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GENETIC VARIATION AMONG FORAGE PEARL MILLET GENOTYPES FOR FODDER YIELD AND ITS COMPONENT TRAITS UNDER RAINFED CONDITIONS OF GUJARAT

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ABSTRACT

To assess the genetic variability and character association among 17 genotypes of forage pearl millet were studied for seven quantitative traits at Jamnagar and Dhari centre under rainfed condition of Gujarat during rainy season of 2014. PCV and GCV estimates were found to be high to moderate for harvest index (48.65%, 45.48%), grain yield per plant (43.92%, 36.59%), dry fodder yield per plant (21.77%, 15.32%) and green fodder yield per plant (18.09%, 11.35%) which suggests that there is enough scope for selection based on these characters. The high heritability coupled with high to moderate genetic advance expressed as percentage of mean was observed for harvest index (87.40%, 87.58%), grain yield per plant (69.40%, 62.80%), dry fodder yield per plant (50.10%, 22.20%), days to 50% flowering (65.30%, 14.52%) and plant height (50.60%, 10.17%) which showed that these traits were controlled by additive gene effects and phenotypic selection were for these traits were likely to be effective. Correlation analysis revealed that dry fodder yield per plant (0.961, 0.711), plant height (0.134, 0.30) and days to 50% flowering (0.121, 0.041) had positive correlation with green fodder yield per plant. Hence, these characters would be more effective for boosting green fodder yield performance of pearl millet genotypes.

INTRODUCTION

Pearl millet [*Pennisetum glaucum* (L.) R. Br.], the world's hardiest warm season cereal crop (Dapke *et al.,* 2014). It is an indispensable source of fodder in many regions of the world. Being a C_4 species, it has tremendous potential for biomass production, most of which is accumulated in its vegetative parts. Shashikala *et al.* (2013) mentioned that the green fodder of pearl millet is leafy, palatable and very nutritious feed stock for cattle ensuring good milk yield. Being any time forage, pearl millet, unlike sorghum, can be grazed, or cut and fed at any growth stage, as it has no HCN content. Pearl millet is excellent for producing silage, particularly in regions with dry spells during the rainy season. The production potential of green fodder of pearl millet at present is however, low. Obviously if productivity of the animal population has to be improved, high fodder yielding varieties of pearl millet need to be developed. Genetic studies provide basic information regarding the genetic properties of the population based on which breeding methods are formulated for further improvement of the crop. These studies are also helpful to know about the nature and extent of variability that can be attributed to different cause's sensitive nature of the crop to environmental influences heritability of the characters and genetic advance that can be realized in practical breeding. Progress in any crop improvement venture depends mainly on the magnitude of genetic variability and heritability present in the source material. The extent of variability is measured by GCV and PCV which provides information about relative amount of variation in different characters. Hence, to have a thorough comprehensive idea it is necessary to have an analytical assessment of yield components. Since heritability is also influenced by environment, the information on heritability alone may not help in pin pointing characters enforcing selection. Nevertheless the heritability estimates in conjunction with the predicted genetic advance will be more reliable (Johnson *et al.,* 1955). Heritability gives the information on the magnitude of inheritance of quantitative traits while genetic advance will be helpful in formulating suitable selection procedures. High heritability coupled with high genetic advance values were reported in pearl millet by Vidyadhar *et al.* (2007) for days to flowering and days to maturity; Lakshmana *et al.* (2009) for plant height, productive tillers per plant and grain yield per plant; Singh *et al.* (2013) for Number of tillers per plant and fodder yield per plant in sorghum and Singh *et al.* (2014) for plant height, biological yield per plant, dry fodder yield per plant and grain yield per plant in pearl millet suggesting selection for these traits would give good responses. Knowledge of the presence of association among the supplementary characters assumes a unique prominence as the basis for selecting desirable genotypes with high fodder yield potential. Bhagirath Ram *et al.* (2007) reported that green fodder yield per plot showed high positive correlation with tillers per plant, dry fodder yield per plant, green fodder yield per plant, stem diameter and plant height. Singh *et al.* (2014) mentioned that grain yield per plant had significant positive correlation with plant height, biological yield per plant, dry fodder yield per plant and harvest index. Therefore, the present investigation was conducted at two locations with the objectives to determine the variability of traits and provide information on interrelationship of fodder yield with some important yield components in selected genotypes of pearl millet during *kharif,* 2014.

MATERIALS AND METHODS

Two seed set of 17 genotypes of forage pearl millet viz., IP 10437, IP 14776, IP 20577, IP 10151, IP 14753, IP 14294, IP 20929, IP 5957, IP 3642, IP 20409, IP 19415, IP 17396, IP 20611, IP 11010, IP 6193, DFMH 30 (check) and PAC 981(check) were supplied by International Crop Research Institute for the Semi Arid Tropics (ICRISAT), Patancheru, Hyderabad to the Pearl millet Research Station, Junagadh Agricultural University, Jamnagar. Field experiments were conducted at Pearl millet Research Station, Junagadh Agricultural University, Jamnagar and Grassland Research Station, Junagadh Agricultural University, Dhari, during rainy season of 2014. The design of the trail was randomization complete block design with two replications at both the locations. Each plot consisted of four rows of 4.0 m long and 60 cm apart at both locations. Middle two rows were considered for all the observations. Thus, the net plot size was 4.0 x 1.20m^2. The trial was planted on 24^{th} July, 2014 and 25^{th} July, 2014 at Jamnagar and Dhari centre, respectively. While, the trial was harvested on 31^{st} October, 2014 and 13^{th} November, 2014 at Jamnagar and Dhari centre, respectively. The crop was supplied with recommended dose of fertilizer 80-40-00 NPK kg per ha at both locations. Nitrogen was given in two splits, half as basal and the remaining half at 30 days after sowing. Observations on days to 50% flowering, days to maturity, plant height (cm), plant population per plot, grain yield (kg/plot), dry fodder yield (kg/plot) and green fodder yield (kg/plot) were recorded. Days to 50% flowering and days to maturity was recorded on plot basis. The plant height in centimeter was recorded from the base of the plant to the tip of the panicle at harvesting stage. Five randomly selected plants from each plot were used to record the plant height. The data of grain yield (kg/plot), dry fodder yield (kg/plot) and green fodder yield (kg/plot) from net plot were recorded and computed as in gram per plant. Mean values were subjected to standard statistical procedures namely, analysis of variance (Panse and Sukhatme, 1978), phenotypic and genotypic variances (Lush, 1940), genotypic and phenotypic co-efficient of variations (Burton, 1952), and heritability in broad sense and genetic advance (Johnson *et al.*, 1955). The genotypic correlations between green fodder yield per plant and its component traits and among themselves were worked out as per the methods suggested by Al-jibouri *et al.* (1958).

RESULTS AND DISCUSSION

Analysis of variance, mean, range of variation and the estimates of genetic parameters like heritability in broad sense, coefficient of variation (PCV and GCV) and genetic advance expressed as percentage of mean pooled over locations are presented in Table 1.While, genotypic and phenotypic correlation coefficients among traits pooled over locations are presented in Table 2. Analysis of variance (Table 1) revealed significant variation for all the characters under study except harvest index indicating considerable amount of genetic variation present in the materials and ample scope of improvement by selection. Perusal of Table 1 indicates that the traits *viz*., green fodder yield per plant, dry fodder yield per plant and plant height recorded higher genotypic and phenotypic variation than the other characters studied. Wide range of phenotypic variability was observed for green fodder yield per plant, dry fodder yield per plant and plant height, indicating the scope for genetic improvement in these characters through selection and other breeding methods. On the other hand, days to 50% flowering, days to maturity and grain yield per plant exhibited moderate range of phenotypic variability. Harvest index showed low magnitude of phenotypic variability. The higher estimates of genotypic variance over environmental variance in all the characters studied revealed that the variation among the genotypes had a genetic basis. The estimates of phenotypic and genotypic variances were high for green fodder yield per plant (2143, 1299), dry fodder yield per plant (796, 402) and plant height (634, 321). The phenotypic and genotypic variances were moderate for days to 50% flowering (51.81, 33.81), days to maturity (31.64, 17.36) and grain yield per plant (24.36, 16.91); while, it was low for harvest index (0.002, 0.002). The results achieved in the present study are in akin with Bhagirath Ram *et al*. (2007), Salih *et al*. (2014) and Singh *et al*. (2014) in pearl millet.

The relative amount of variation expressed by different traits was judged through estimates of phenotypic and genotypic co-efficient of variation. Though the phenotypic coefficient of variation (PCV) was greater than genotypic coefficient of variation (GCV) for all the characters studied, the close resemblance between the corresponding estimates of PCV and GCV in all the characters suggested that the environment had little role in the expression of these characters. The characters like harvest index (48.65%, 45.48%), grain yield per plant (43.92%, 36.59%), dry fodder yield per plant (21.77%, 15.32%) and green fodder yield per plant (18.09%, 11.35%) exhibited high to medium magnitude of PCV and GCV indicating the presence of wide genetic variability for these traits and chances for improvement of these characters are fairly high. Low values of PCV and GCV were observed for days to 50% flowering (10.80%, 8.72%), days to maturity (6.06%, 4.49%) and plant height (9.75%, 6.94%). These results are in conformity with the report of Vetriventhan and Nirmalakumari (2007), Dapke *et al*. (2014), Singh *et al*. (2014) and Harinarayan *et al*. (2015) in pearl millet and Arunkumar (2013) in sorghum.

The effectiveness of selection for any character depends, not only the extent of genetic variability but also in the extent to which it will be transferred from one generation to the other generation, because, only heritable portion of variation is exploitable through selection. The heritability estimates was interpreted as low (<30%), moderate (30-50%), high (50-70%) and very high (>70%) as per classification of Hallauer and Miranda (1981). Broad sense heritability ranged from 39.40 (green fodder yield per plant) to 87.40% (harvest index). Very high heritability estimate was recorded for harvest index (87.40%), while high heritability estimate was observed for grain yield per plant (69.40%), days to 50% flowering (65.30%), days to maturity (54.90%), plant height (50.60%) and dry fodder yield per plant (50.10%). The high heritability may be due to additive gene effects hence these traits are

Table 1: Analysis of variance showing mean squares, and variability parameters for different traits in pooled over locations in forage pearl millet

Parameters		Days to 50 % flowering	Days to maturity	Plant height (cm)	Green fodder yield/ plant (g)	Dry fodder yield / plant (g)	Grain yield/plant (g)	Harvest index (%)
Mean sum of squares	Replications (1 df)	0.001	12.97**	0.001	753**	19.88**	19.43**	0.001
	Genotypes (16 df)	85.61**	49.00**	955**	2987**	1190**	41.27**	0.004
	Error (16 df)	18.00	14.28	313	1299	402	7.45	0.001
Mean		67	93	258	256	130	11.24	0.090
Range		60-72	85-100	233-278	204-328	102-186	7.64-15.33	0.057-0.138
Phenotypic variance		51.81	31.64	634	2143	796	24.36	0.002
Genotypic variance		33.81	17.36	321	1299	402	16.91	0.002
Environment variance		18.00	14.28	313	844	394	7.45	0.0001
PCV %		10.80	6.06	9.75	18.09	21.77	43.92	48.65
GCV %		8.72	4.49	6.94	11.35	15.32	36.59	45.48
Heritability %		65.30	54.90	50.60	39.40	50.10	69.40	87.40
GA (% mean)		14.52	6.85	10.17	14.67	22.20	62.80	87.58

*, ** P = 0.05 and P = 0.01 levels, respectively. GCV = Genotypic coefficient of variation; PCV = Phenotypic coefficient of variation; GA (% mean) = Genetic advance as per cent of mean

Table 2: Genotypic (r_g) and phenotypic (r_p) corrélation coefficients among traits in forage Pearl millet pooled over locations

Characters		Days to 50% flowering	Days to maturity	Plant height (cm)	Green fodder yield /plant (g)	Dry fodder yield / plant (g)	Grain yield/ plant (g)	Harvest index (%)
Days to 50 %	r_g	1.000	0.945**	0.124	0.121	0.079	-0.496*	-0.561*
flowering	r_p	1.000	0.613**	0.023	0.041	0.123	-0.399	-0.477
Days to maturity	r_g		1.000	0.179	-0.252	-0.147	-0.423	-0.363
	r_p		1.000	0.087	-0.241	-0.108	-0.335	-0.257
Plant height (cm)	r_g			1.000	0.134	0.369	0.254	0.154
	r_p			1.000	0.310	0.265	0.339	0.187
Green fodder yield	r_g				1.000	0.961**	-0.0001	-0.448
/plant (g)	r_p				1.000	0.711**	0.302	-0.165
Dry fodder yield /	r_g					1.000	0.044	-0.441
plant (g)	r_p					1.000	0.060	-0.304
Grain yield /plant (g)	r_g						1.000	0.899**
	r_p						1.000	0.869**
Harvest index (%)	r_g							1.000
	r_p							1.000

likely to respond to direct selection. This was in agreement with the findings of Bhagirath Ram *et al*. (2007), Meena Kumari and Nagarajan (2008), Lakshmana *et al*. (2009) and Dapke *et al*. (2014). Genotypic coefficient of variability along with heritability estimates provides a better picture for the amount of genetic gain expected to be obtained from phenotypic selection (Burton, 1952). It was interesting to note that high GCV was accompanied with high heritability estimates for harvest index (45.48%, 87.40%), grain yield per plant (36.59%, 69.40%) and dry fodder yield per plant (15.32%, 50.10%) in the present material which further revealed that selection could be more effective for the improvement of these traits. The estimates of genetic advance did not project the actual genetic gain that has been attained in relation to the *per se* performance which obviously is not uniform in different populations and even in the same population under different environments. Therefore, the expected genetic gain as per cent of mean was computed. Estimates of genetic advance as percentage of mean ranged from 6.85 (days to maturity) to 87.58% (harvest index). Heritability in coupled with genetic gain was more useful than the heritability values alone in the prediction of the resultant effect for selecting the best individual genotypes (Johnson *et al*., 1955). Genetic gain gives an indication of expected genetic progress for a particular trait under suitable selection pressure. In the present study, the characters harvest index (87.40%, 87.58%), grain yield per plant (69.40%, 62.80%), dry fodder yield per plant (50.10%, 22.20%), days to 50% flowering (65.30%, 14.52%) and plant height (50.60%, 10.17%) exhibited high heritability coupled with high to moderate genetic advance expressed as percentage of mean. These indicated the predominance of additive gene action in governing the traits and their suitability of selection for further improvement among the genotypes studied. These results are in accordance with those of Bhagirath Ram *et al*. (2007), Vidyadhar *et al*. (2007), Bhoite *et al*. (2008), Vinodhara *et al*. (2013), Salih *et al*. (2014) and Harinarayan *et al*. (2015) in pearl millet. High heritability coupled with high genetic advance values for number of tillers per plant and fodder yield per plant in sorghum was reported by Singh *et al*. (2013). In the present studied, high to moderate heritability coupled with low genetic advance as per cent of mean was recorded for days to maturity (54.90%, 6.85%) and green fodder yield per plant (39.40%, 14.67%) which might be due to preponderance of non-additive gene effects. Hence, it could be suggested that improvement of these characters might be difficult through simple selection. From the study of GCV, PCV, heritability and genetic advance it is inferred that simple selection among genotypes could bring about significant improvement in the green fodder yield and its component characters as the GCV, PCV, heritability and estimated genetic advance were high.

Correlation coefficient is a statistical measure, which denotes the degree and magnitude of association between any two casually related variables. This association is due to pleiotropic gene action or linkage or more likely both. In plant breeding correlation coefficient analysis measures the mutual relationship between two characters and it determines character association for improvement fodder yield and other characters. Since the association pattern among yield components help to select the superior genotypes from divergent population based on more than one interrelated characters. Thus, information on the degree and magnitude of association between characters is of prime important for the breeder to initiate any selection plan. In general the genotypic correlation was generally of higher magnitude than phenotypic correlation (Table 2), indicating that inherent association between various characters studied. Green fodder yield per plant exhibited significant positive association with dry fodder yield per plant (0.961, 0.711) at both genotypic and phenotypic levels. Green fodder yield per plant depicted non-significant and positive correlation with plant height (0.134, 0.310) and days to 50% flowering (0.121, 0.041) at both genotypic and phenotypic levels, and with grain yield per plant (0.302) at phenotypic level only. Negative and non-significant association of green fodder yield per plant was observed with days to maturity (-0.252, -0.241) and harvest index (-0.448, -0.165) at both genotypic and phenotypic levels. Interestingly, the characters which exhibited positive correlation with green fodder yield per plant have also depicted positive association among themselves. In the present study, significant positive association was observed for days to maturity with days to 50% flowering (0.945, 0.613); and grain yield per plant with harvest index (0.899, 0.869) at both genotypic and phenotypic levels. The similar results obtained by Bhagirath Ram *et al*. (2007), Abuali *et al*. (2012), Vinodhara *et al*. (2013), Dapke *et al*. (2014) and Singh *et al*. (2014) in pearl millet. Kumar *et al*. (2013) observed significant and positive correlation of grain yield per plant with plant height, number of tillers per plant and test weight in wheat.

The present results suggested that there is adequate genetic variability present in the material studied. In broad sense heritability, GCV, PCV, genetic gain and correlation among traits found that the selection for dry fodder yield per plant, grain yield per plant, harvest index, days to 50% flowering and plant height would be more effective traits in boosting green fodder yield performance of pearl millet genotypes.

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