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Research Article

Stability analysis for quality traits in Forage Sorghum (*Sorghum bicolour* L. Moench)

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ABSTRACT

The study involved the stability analysis of the parents and hybrids, using line x tester mating design. Twenty four hybrids along with their ten parents and checks ((SSG 59-3 and MFSH 4)) were evaluated at two locations with two dates of sowing (Early and late sowing) during the kharif season of 2015-16 for quality traits. Data on different qualiitative characters at first cut (55 days after sowing) and second cut (45 days after first cut) were recorded. Stable hybrids are desirable for commercial exploitation over a wide range of agro-climatic conditions. It is clear that mean sum of squares due to genotypes for all the characters were highly significant when tested against pooled deviation, which revealed that the hybrids had significant differences in response to varying environmental conditions. Five hybrids were found to have both b_i *and* $\overline{S}_{di}^2$ *significant, indicating the presence of both linear and non-linear components of G × E interaction for protein content. Hybrids 56A × IS 2389 was found stable, average responsive and suitable for all the test environments for IVDMD. The cross combination of 14A × HJ 513, 31A × HJ 541 and 14A × IS 2389 were found stable, average responsive and suitable for all the test environments for HCN content. On the otherhand, hybrids 465A × G 46 and 465A × IS 2389 and parent G 46 were found highly responsive and suitable for the favourable environments. Therefore, these hybrids can be utilized in further genetic study in future in plant breeding.*

Keywords: *Sorghum, Xerophilic, Crops, Environmental conditions*

INTRODUCTION

Sorghum [*Sorghum bicolor* (L.) Moench] originated in Africa, has extremely drought tolerant ability makes it an excellent choice for arid and dry areas. It is one of the major multi-purpose crops grown for forage and grain production purpose. Among forage crops, forage sorghum could be a strategic option because of its xerophilic characteristics, adaptation potential, quick growing habit, good ratoonability, palatability, digestibility and wide range of potential uses as green fodder, dry roughage, hay and silage.

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Sorghum is fast-growing, warm weather annual crop that can provide plenty of feed in mid-summer during lean period of fodder availability (Hovny et al., 2001).

Sorghum is popular as a dual purpose crop and is next to rice and wheat in its acreage and importance in India. It is well known that the animal industry in any country revolves around sufficient quantity of good quality feed and fodder (Siddiqui & Baig, 2001). Stable hybrids are desirable for commercial exploitation over a wide range of agro-climatic conditions. Their adaptability in real sense is due to the genetic make-up. The Eberhart and Russell (1966) method would be of great help, because it not only provides measure and magnitude of linear and non-linear genotype x environment interaction but also gives estimate of stability parameters of individual hybrid. Stability of a hybrid depends on the ability to retain certain morphological and physiological characters steadily and allowing other to vary, resulting in predictable genotype x environment interactions for yield. Keeping the above points in view, the present investigation was undertaken with the following objective to identify stable hybrids over various environments.

MATERIALS AND METHODS

Hybrids were developed in a Line × Tester mating fashion on six females (lines) using four males (testers). The crosses were made in research area of Forage section, Department of Genetics and Plant Breeding, CCS HAU, Hisar during the kharif season of 2014-15. Hybrids and parents were evaluated at two locations i.e. research area of Forage Section, Department of Genetics and Plant Breeding, Chaudhary Charan Singh Haryana Agricultural University, Hisar and Regional Research Station Uchani, Karnal with two date of sowing (Early and late sowing) during the kharif season of 2015-16. All the thirty-six genotypes (24 hybrids, 10 parents and two standard checks (SSG 59-3 and MFSH 4) were grown in a randomized block design in three replications of a two-row plot of 4.0 m length. All the recommended cultural package of practices was followed from sowing to harvesting of the crop.

Data on five randomly taken plants from each genotype in each replication were recorded on different quality characters viz. TSS content (total soluble sugars), protein content (%), protein yield (g/plant), IVDMD [(*in vitro* dry matter digestibility (%)], dry matter digestibility [DDM (g/plant)] and HCN content (mg/kg green weight) in all the four environments at first cut (55 days after sowing) and second cut (45 days after first cut). The estimates of stability parameters *viz.*, mean ($\overline{X}$), regression coefficient (b_i) and deviation from regression ($\overline{S}_{di}^2$) of all the 24 crosses along with ten parents and two checks for all the characters under study were estimated.

RESULTS AND DISCUSSION

The results of analysis of variance for phenotypic stability based on Eberhart and Russell's (1966) model stated that mean sum of squares due to genotypes for all the characters were highly significant when tested against pooled deviation, which revealed that the hybrids had significant differences in response to varying environmental conditions. When the mean sum of square due to environment (linear) was tested against pooled deviation, it was found significantly different for all the characters studied. This indicated that the environments were significantly different and warranted estimation of G × E interactions. Significance of pooled deviation for all the traits showed that these hybrids differed significantly with respect to their stability for these traits.

Out of total 36 genotypes (24 hybrids, 10 parents and 2 checks) only six hybrids, four parents and check SSG 59-3 had both b_i and $\overline{S}_{di}^2$ non significant, indicating the absence of G × E interaction. Two hybrids were found to have both b_i and $\overline{S}_{di}^2$ significant, indicating the presence of both linear and non-linear components of G × E interaction. However, only one hybrid and one parent were found to have significant bi, indicating the presence of linear component. Fifteen hybrids, five parents and check MFSH 4 were found to have significant $\overline{S}_{di}^2$, indicating the presence of non-linear component.

Total soluble sugars (TSS)

Three hybrids and two parents had both b_i and $\overline{S}_{di}^2$ non significant, indicating the absence of G × E interaction. Twelve hybrids, six parents and check SSG 59-3 had both b_i and $\overline{S}_{di}^2$ significant, indicating the presence of both linear and non-linear components of G × E interaction. One parent and check MFSH 4 were found to have significant bi, indicating the presence of linear component. Nine hybrids and one parent were found to have significant $\overline{S}_{di}^2$, indicating the presence of non-linear component.

Protein content

Results revealed that three hybrids out of 36 genotypes had both b_i and $\overline{S}_{di}^2$ non significant, indicating the absence of G × E interaction. Five hybrids were found to have both b_i and $\overline{S}_{di}^2$ significant, indicating the presence of both linear and non-linear components of G × E interaction. Three hybrids, one parent and check MFSH 4 were found to have significant bi, indicating the presence of linear component. Thirteen hybrids, nine parents and check SSG 59-3 were found to have significant $\overline{S}_{di}^2$, indicating the presence of non-linear component.

Protein yield per plant

Out of 36 genotypes, only three hybrids, three parents and checks (SSG 59-3 and MFSH 4) had both b_i and $\overline{S}_{di}^2$ non significant, indicating the absence of G × E interaction. Seven hybrids were found to have both b_i and $\overline{S}_{di}^2$ significant, indicating the presence of both linear and non-linear components of G × E interaction. Three hybrids and one parent were found to have significant bi, indicating the presence of linear component. Eleven hybrids and six parents were found to have significant $\overline{S}_{di}^2$, indicating the presence of non-linear component.

***In vitro* dry matter digestibility (IVDMD)**

Results revealed that seven hybrids, two parents and check SSG 59-3 out of 36 genotypes had both b_i and $\overline{S}_{di}^2$ non significant, indicating the absence of G × E interaction. Two hybrids were found to have both b_i and $\overline{S}_{di}^2$ significant, indicating the presence of both linear and non-linear components of G × E interaction. Two parents were found to have significant bi, indicating the presence of linear component. Fifteen hybrids, six parents and check MFSH 4 were found to have significant $\overline{S}_{di}^2$, indicating the presence of non-linear component.

Dry matter digestibility per plant (DDM)

A critical examination of the results revealed that thirteen hybrids, six parents and checks (SSG 59-3 and MFSH 4) out of 36 genotypes had both b_i and $\overline{S}_{di}^2$ non significant, indicating the absence of G × E interaction. Two hybrids were found to have both b_i and $\overline{S}_{di}^2$ significant, indicating the presence of both linear and non-linear components of G × E interaction. Eight hybrids and two parents were found to have significant $\overline{S}_{di}^2$, indicating the presence of non-linear component.

HCN content

Out of 36 genotypes, five hybrids and five parents had both b_i and $\overline{S}_{di}^2$ non significant, indicating the absence of G × E interaction. Three hybrids were found to have both b_i and $\overline{S}_{di}^2$ significant, indicating the presence of both linear and non-linear components of G × E interaction. Fifteen hybrids, five parents and checks (SSG 59-3 and MFSH 4) were found to have significant $\overline{S}_{di}^2$, indicating the presence of non-linear component. The cross combination of 14A × HJ 513, 31A × HJ 541 and 14A × IS 2389 were found stable, average responsive and suitable for all the test environments for HCN content. On the otherhand, hybrids 465A × G 46 and 465A × IS 2389 and parent G 46 were found highly responsive and suitable for the favourable environments.

It further revealed that hybrids reacted differently in different environments. This indicated that the environments were significantly different and warranted for estimation of G × E interaction in which both linear as well as non-linear components were equally important.

Table 1: Promising stable hybrids identified for different characters in forage sorghum

Characters	Hybrids	Mean	b_i	$\overline{S}_{di}^2$
TSS content (%)	56A × HJ 541	3.38	0.96	0.38
Protein content (%)	31A × G 46	10.03	1.06	0.83
	56A × HJ 513	8.58	0.95	0.60
Protein yield (g/plant)	31A × G 46	8.89	1.04	0.36
IVDMD (%)	14A × G 46	48.16	0.95	0.59
	56A × IS 2389	52.15	0.94	0.28
Dry matter digestibility (g/plant)	9A × HJ 513	51.62	1.13	0.49
	56A × IS 2389	47.39	0.97	0.31
HCN content (mg/kg green weight)	14A × HJ 513	49.12	1.05	0.18
	14A × IS 2389	48.40	0.95	1.67
	31A × HJ 541	53.12	1.00	0.45

Hybrid 56A × HJ 541 for TSS content and 31A × G 46 for protein yield were found stable, average responsive and suitable for all the test environments whereas hybrids 56A × HJ 513 and 31A × G 46 were found stable, average responsive and suitable for all the test environments for protein content.

In case of IVDMD and DDM, hybrid, 56A × IS 2389 was found to be stable, average responsive and suitable for all the test environments whereas hybrids 14A × HJ 513, 31A × HJ 541 and 14A × IS 2389 were found stable, average responsive and suitable for all the test environments for HCN content.

Similar results have been reported by Patil et al. (1991), Reddy et al. (2004), Mukri (2007), Amit et al. (2007), Kher et al. (2008), Sharanabasappa (2009) and Sameer et al. (2010).

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