa* L.)

S.No.	**Genotypes**	**Plant height**			**Basal stem diameter**		
		Mean (cm)	**b_i**	**S^2d_i**	**Mean (mm)**	**b_i**	**S^2d_i**
1	ER-1	303.3	0.967	40.846	17.382	17.382	-1.105
2	ER-10	272	0.531	311.634	15.757	15.757	0.066
3	ER-38	270.8	0.755	4622.62	15.706	15.706	1.349
4	ER-58	265.7	0.764	332.013	16.161	17.382	-1.025
5	ER-63	263.3	1.018	-158.4	16.787	15.757	4.604
6	AR-12	269.5	0.608	83.335	16.689	15.706	-1.17
7	AR-71	267.1	1.209	412.638	15.94	17.382	-1.124
8	AR-72	255.3	1.314	645.408	15.793	15.757	-0.707
9	R-28	273.7	0.844	-36.619	16.231	15.706	-1.135
10	R-93	255.9	0.645	-142.89	17.704	17.382	-0.385
11	R-78	277.8	1.494	-54.312	16.499	15.757	-1.081
12	R-134	251.8	0.947	353.623	17.749	15.706	-1.113
13	R-200	257.9	0.584	-181.68	16.641	17.382	2.719
14	R-83	269.1	1.701	2007.29	16.717	15.757	0.425
15	AS-80-29	260.4	1.303	-180.22	17.598	15.706	0.512
16	AS-80-31	288.3	1.243	396.625	17.388	17.382	7.077
17	AS-80-19	273	1.285	-41.326	16.107	15.757	-1.001
18	CRIJAFR-2	278.3	0.879	4.152	16.588	15.706	0.823
19	CRIJAFR-8	280.3	0.988	-178.21	16.271	17.382	0.917
20	JRR-9	271.1	1.433	-115.92	16.414	15.757	-0.867
21	JRRM-9-1	276.1	1.453	-188.22	16.427	15.706	-1.096
22	AHS-160	265.9	0.748	-189.07	17.27	17.382	-1.122
23	AHS-161	296.8	0.658	701.456	16.616	15.757	2.47
24	AHS-152	311.7	0.888	622.146	16.146	15.706	4.352
25	AHS-162	273.6	1.293	-43.446	15.623	17.382	7.249
26	AHS-172	274.2	1.532	2655.08	16.638	15.757	11.451
27	AHS-179	252.8	0.016	837.503	15.312	15.706	2.12
28	AMV-4	284	1.066	-77.375	16.834	17.382	0.111
29	AMV-5	255.1	0.942	760.846	15.343	15.757	2.235
30	HS-4288	291.3	0.893	-186.11	16.647	15.706	7.785
	µ	272.9			16.49		
	S.E (µ)	17.6			1.14		
	S.E(bi)	0.4			0.3		

**Significant at 5% level* *µ= population mean*
***Significant at 1% level* *S.E (µ) = standard error mean*

Table 3: Mean performance and stability parameters for green plant weight and fibre yield per plant in roselle (*Hibiscus sabdariffa* L.)

S.No.	Genotypes	Green plant weight			Fibre yield per plant		
		Mean (g)	b_i	S^2d_i	Mean (g)	b_i	S^2d_i
1	ER-1	349.2	1.163	-982.86	15.044	0.861	-2.731
2	ER-10	290.6	0.655	709.761	15.731	0.761	-0.707
3	ER-38	291.5	0.744	14507.4	12.1	0.629	2.22
4	ER-58	286.5	0.908	160.972	15.737	1.014	10.075
5	ER-63	296.1	0.757	12535.9	14.328	0.716	3.774
6	AR-12	297	0.862	-710.92	14.434	0.738	2.564
7	AR-71	338.7	1.195	-708.6	13.603	0.69	-1.606
8	AR-72	287.4	1.265	-772.92	14.687	1.259	-2.719
9	R-28	268.4	0.757	-843.3	14.592	0.746	-2.545
10	R-93	348.1	0.884	1845.03	16.658	0.643	3.632
11	R-78	341.4	1.106	-397.01	18.777	1.263	-2.679
12	R-134	342.2	0.815	6426.96	14.406	0.778	4.635
13	R-200	294.9	1.223	287.339	14.769	0.944	6.864
14	R-83	286.1	0.857	-217.46	17.37	1.931	0.846
15	AS-80-29	315.6	1.033	-482	16.372	1.159	2.325
16	AS-80-31	326	1.001	5492.32	19.602	0.795	20.976
17	AS-80-19	332.7	1.035	-656.91	12.491	0.305	-2.391
18	CRIJAFR-2	313.9	0.822	2807.08	14.74	0.937	-2.676
19	CRIJAFR-8	339.8	1.542	7349.13	17.202	1.438	-2.733
20	JRR-9	296	1.291	2937.52	16.878	1.159	0.958
21	JRRM-9-1	302	1.092	-33.353	15.621	0.873	-2.5
22	AHS-160	342.5	1.426	1573.71	22.136	2.045	6.858
23	AHS-161	328.1	0.755	2771.26	15.093	0.505	0.557
24	AHS-152	289.3	0.603	4983.21	15.198	0.548	0.112
25	AHS-162	315.6	1.359	1323.04	16.167	1.392	-0.942
26	AHS-172	351.1	1.521	3655.05	17.432	1.965	1.943
27	AHS-179	249.2	0.274	1789.65	14.476	0.579	-1.334
28	AMV-4	310.4	0.976	-141.46	14.201	1.009	-2.43
29	AMV-5	289.8	1.193	7064.04	14.876	1.352	3.44
30	HS-4288	309.5	0.886	-653.32	17.114	0.968	-2.597
	µ	311			15.72		
	S.E (µ)	41.1			1.43		
	S.E(bi)	0.3			0.18		

**Significant at 5% level* *µ = population mean*
***Significant at 1% level S.E* *(µ) = standard error mean*

Table 4: Genotypes classified into different groups in relation to environmental conditions

Characters	**Stable for average environmental conditions**	**Stable for favourable environmental conditions**	**Stable for poor environmental conditions**
Plant height	ER-1, CRIJAFR-8, AMV-4	AS-80-19, AHS-162, R-78	AHS-152, HS-4288, R-28
Basal stem diameter	ER-1, R-93	R-78, CRIJAFR-8, JRR-9, AMV-4	AR-12, AS-80-29, JRRM-9-1
Green plant weight	AS-80-29, AS-80-19	ER-1, AR-71, R-78, JRRM-9-1	R-83, AMV-4, HS-4288
Fibre yield/plant	HS-4288	R-78, R-83, AHS-162	CRIJAFR-2, HS-4288

Stability of yield of a genotype is determined, to a considerable extent by the relative stability of different component characters (Luthra *et al.,* 1977), Table 4. In the present study, the genotype HS-4288 possessed wide/general adaptability and could be recommended for wide cultivation. The genotypes HS-4288, AMV-4, CRIJAFR-2, AS-80-29, JRR-9, R-83 and R-78 were found to be stable over environments. These genotypes can be used as parents in future breeding programmes to generate desirable seggregants with adaptable nature over environments.

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