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STABILITY OF NEWLY DEVELOPED GENOTYPES IN *KHARIF* SORGHUM (*Sorghum bicolor* (L.) Moench)

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ABSTRACT

A study was conducted during *kharif* 2015–17 to evaluate newly developed promising sorghum [*Sorghum bicolor* (L.) Moench] genotypes to identify suitability for dual purpose under rain-fed condition of Gujarat. Genotype × environment interactions in 5 sorghum genotypes were studied over different agro-climatic conditions of Gujarat (15 environments) for grain and fodder yields. Significant differences were observed among environments and varieties for the characters. The G × E interaction for the characters was significant and the significant mean squares due to environment (linear) indicated the existence of real varietal differences in characters for regression over the environmental mean. The genotype DS 127 found higher yielder and most stable and found suitable for recommendation for release as dual purpose under rainfed condition of Gujarat.

(Key words: *kharif* sorghum, Deviation from regression, Genotypes, G × E interaction, Regression co-efficient)

INTRODUCTION

Genotype × environmental interaction has great significance in evaluating crop varieties over a wide range of environmental conditions. The information on G × E interaction leads to successful evaluation of stable genotypes which could be used either for general cultivation or in future breeding programme. Sorghum or Great millet [*Sorghum bicolor* (L.) Moench] is one of the major staple foods for the poorest and most food insecure people across the semi-arid tropics of the world. It is grown for a variety of uses like food, feed, forage and fuel. Besides being an important food, feed, and forage crop. It provides raw material for the production of starch, fiber, dextrose syrup, biofuels, alcohol, and other products. Sorghum was domesticated in African continent, particularly in Ethiopia, from where it was introduced to other regions of the world with diverse agro climatic conditions. *Sorghum bicolor* ssp. *Verticilli florum* is believed to be the progenitor of cultivated sorghum. The major states in the country where this cereal grain is produced are Maharastra, Karnataka, Andhra Pradesh, Madhya Pradesh, Gujarat and Rajasthan. In Gujarat, sorghum is grown as grain crop in South Gujarat, dual purpose in North Gujarat, Kutchh, and Saurashtra and partly as fodder in dairy developed area which occupies on an average about 1.80 lakh hectares. The productivity is 1338 kg ha^{-1}. In spite of low productivity of *kharif* sorghum in Gujarat it continues to be an important component for feed and fodder for dairy cattle's of Gujarat with fairly consistent area over many years. One of the major reasons for instability in yield of dual sorghum is due to the non-availability of stable dual sorghum genotypes in Gujarat. The present study, therefore, was undertaken to evaluate promising newly developed sorghum genotypes over different agro climatic conditions of Gujarat in order to identify stable genotypes for high grain and fodder yields.

MATERIALS AND METHODS

The experimental material consisting of three newly developed dual sorghum genotypes viz., DS -105 (C 43 x ICSR 160), DS-123 (NR 37 x ICSR 143) and DS-127 (AKR 354 x SPV 1616) with two commercial check varieties GJ-39 and CSV-20 were grown in a randomized block design with 3 replications across different locations of Gujarat (Deesa, Bhiloda, Adiya, Surat, Viramgam, Waghai, Mangrol, and Acchaliya) during *kharif* season of 2014-2015 to 2016–17 under rainfed conditions. Detail features of testing locations are given in table 1. During all the three years, the crops were sown during June-July depending on the onset of monsoon at the particular location. In each location, the experiment was conducted in randomized block design with six rows each of 6 m length with 45 x 15 cm^2 crop geometry. Crop management practices were standard across all locations. Yield data were recorded at physiological maturity. Plot yield data were converted to kg/quintal ha^{-1} using the plot size as factor. The data recorded for 3 seasons at different locations were analyzed for stability parameters as per the method suggested by Eberhart and Russell (1966).

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Table 1. Information on the trial environments

Sr. No.	Site	Elevation (msl)	Latitude	Longitude	Average Rainfall (mm)
1	Deesa	136.00	24.50	72.00	400
2	Adiya	82.08	23.46	72.00	600
3	Bhiloda	204.00	23.76	73.24	450
4	Viramgam	36.5	23.05	72.09	576
5	Surat	12.00	20.12	72.52	1247
6	Waghai	122.11	20.77	73.50	2410
7	Mangrol	19.64	21.24	73.60	750
8	Achaliya	38.00	21.97	73,18	1150

RESULTS AND DISCUSSION

Because of genotype environment interactions, a variety does not perform consistently in different agro-climatic situation. These types of situation pose serious difficulty to plant breeders in making proper assessment of varieties when the same are compared over a series of environments. The G x E interactions had been emphasized by Johnson *et al*. (1955) in selection of soybean. Comstock and Moll (1963) statistically confirmed that effect of large G x E interaction could reduce progress from selection. Hence, knowledge of kind and magnitude of G x E interaction had become essential to plant breeder in taking the decisions concerning breeding methods. Even though, stratification of the environment to reduce the G x E interaction and enhance the precision in selection, the interaction of genotype with location in a sub region and with environments within the same year remains very large (Allard and Bradshaw, 1964). Even, if we know the factors responsible for interaction, we can reduce materially these factors up to certain limit in the field experiments (Sprague, 1966). The results of stability in present study is summarized and concluded as under.

The analysis of variance for stability (Table 2) revealed significant differences among environments and genotypes for all the characters suggesting the presence of variation among genotypes and environments. The genotype × environment (G × E) interaction for grain and fodder yield was found significant. The significant mean squares due to environment (linear) indicated the existence of real varietal differences in the characters for regression over environmental mean.The significant values for G x E interaction, mean square due to environment (linear) and pooled deviation were observed by Borole *et al*. (2007), Patil *et al*. (2007), Prabhakar, *et al*., (2010) and Sujatha *et al*., (2016) for yield and yield contributing traits in *rabi* sorghum, which indicate the existence for real varietal differences in characters for regression over the environmental mean. These findings are close agreement with present study. The values of environmental index are given in table 3. The means (x) for grain and fodder yields along with 2 stability parameters, viz., regression co-efficient (bi) and deviation from regression (s2di) are presented in Table 4. Among the 15 environments, Environment 13 (Waghai, *kharif* 2017), environment 3 (Surat, *kharif* 2017), environment 4 (Deesa, *kharif* 2015), environment 1 (Deesa, *kharif*) and environment 2 (Adiya, *kharif* 2015) with high positive values of environmental indices (1223.995, 961.455, 956, 149, 912.258 and 738.25, respectively) appeared suitable for better exploitation of grain yield of *kharif* sorghum (Table 2). Good rains received during crop season helped the genotypes to perform better. The environment 6 (Surat, *kharif* 2016) followed by environment 7 (Adiya, *kharif* 2016), environment 14 (Mangrol, *kharif* 2017) and environment 15 (Achhaliya, *kharif* 2017) with high negative value of environmental index (-1559.16, -954.659, -784.88 and-526.941, respectively) were not suitable as there was unfavorable environment experienced during the crop period. The genotype which gave higher mean grain yields over different years and locations was DS 127 (2636.881 kg ha^{-1}).The results indicated that the genotype DS 127 was found most stable, since it showed regression co-efficient values (bi= 1.06) near to unity, least non-significant deviation from regression (s2di values) and higher mean grain yield (Table 3).

For fodder yield among the 15 environments, environment 3 (Surat, *kharif* 2015), environment 4 (Deesa, *kharif*, 2016), environment 9 (Deesa, *kharif* 2017),

Table 2. Analysis for stability in *kharif* sorghum genotypes for grain and fodder yield over fifteen environments

Source of Variations	DF	Grain yield	Fodder yield
Rep. within Env.	30	46760.35	285.3275
Varieties	4	1623334**	6723.863**
Env.+ (Var.* Env.)	70	814908.7**	3042.851**
Environments	14	3305843**	12939.3**
Var.* Env.	56	192175.1	568.7396
Environments (Lin.)	1	46281808**	181150.1**
Var.* Env.(Lin.)	4	449119.5*	903.8736
Pooled Deviation	65	137928.1**	434.368**
Pooled Error	120	29769.35	111.9531
Total	74	858607.4	3241.824

*, ** Significant at 5% and 1% level, respectively.

Table 3. Environmental Index in *kharif* sorghum genotypes for grain and fodder yield for different environments

Sr. No.	Environment	Environmental Index	
		Grain yield	Fodder yield
1	Deesa, *kharif* 2015	912.258	5.477
2	Adiya, *kharif* 2015	738.251	31.987
3	Surat, *kharif* 2015	961.445	94.393
4	Deesa *kharif*, 2016	956.149	86.904
5	Bhiloda, *kharif* 2016	-377.459	-33.391
6	Surat, *kharif* 2016	-1559.16	-37.113
7	Adiya, *kharif* 2016	-954.659	-44.198
8	Viramgam, *kharif* 2016	-281.711	29.444
9	Deesa, *kharif* 2017	37.583	47.291
10	Bhiloda, *kharif* 2017	12.408	-7.207
11	Viram gam, *kharif* 2017	-80.925	21.404
12	Surat , *kharif* 2017	-276.357	-22.687
13	Waghai, *Kharif* 2017	1223.995	-50.551
14	Mangrol, *Kharif* 2017	-784.88	-70.194
15	Achhaliya, *Kharif* 2017	-526.941	-51.557

Table 4. Stability parameters for *grain* and fodder yield in promising *kharif sorghum* genotypes

Sr.No.	Genotype	Grain yield (kg ha^{-1})			Fodder yield (q ha^{-1})		
		Mean	bi	s²di	Mean	bi	s²di
1	DS 105	1891.886	1.05	65218*	113.179	0.9	562.48**
2	DS 123	1910.493	0.62	183498**	159.786	1.26	496.21**
3	DS 127	2636.881	1.06	11127	137.511	1.01	17.28
4	GJ 39	1851.415	1.18	137235**	107.947	0.85	182.82*
5	CSV 20	2163.619	1.09	26582*	119.557	0.98	179.92*

environment 2 (Adiya, *kharif* 2015), environment 8 (Viramgam, *kharif* 2016), environment 11 (Viramgam, *kharif* 2017) and environment 1 (Deesa, *kharif* 2015) with high positive values of environmental indices (94.393 , 86.90, 47.291, 31.987, 29.444 9, 21.404 and 5.477, respectively) appeared suitable for better exploitation of fodder yield of *kharif* sorghum. Good rains received during crop season helped the genotypes to perform better. The environment 14 (Mangrol, *kharif* 2017), environment 15 (Achhaliya, *kharif* 2017), environment 13 (Waghai, *kharif* 2017), environment 7 (Adiya, *kharif* 2016), environment 6 (Surat, *kharif* 2016), environment 5 (Bhiloda, *kharif* 2016), environment 12 (Surat, *kharif* 2017) and environment 10 (Bhiloda, *kharif* 2017) with high negative value of environmental index (-70.194, -51.557, -50.551, -44.198, -37.113, -33.39, -22.687 and -7.207, respectively) were not suitable due to unfavorable environment experienced during the crop period (Table 3). The genotypes which gave higher mean fodder yields over 3 years at different locations were DS-123 (159.786 q ha^{-1}) and DS-127 (137.511 q ha^{-1}). However the results indicated that the genotype DS-127 was found most stable, since it showed regression co-efficient values (bi=1.01) near to unity, least non significant deviation from regression (s2di values) and higher mean fodder yield. The highly unstable variety was DS-123 since it showed regression co-efficient values (bi=1.26) higher then unity and significant deviation from regression. Thus, it can be concluded for improvement of grain and fodder yield, the variety DS-127 was the most stable under rainfed situation at different locations and this variety can be released as dual purpose for enhancing the *kharif* sorghum productivity and provide feed and fodder security to animals in rainfed areas of Gujarat state.

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