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Stability in performance of marvel grass genotypes (*Dichanthium annulatum*) under north western arid rangeland

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Abstract

The study was conducted during *kharif* season of 2006, 2007 and 2008 to test the stability of genotypes of marvel grass (*Dichanthium annulatum*). Pooled analysis of variance on five characters was carried out individually as well as pooled over the years. Genotype x environment interaction was significant for all the characters included in the study. Significant G x E (linear) for all the characters indicated presence of substantial amount of predictable G x E interaction. All seven genotypes were tested for three stability parameters, *viz*, mean, bi and S^2di. It indicated that direct selection for plant height and green fodder yield along with simultaneously selection for tillers per plant will be responsive for improvement of dry fodder yield and seed yield per plant. The results provide useful information to aid the choice of marvel grass genotypes in north western arid area of Gujarat. CAZRI-BH-DA-3 and CAZRI-BH-DA-2 should be included in any breeding programme where objective is to develop high-yielding stable genotype over the environment.

Keywords: *Dichanthium annulatum,* Fodder, G x E interaction, Genotypes, Perennial grasses, Rangeland, Selection, Stability

Introduction

Marvel grass (*Dichanthium annulatum* (Forssk.) Stapf) is a highly preferred forage grass in India. Being indigenous to the Indian and African gene centre, it shows maximum genetic diversity in India and South Africa (Mehra and Magoon, 1974). Out of the 20 species of the genus *Dichanthium* reported from the tropics and subtropics, India has 8 species distributed in various agro- ecological zones (Arora *et al*., 1975) but only two species, *viz*. *D. annulatum* (Forssk.) Stapf and *D. caricosum* (L.) A. Camus, are widely used for large scale forage production. Marvel grass is commonly distributed throughout the plain and hills of India up to 1500 m altitude (Gupta and Shankar, 1995). It has a wide range of adaptations from low rainfall areas in Rajasthan and Gujarat states to heavy rainfall areas of western and southern India (Kanodia, 1987). It forms the dominant species of *Dichanthium- Cenchrus-Lasiurus* grass cover which is spread over an area of about 436,000 km², including northern parts of Delhi, Aravalli ranges, parts of Punjab, almost whole Rajasthan, Gujarat and southern Uttar Pradesh. (Anonymous, 2007).

Kachchh, the largest and the western most district of Gujarat state, has a very different terrain. Recurring drought, periodic seismicity, vast areas under salt marshes and ranns, undulating rocky terrain, shallow soil, high exploitation of potable ground water and depleting biodiversity pose serious threats to sustainable use of the land in the district (Devidayal *et al*., 2009). Most often, livestock is the only source of cash income for subsistence farms and also serves as insurance in the event of crop failure under this fragile ecosystem. The available forages are poor in quality, being deficient in available energy, protein and minerals. One of the important constraints in achieving higher forage yield is non-availability of stable genotypes under varied environments. To increase and stabilize the production and productivity, identification of suitable genotypes with high forage yield potential is of paramount importance. Stability analysis helps in understanding the genotypic adaptation under variable environmental changes. Thus use of highly adaptable genotypes is important in stabilizing forage crop productivity over seasons.

Materials and Methods

The present experiment was carried out at the research farm of Central Arid Zone Research Institute, Regional Station, Kukma, Bhuj (at 22^0 41ô11öto 24^0 41ô47öN and 68^0 9ô46öto 71^0 54ô47öE) during *kharif* season of 2006,

2007 and 2008. The area received 689.4 mm, 701.60 mm and 315 mm, rainfall, during May to October of the years 2006, 2007 and 2008, respectively. The soil of the experimental site was gravelly sand to loamy sand in texture with shallow depth (21 cm), low in organic C (0.38%), available N (214 kg/ha), P (7.0 kg/ha), and medium in available K (138.3 kg/ha) with a pH of 8.7. The range grass crop was raised strictly under rainfed conditions with basal dose of 45 kg N and 20 kg P_2O_5/ ha. The germplasm CAZRI- BH - *DA*- 1, CAZRI- BH -*DA* ï 2, CAZRI- BH - *DA* ï 3, CAZRI- BH ï *DA*- 4, CAZRI- BH *DA* ï 6 were collected from Naliya, Rapar, Khavda, Bhirandiyara, Sumrasar and Dhurvana of Kachchh region respectively and established in nursery during *kharif* season of 2005. Seven germplasm lines including one check GMG 1 were evaluated in a randomized block design with three replications. Each genotype was grown in 4 rows of 5 m length/ replication with row-to-row distance of 75 cm and plants spaced at 50 cm apart. The observations were recorded on 5 competitive plants from each plot for morphological characters, *viz*., plant height (cm), number of tillers per plant, green fodder yield (kg/ ha), dry fodder yield (kg/ha) and seed yield (kg/ha). The mean values were used for statistical analysis. Analysis of variance in respect of various characters was done as suggested by Panse and Sukhatme (1978). Genotype x Environment interaction were found to be significant in respect of all the characters studied, hence the data were subjected to stability of different genotypes. To identify the stable genotypes Eberhart & Russel (1966) model was used.

Results and Discussion

For each environment, analysis of variance on five characters was carried out individually as well as pooled over the years. Analysis of variance revealed significant differences amongst genotypes for all the observed characters in each of the three environments. Pooled analysis of variance over the three environments was also carried out in order to verify presence of G x E interactions. G x E interactions variance was significant for all the observed characters. Variance due to genotype was also significant for all the observed characters. Variance due to environment was also significant for all the observed characters. These results indicated presence of substantial amount of genotype x environment interaction. Stability analysis was carried out as per Eberhart and Russell (1966) model for all the observed characters in order to identify the stable genotypes for yield and related traits over the years. Samuel *et al* (1970) and Paroda and Hays (1971) emphasized that linear regression (b_i) could simply be regarded as a measure of response of a particular genotype, where the deviation around regression line (S^2_{di}) is the most appropriate measure of stability. According to model a genotype with b_i =1 and lowest deviation around regression line could be termed most stable and vice- versa. Thus, it was possible to judge the stability of genotypes, with due consideration to their mean performance and linear response.

Genotype x environment interaction was significant for plant height, number of tillers per plant, green fodder yield , dry fodder yield and seed yield indicating that genotypes are varying over the environment due to G x E. The significant G x E interaction has been reported for various traits by Roy *et al*. (1995), Purushotham *et al*. (2002), which confirm the finding of present investigation. The genotype x environment interaction was highly significant for all the characters studied. As the environments selected in the present study were diverse (three consecutive year), the presence of significant G x E for characters indicated the relevance of the stability analysis. Genotypes CAZRI -BH-DA-2, CAZRI-BH-DA-3 and CAZRI-BH-DA-4 were stable-responsive and had high performance for plant height (cm), number of tillers per plant, green fodder yield (kg/ha) over respective population mean (Table 1). Similarly, range was wider amongst all the genotypes tested. The result indicated that genotype CAZRI-BH-DA-2, CAZRI-BH-DA-3, and CAZRI-BH-DA-4 expressed relatively wider range for character plant height, green fodder yield and dry fodder yield. The genotype CAZRI-BH-DA-2 attained more plant height along with regression coefficient equivalent to unity and S^2di near to zero considered as stable. The genotype CAZRI-BH-DA-3 had attained maximum plant height along with regression coefficient near to unity, exhibit average stability. The stability parameters for number of tillers per plant revealed that genotype CAZRI- BH- DA-4 had higher mean number of tillers per plant compared to general mean along with regression coefficient near to unity considered as average stable and desirable genotype. The genotype CAZRI-BH-DA-3 recorded maximum mean green fodder yield along with regression co-efficient near to unity, exhibiting average stability. Genotype CAZRI-BH-DA-2 had high green fodder yield to general mean along with regression co-efficient near to unity was considered as average stable and desirable. The stability parameters for dry fodder yield revealed that genotype CAZRI- BH-DA-3 had higher mean dry fodder yield to general mean along with non- significant regression coefficient and deviation from regression coefficient showing average response and stability (Table 2). The genotype CAZRI - BH-DA-2 recorded high mean

Table 1: Stability parameters of different genotypes for forage yield and yield attributing characters in *Dichanthium annulatum*

Genotype	Plant height (cm			Number of tillers per plant			Green fodder yield (kg/ha)		
	Mean	b_i	S^2_{di}	Mean	b_i	S^2_{di}	Mean	b_i	S^2_{di}
CAZRI- BH - *DA* - 1	98.37	-0.10	205.58*	60.89	2.33*	1553.27**	3677.26	-0.19	7896.00**
CAZRI- BH - *DA* - 2	113.43	0.79*	4.72	40.16	0.52*	8.18	4043.61	1.12*	2759.73**
CAZRI- BH - *DA* - 3	125.94	1.13*	107.84*	48.69	0.05	46.58*	6508.56	-0.79*	3640.00**
CAZRI- BH - *DA* - 4	113.49	1.57*	315.65*	45.29	0.89*	52.55*	5427.55	4.86*	25076.00**
CAZRI- BH - *DA* - 5	94.95	1.60*	75.90*	25.47	1.23*	247.04*	2685.62	1.47*	4013.40**
CAZRI- BH - *DA* - 6	107.58	0.48*	230.16*	33.04	-0.17	98.20*	2637.33	0.85*	5782.70**
GMG 1 (C)	99.65	1.53*	384.00**	56.92	2.15*	2568.17**	2503.70	0.92*	146.99*
Population mean	107.63			44.35			3926.23		

* and ** Significant at 5 and 1 per cent level of significance, respectively

Table 2: Stability parameters of different genotypes for forage yield and yield attributing characters in *Dichanthium annulatum*

Genotype	Dry fodder yield (kg/ha)			Seed yield (kg/ha)		
	Mean	b_i	S^2_{di}	Mean	b_i	S^2_{di}
CAZRI- BH - *DA* - 1	2547.61	-1.35*	4763.40**	160.68	-1.10*	541.98**
CAZRI- BH - *DA* - 2	3072.09	1.72*	1624.35**	167.81	1.70*	-2.15
CAZRI- BH - *DA* - 3	3467.11	-0.34*	1413.29**	183.70	-0.10	52.03*
CAZRI- BH - *DA* - 4	2757.92	2.46*	1325.50**	171.68	2.79*	337.49*
CAZRI- BH - *DA* - 5	1944.56	2.44*	0716.44**	154.70	1.56*	5.21
CAZRI- BH - *DA* - 6	1691.35	1.12*	96.17*	155.40	0.32*	-22.97*
GMG 1 (C)	1712.43	0.61*	866.03**	143.16	1.83*	-8.73
Population mean	2456.15			162.45		

* and ** Significant at 5 and 1 per cent level of significance, respectively

seed yield to general mean along with regression coefficient near to unity and S^2di near to zero exhibiting the stability, therefore, their performance was stable and desirable. While genotype CAZRI-BH-DA- 3 had maximum seed yield along with non- significant regression coefficient and deviation from regression showing average response and stability.

The results suggest that the green fodder yield and plant height are the stable traits in the tested marvel grass potential to respond better in favourable growing conditions. CAZRI-BH-DA-3 and CAZRI-BH-DA-2 should be included in any breeding programme where objective is to develop high-yielding stable genotype over the environment. Moreover, based on the results of present study, it is revealed that in segregating generations of such crosses including these parents, direct selection for plant height and green fodder yield along with simultaneously selection for tillers per plant will be responsive for improvement of dry fodder yield and seed yield per plant.

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