

Stability Analysis for Fodder Yield and its Attributing Traits in Different Environments in Forage Sorghum (*Sorghum bicolor* L. Moench)

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ABSTRACT

The study envisaged assessing the stability analysis of the parents and hybrids, using line x tester mating design. Twenty four hybrids (derived from mating four testers with six lines in $L \times T$ design) along with their parents (10) and checks ((SSG 59-3 and MFSH 4)) were evaluated at two locations with two date of sowing (Early and late sowing) during the kharif season of 2015-16. Data on five randomly taken plants from each genotype in each replication were recorded on different quantitative characters at first cut and second cut. Stable hybrids are desirable for commercial exploitation over a wide range of agro-climatic 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 $G \times E$ interactions. Ten hybrids and three parents were found to have significant \bar{S}_{di}^2 , indicating the presence of non-linear component for dry fodder yield. The higher green fodder yield was exhibited by hybrids 465A \times G 46 and 467A \times IS 2389 and were found stable and suitable for all the test environments while hybrid 31A \times HJ 513 was found highly responsive for the favourable environments. The cross 31A \times IS 2389 was found stable, average responsive and suitable for all the test environments for dry fodder yield while hybrids 14A \times HJ 513 and 467A \times IS 2389 were found highly responsive and suitable for the favourable environments. Hybrids 465A \times HJ 513 and 9A \times IS 2389 may be further advanced to select the good segregants for green and dry fodder yield as these had high sca and stability.

Keywords: Sorghum, Fodder yield, Stability, Line x tester analysis

INTRODUCTION

Sorghum [*Sorghum bicolor* (L.) Moench] originated in Africa, ranks fifth in the world after wheat, rice, maize and barley. It is an important staple food for more than 300 million people and feed for cattle in Asia and

Africa. In India, it is grown as dual-purpose crop serving both farming community and livestock. It's extremely drought tolerant ability makes it an excellent choice for arid and dry areas.

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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. 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).

Although India is the highest milk producing country yet per capita milk production is very low due to the huge deficit in the availability of feed stuffs. Hence, efforts should be directed to intensify forage production per unit area per unit time, which can be achieved through improved high yielding varieties and better management practices.

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. There has been a great concern for homeostasis which has stimulated plant breeder's awareness to develop well buffered cultivars. 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. A population that can adjust its genotypic and phenotypic state in response to environmental fluctuation in such a way to give high and stable yield is termed "well buffered". Keeping the above points in view, the present investigation was undertaken with the objectives 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 fodder yield and its attributing characters viz. plant height (cm), number of tillers per plant, leaf length (cm), leaf breadth (cm) and stem diameter (cm) 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 (\bar{X}), regression coefficient (b_i) and deviation from regression (\bar{S}_{di}^2) of all the 24 crosses alongwith 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 $G \times E$

interactions. Significance of pooled deviation for all the traits, except effective tillers per plant 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 \bar{S}_{di}^2 non significant, indicating the absence of $G \times E$ interaction. Two hybrids were found to have both b_i and \bar{S}_{di}^2 significant, indicating the presence of both linear and non-linear components of $G \times E$ interaction. However, only one hybrid and one parent were found to have significant b_i , indicating the presence of linear component. Fifteen hybrids, five parents and check MFSH 4 were found to have significant \bar{S}_{di}^2 , indicating the presence of non-linear component.

Green fodder yield per plant

Out of 36 genotypes only eight hybrids, four parents and checks (SSG 59-3 and MFSH 4) had both b_i and \bar{S}_{di}^2 non significant, indicating the absence of $G \times E$ interaction. Four hybrids alongwith two parents were found to have both b_i and \bar{S}_{di}^2 significant, indicating the presence of both linear and non-linear components of $G \times E$ interaction. Two hybrids and one parent were found to have significant b_i , indicating the presence of linear component. Ten hybrids and three parents were found to have significant \bar{S}_{di}^2 , indicating the presence of non-linear component.

Dry fodder yield per plant

A critical examination of the results revealed that out of 36 genotypes only six hybrids, four parents and check SSG 59-3 had both b_i and \bar{S}_{di}^2 non significant, indicating the absence of $G \times E$ interaction. Five hybrids were found to have both b_i and \bar{S}_{di}^2 significant, indicating the presence of both linear and non-linear components of $G \times E$ interaction. Four hybrids and two parents were found to have significant b_i , indicating the presence of linear component. Nine hybrids, four parents and check MFSH 4 were found to have significant \bar{S}_{di}^2 , indicating the presence of non-linear component.

Number of tillers per plant

Results revealed that ten hybrids and four parents had both b_i and \bar{S}_{di}^2 non significant, indicating the absence of $G \times E$ interaction. Two hybrids were found to have both b_i and \bar{S}_{di}^2 significant, indicating the presence of both linear and non-linear components of $G \times E$ interaction. One hybrid was found to have significant b_i , indicating the presence of linear component. Eleven hybrids, six parents and both the check MFSH 4 and SSG 59-3 were found to have significant \bar{S}_{di}^2 , indicating the presence of non-linear component.

Leaf length

A critical examination of the results revealed that out of 36 only four hybrids and check MFSH 4 had both b_i and \bar{S}_{di}^2 non significant, indicating the absence of $G \times E$ interaction. Seventeen hybrids and five parents were found to have both b_i and \bar{S}_{di}^2 significant, indicating the presence of both linear and non-linear components of $G \times E$ interaction. One hybrid was found to have significant b_i , indicating the presence of linear component. Two hybrids, five parents and checks SSG 59-3 were found to have significant \bar{S}_{di}^2 , indicating the presence of non-linear component.

Leaf breadth

Results revealed that five hybrids, four parents and check SSG 59-3 had both b_i and \bar{S}_{di}^2 non significant, indicating the absence of $G \times E$ interaction. Three hybrids and one parent were found to have both b_i and \bar{S}_{di}^2 significant, indicating the presence of both linear and non-linear components of $G \times E$ interaction. Sixteen hybrids, five parents and check MFSH 4 were found to have significant \bar{S}_{di}^2 , indicating the presence of non-linear component.

Stem diameter

Out of 36 genotypes (24 hybrids, 10 parents and 2 checks) only three hybrids, one parent and checks (SSG 59-3 and MFSH 4) had both b_i and \bar{S}_{di}^2 non significant, indicating the absence of $G \times E$ interaction. Only four hybrids and two parents were found to have both b_i and \bar{S}_{di}^2 significant, indicating the

presence of both linear and non-linear components of $G \times E$ interaction. Three hybrids and one parent were found to have significant b_i , indicating the presence of linear component. Fourteen hybrids and six parents were found to have significant \bar{S}_{di}^2 , indicating the presence of non-linear component.

It further revealed that hybrids reacted differently in different environments. This indicated that the environments were significantly different and warranted for estimation of $G \times E$ 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	\bar{S}_{di}^2
Green fodder yield (g/plant)	467A × IS 2389	327.08	1.08	0.15
	465A × G 46	306.67	0.93	0.39
Dry fodder yield (g/plant)	31A × IS 2389	98.33	1.06	0.62
	467A × IS 2389	101.25	1.31	0.23
Plant height (cm)	9A × G 46	143.88	0.97	0.09
Number of tillers per plant	465A × HJ 541	1.58	1.09	0.01
	465A × G 46	1.33	1.09	0.14
Leaf length (cm)	9A × HJ 513	72.08	1.04	0.42
	467A × HJ 513	77.21	1.07	0.26
Leaf breadth (cm)	31A × HJ 541	6.75	1.04	0.62
Stem diameter (cm)	9A × IS 2389	16.00	1.09	0.69
	14A × G 46	13.63	0.94	0.38

Hybrids 465A × G 46 and 467A × IS 2389 for green fodder yield and hybrid 31A × IS 2389 for dry fodder yield were found stable, average responsive and suitable for all the test environments (Table 1). Hybrids 9A × G 46 for plant height and hybrids 465A × HJ 541 and 465A × G 46 for number of tillers per plant were found stable, average responsive and suitable for all the test environments. In case of leaf length, hybrids 9A × HJ 513 and 467A × HJ 513 were found to be stable and for leaf breadth hybrid 31A × HJ 541 was found stable, average responsive and suitable for all the test environments whereas for stem diameter hybrids 9A × IS 2389 and 14A × G 46 were found stable and suitable for all the test environments for stem girth. Similar results have been reported by Reddy et al. (2004), Mukri (2007), Kher et al. (2008), Sharanabasappa (2009) and Sameer et al. (2010).

Among the female parents 9A and 14A and among the male parents HJ 513 and G 46 were

good general combiners for fodder yield and component traits. Hence, these parents may be used in development of commercial hybrids for fodder yield. Hybrids 465A × HJ 513 and 9A × IS 2389 may be further tested at multilocations and if found better may be released as these had high SCA effects for green and dry fodder yield and were also stable.

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