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Study of variability parameters in forage sorghum [*Sorghum bicolor* (L.) Moench]

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Abstract: The present experiment was carried out with 126 diverse genotypes of forage sorghum including two checks (SSG-59-3 and SMU-1) in Randomized Block Design with three replications during *kharif*, 2013. Observations were recorded for 24 characters. GCV ranged from 7.10 to 37.19 % with 6.5 SD and was high (> "mean + SD" *i.e.* >20.92) for stem juiciness (37.19). The magnitude of PCV ranged from 10.23 to 50.57 with 9.40 SD and was high (mean + SD, *i.e.* >34.2) for stem juiciness (50.57). Heritability (h^2) was high (mean +SD, *i.e.* >54.58) for number of leaves per plant (74.05) and medium (in between mean + SD, >15.32 to <54.58) for stem juiciness (54.09). The expected genetic gain was high ("mean +SD", *i.e.* >29.22) for stem juiciness (54.35). Most selection responsive character was stem juiciness as it was having higher GCV, PCV and genetic gain and moderate heritability (h^2). On the basis of heritability and genetic gain, selection criteria based on number of leaves per plant, leaf length leaf breadth, stem juiciness, protein per cent may be useful for further developing good quality and high yielding forage sorghum cultivars.

Keywords: Forage sorghum, Variability, GCV, PCV, Heritability and Genetic gain

Introduction

Sorghum bicolor (L.) Moench is one of the gifted genera of the tropical regions that provide food, feed, fodder and fuel to millions of poor farmer families and their livestock's. It is one of the most important crops in the world because of its adaptation to a wide range of ecological conditions, suitability for low input cultivation and diverse uses (Doggett, 1988). It occupies 5th place among the food grains after wheat, rice, maize and barley in terms of production and acreage**.** In India, it covers about 6.18 m hectares with an annual grain production of 5.28 m tonnes and productivity of 854.4 kg/ha (Anonymous, 2013). The major sorghum growing states in our country are Maharashtra, Karnataka, Madhya Pradesh, Andhra Pradesh, Rajasthan, Tamil Nadu, Uttar Pradesh and Gujarat. In Rajasthan, sorghum is primarily cultivated either for dual purpose or exclusively for fodder. Basically it is a fodder crop with limited regeneration ability, a trait essential for taking a multicut crop. Before planning of any breeding programme, the assessment of genetic variability is primary requirement. Creation of genetic variability and selection for important traits is a crucial activity that any plant breeder should apply to achieve better yield and other desirable agronomic traits. However, to carry out effective selection, the information on available genetic variation among sorghum genotypes, the nature of component traits on which selection would be effective and the influence of environmental factors on each trait need to be known (Jaleta *et al.,* 2011).

Keeping the above view in mind, this study was done with the objective to assess the Genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability and genetic advance of grain yield and some of its related components to select a more desired trait that may contribute for the improvement of forage sorghum.

Material and methods

The experimental material consists of 126 diverse genotypes of forage sorghum along with two checks i.e. SSG-59-3 and SMU-1 provided by All India Coordinated Research Project on Sorghum, Department of Plant Breeding and Genetics, Rajasthan College of Agriculture, Udaipur. The experimental material was planted in a Randomized Block Design (RBD) with three replications. Each genotype had one row of 4.5 Meter length, spaced at 30 cm. Plant to plant distance was kept 10 cm. All the recommended cultural and plant protection practices were adopted for raising the crop. The data were recorded on five competitive randomly selected plants for each genotype in each replication. Observations were recorded for 24 characters. The mean value of the recorded data was subjected to analysis of variance (ANOVA) using the statistical analysis procedures of Panse and Sukhatme (1985). The phenotypic and genotypic variances were also estimated according to the method suggested by Burton (1952). Heritability (h^2) in broad sense for all characters was computed using the formula adopted by Lush (1940). Genetic gain for each character was computed using the formula by Johnson *et al.* (1955).

Results and Discussion

The result of analysis of variance on 24 quantitative characters for the genotypes is presented in table1. In the present

Table-1: Mean square for twenty four characters in forage sorghum

Characters	Replication	Genotype	Error
	[2]	[125]	[250]
Green fodder yield (q.ha^{-1}) I cut	11836.50	17153.68**	11510.00
Green fodder yield (q.ha^{-1}) II cut	1868.79	6689.33**	3157.00
Green fodder yield (q.ha^{-1}) III cut	194.27	217.31	254.30
Green fodder yield over 3 cuts	6850.87	23416.32**	14400.00
Dry fodder yield (q.ha^{-1}) I cut	3214.34	5769.75**	2755.00
Dry fodder yield (q.ha^{-1}) II cut	0.19	0.67**	0.32
Green fodder yield per day (q.ha^{-1}) I cut	3.16	4.61**	3.09
Green fodder yield (q.ha^{-1}) day (q.ha^{-1}) II cut	0.91	3.31**	1.56
Green fodder yield (q.ha^{-1}) /day (q.ha^{-1}) III cut	0.1	0.11	0.13
Dry fodder yield per day (q.ha^{-1}) I cut	0.86	1.55**	0.74
Dry fodder yield per day (q.ha^{-1}) II cut	0.00	0.0004**	0.00
Early vigor	10.10**	0.73**	0.34
Regeneration ability	5.11**	1.13**	0.56
Plant height	15698.72**	938.86	813.30
Number of leaves per plant	17.18**	5.37**	0.56
Leaf length (cm)	547.52**	241.74**	33.92
Leaf breadth (cm)	1.52*	2.88**	0.44
Leaf: stem ratio	0.04**	0.01**	0.00
Stem girth (cm)	1.22**	0.01	0.01
HCN content	1604.02**	260.89	227.20
Stem Juiciness	1.16*	1.72**	0.38
Total soluble solids (%)	15.73**	3.18*	2.28
Protein percent	35.04**	2.82**	0.65
plant population at harvest	103.66	2.82	42.50

Table-2: Estimates of genotypic (GCV) and phenotypic (PCV) coefficients of variation, heritability (h^2), genetic gain (GG) of seventeen traits of forage sorghum

Characters	GCV	PCV	h^2	GG
Green fodder yield I cut	7.10	18.95	14.05	5.48
Green fodder yield II cut	15.81	30.34	27.16	16.97
Dry fodder yield I cut		11.25	21.76	26.72
11.98				
Dry fodder yield II cut	15.81	30.34	27.16	16.97
Green fodder yield per day I cut	7.10	18.94	14.06	5.49
Green fodder yield per day II cut	15.82	30.35	27.17	16.99
Dry fodder yield per day I cut	11.25	21.76	26.74	11.99
Dry fodder yield per day II cut	17.14	32.61	27.62	18.56
Early vigor score	10.56	20.04	27.78	11.47
Regeneration ability score	16.22	32.20	25.37	16.83
Number of leaves per plant	14.65	17.03	74.05	25.97
Leaf length	8.38	10.23	67.13	14.14
Leaf breadth	17.05	21.16	64.92	28.30
Leaf: stem ratio	8.23	16.21	25.78	8.61
Stem juiciness	37.19	50.57	54.09	56.35
Total soluble solids	10.41	30.66	11.53	7.28
Protein percent	13.53	18.61	52.86	20.26

investigation, Mean square due to genotypes were significant for 17 characters out of 24. Therefore, variability parameters were calculated for these 17 characters only. Mean square of the character showed significant difference among the tested genotypes indicating the presence of variability which can be exploited through selection. In general, estimates of phenotypic coefficient of variation (PCV) were slightly higher than corresponding genotypic coefficient of variation (GCV) indicating role of environment in the expression of the characters. Similar findings were reported by Median and Choudhary (1980) and Godbharle *et al.* (2010) in sorghum.

The magnitude of GCV ranged from 7.10 to 37.19 per cent with 6.5 SD. On account of skewed distribution of GCV characters were classified only in two categories either greater than "mean +SD" or in between "mean+SD". No character was fallen in "Mean – SD" category. GCV was high (> "mean + SD" *i.e.* >20.92) for stem juiciness (37.19) and medium (in between "mean SD") for all other characters. Among medium GCV characters maximum GCV was for dry fodder yield per day II cut (17.14) followed by leaf breadth (17.05), regeneration ability (16.22), green fodder yield per day II cut (15.82), green fodder yield II cut (15.81), dry fodder yield II cut (15.81), number of leaves per plant (14.65), protein per cent (13.53), dry fodder yield per day I cut (11.25), dry fodder yield per day I cut (11.25), early vigor (10.56), total soluble solids (10.41), leaf length (8.38), leaf: stem ratio (8.23), green fodder yield I cut (7.10) and green fodder yield per day I cut (7.10).

The magnitude of PCV ranged from 10.23 to 50.57 with 9.40 SD. The same criteria was used for classification of characters on the basis of mean and SD. The PCV was high (>mean + SDi.e. > 34.2) for stem juiciness (50.57) and medium (in between mean+SD *i.e.* >15.4 to <34.2) for dry fodder yield per day II cut (32.61), regeneration ability score (32.20), total soluble solids (30.66), green fodder yield per day II cut (30.35), green fodder yield II cut (30.34), dry fodder yield II cut (30.34), dry fodder yield I cut (21.76), dry fodder yield per day I cut (21.76), leaf breadth (21.16), early vigor score (20.04), green fodder yield I cut (18.95), green fodder yield per day I cut (18.94), protein percent (18.61), number of leaves per plant (17.03) and leaf: stem ratio (16.21), and was low (mean–SD,15.4) for leaf length (10.23).

The efficiency of selection depends upon heritable portion of variability. In the present study heritability in broad sense was calculated. Heritability (h^2) was high (>mean +SD *i.e.* >54.58) for number of leaves per plant (74.05), leaf length (67.13) and leaf breadth (64.92); medium (in between mean+SD *i.e.* >15.32 to <54.58) for stem juiciness (54.09), protein percent (52.86), early vigor (27.78), dry fodder yield per day II cut (27.62), green fodder yield per day II cut (27.17), green fodder yield II cut (27.16), dry fodder yield II cut (27.16), dry fodder yield per day I cut (26.74), dry fodder yield I cut (26.72), leaf: stem ratio (25.78) and regeneration ability (25.37); and low (mean -SD,15.32) for green fodder yield per day I cut (14.06), green fodder yield I cut (14.05) and total soluble solids (11.53). High heritability was also reported by Veerabadhiran and Kennedy (2001) and Shinde *et al.* (2010) for number of leaves per plant and, Singh *et al.* (2010) and Jain and Patel (2012) for leaf length.

The ultimate aim of studying the variability and heritability of any trait is to have an idea about the feasibility of selection. The improvement in the mean performance of progeny of the selected families over the base population is known as genetic advance, when expressed as per cent of mean is called genetic gain (Johnson, 1955). The expected

genetic gain was high (>"mean +SD" *i.e.* >29.22) for stem juiciness (54.35); medium (in between "mean+SD *i.e.* >5.32 to <29.22) for leaf breadth (28.30), number of leaves per plant (25.97), green fodder yield II cut (16.97), dry fodder yield I cut (11.98), dry fodder yield II cut (16.97), green fodder yield per day II cut (16.99), dry fodder yield per day I cut (11.99), dry fodder yield per day II cut (18.56), early vigor (11.47), regeneration ability (16.83), leaf length (14.14) and protein percent (20.26); and was low ("mean –SD") for green fodder yield I cut (5.48), green fodder yield per day I cut (5.49), leaf: stem ratio (8.61) and total soluble solids (7.28).

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