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Genetic Studies on Variability, Heritability and Traits association for Green Fodder Yield and Quality in Fodder Pearl Millet [*Pennisetum glaucum* (L.)]

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ABSTRACT: An experiment was done with 121 pearl millet germplasm accessions to determine genetic variability, heritability, and genetic advance, as well as the relationship between green fodder yield and other component traits. The PCV was slightly higher than GCV indicating little influence of environment on the expression of characters. High PCV and GCV were recorded for all the characters except days to 50% flowering, crude fibre, leaf length, neutral detergent fibre, acid detergent fibre, and dry matter content. High heritability with high genetic advance as per cent of mean for plant height, number of tillers per plant, number of leaves per tiller, number of nodes on main tiller, leaf length, leaf width, stem girth, leaf weight, stem weight, leaf to stem ratio, dry matter per cent, dry matter yield, green fodder yield, crude protein, crude fat, ash, crude fibre, acid detergent fibre, neutral detergent fibre except days to 50% flowering indicated the prevalence of additive gene action in their inheritance and hence the selection based on these traits would be quite effective. The traits *viz*., stem weight and leaf weight showed highly significant and positive association with green fodder yield and hence indirect selection for these traits would help the breeder to enhance green fodder yield in future breeding programmes.

Keywords: *Pennisetum glaucum*, Genetic variability, Correlation, Path analysis.

INTRODUCTION

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is a diploid (2n = 14) species in the poaceae family. It is a fascinating dual-purpose crop that can be cultivated as a cereal or as fodder and possess a wide range of agronomically important traits that are adaptable to various agroecological conditions. It is commonly produced in marginal lands with low rainfall during the *Kharif* season (Vidyadhar *et al*., 2007; Bhoite *et al*., 2008) because of its ability to withstand drought and adverse agro-climatic conditions. The current production potential of pearl millet green fodder is relatively poor (Shashikala *et al*., 2013). Multi cut pearl millet varieties with excellent fodder yields must be developed to boost animal production (Harinarayana *et al*., 2005). Genetic improvement for quantitative traits in fodder pearl millet is dependent on the degree of variability for the desired traits in the base material, as well as the degree to which the desirable traits are heritable, and plays a significant role in selecting superior cultivars.

GFY is a complex trait that is the result of activities and interactions of various traits; thus, understanding the relationship between yield and its components is all the more important. Understanding the pattern of variability, the inheritance of target traits, and the nature of character association is required for effective breeding strategies and successful selection for developing superior cultivars. In keeping view of above, the present study aimed to assess the magnitude of variability, inheritance pattern, and character association among contributing traits in 121 pearl millet accessions.

MATERIALS AND METHODS

The experiment was conducted during the year of 2019 at new area farm of Department of Forage Crops, Centre for Plant Breeding and Genetics, Tamil Nadu

Agricultural University, Coimbatore. The experimental material included 121 pearl millet genotypes which were evaluated in Randomized Block Design (RBD) with two replications. Each pearl millet accession was grown in two rows of four metres each with a 45 cm x 15 cm spacing, which was maintained by thinning/transplanting at the 3 leaf stage. To raise a healthy crop, the entire suggested agronomic package of procedures was followed. In each replication, five competitive plants were chosen at random from each genotype, avoiding border plants.

Plants to be selected were tagged before initiation of ear emergence for recording the observations at the time of 50 per cent flowering on 20 quantitative and qualitative traits *viz.*, plant height, number of leaves per tiller, number of tillers per plant, number of nodes in main tiller, leaf width, leaf length, stem girth, stem weight, leaf weight, leaf to stem ratio, crude fibre, neutral detergent fibre, acid detergent fibre, crude protein, ash, crude fat, dry matter content, dry matter yield and green fodder yield per plant. The Australian Fodder Industry Association (AFIS) laboratory procedures manual (http://www.afia.org.au) was used to estimate crude fibre, acid detergent fibre, neutral detergent fibre, crude protein, crude fat, and ash. Plant samples were taken at the time of panicle initiation, chopped, air dried, and then oven dried for two days at 60°C. The samples were crushed and sieved using various sieve sizes after being dried in the oven. Sieve size of 0.5 mm was used for estimation of neutral detergent fibre, acid detergent fibre, crude fibre, ash and 0.1 mm sieve size was used for crude protein and crude fat estimation. Crude fat by soxhlet method using petroleum ether and crude protein was estimated by Kjeldahl's method while crude fibre, acid detergent fibre and neutral detergent fibre was estimated by using crude fibre apparatus by following the method made through in AFIS laboratory methods manual. The genetic parameters were computed using mean values, and data was statistically analysed for each character as reported by Panse and Sukhatme (1967). Burton (1952) suggested estimating genotypic and phenotypic coefficients of variation, while Falconer (1964) and Dewey & Lu (1959) suggested calculating correlation coefficients and path coefficient analyses, respectively.

RESULTS AND DISCUSSION

A. Genetic Variability

The development of an effective breeding programme is dependent on the presence of genetic variability, which provides basic information about the genetic properties of the population, the nature and extent of variability, the heritability of the characters, and genetic advance, all of which are used to formulate breeding methods for crop improvement. The analysis of variance revealed extremely significant differences among genotypes for all of the characters evaluated in this study, indicating that the pearl millet experimental materials have sufficient variability.

The PCV was greater than GCV indicating little influence of environment on the expression of characters (Table 1) (Fig. 1, 2). The evaluated pearl millet genotypes revealed that the greater PCV and GCV were obtained for 14 characters *viz.*, PHT (28.520, 28.046), number of tillers per plant (28.015, 22.811), number of leaves per tiller (22.365, 21.900), number of nodes on main tiller (29.356, 24.186), leaf width (37.733, 32.874), stem girth (40.879, 36.010), leaf weight (48.382, 47.911), stem weight (26.485, 26.310), leaf to stem ratio (20.841, 20.117), dry matter yield (33.007, 30.853), green fodder yield per plant (32.173, 32.005), crude fat (43.006, 38.208), crude protein (23.957, 20.867) and ash content (39.003, 35.948) except for days to 50% flowering (6.906, 4.042), leaf length (23.119, 18.960), dry matter content (20.308, 16.734), crude fibre (15.451, 13.819), acid detergent fibre (16.300, 14.999) and neutral detergent fibre (14.045, 13.179). It revealed the presence of higher genetic variability and it suggests that the selection may be effective. Concomitant results for high GCV and PCV for plant height, total number of leaves, leaf weight, stem weight and green fodder yield per plant was also reported by Suthamathi and Stephen Dorairaj (1995); Vidyadhar *et al*. (2007); Bhoite *et al*. (2008); Kumar *et al*. (2017); Thomas *et al.* (2018) in pearl millet.

Moderate PCV and moderate GCV were observed for leaf length (23.119, 18.960), crude fibre (15.451, 13.819), acid detergent fibre (16.300, 14.999), neutral detergent fibre (14.045, 13.179) and dry matter content (20.308, 16.734) while low PCV and low GCV was found for days to 50% flowering (6.906, 4.042 respectively). Similar results for dry matter percent and crude protein, acid detergent fibre content was reported by Suthamati and Dorairaj (1997); Rahul Kapoor (2017) in Napier grass and Govindaraj *et al.*, (2011) in pearl millet respectively.

Heritable variation cannot be estimated with the help of GCV alone. Yield and its characteristics are significantly influenced by the environment, making it difficult to determine whether the observed variability is heritable or not. As a result, it's critical to separate the observed variability into heritable and non-heritable components. The precision with which a genotype can be determined by its phenotypic performance is referred to as heritability. Burton (1952) suggested that a combination of genotypic coefficient of variation and heritability estimations would be more efficient for selection. The kind of gene action influencing a given character can be determined by comparing heritability estimates and predicted genetic advance as a percentage of the mean.

High heritability with high genetic advance as per cent of mean was observed for plant height (96.700, 56.816), number of tillers per plant (66.300, 38.262), number of leaves per tiller (61.700, 27.404), number of nodes in main tiller (67.900, 41.050), leaf length (67.300, 32.003), leaf width (75.900, 59.002), stem girth

(77.600, 65.347), leaf weight (98.100, 97.736), stem weight (98.700, 53.842), leaf to stem ratio (93.200, 40.001), crude fibre (80.000, 25.460), acid detergent fibre (84.700, 28.431), neutral detergent fibre (88.100, 25.477), crude protein (60.600, 27.431), crude fat (78.900, 69.926), ash (84.900, 68.254), dry matter content (67.900, 28.404), dry matter yield (87.400, 59.409) and green fodder yield (99.000, 65.586). This indicated the lesser influence of environment in expression of these characters and prevalence of additive gene action in their inheritance and hence selection of these traits in breeding programme would facilitate the improvement of both fodder yield and quality. Similarly high heritability for these characters studied *viz*., number of leaves per plant, green fodder yield per plant was reports by Suthamathi and Dorairaj (1997); Babu *et al*. (2009) in Napier grass, Vedansh *et al*. (2010) in fodder maize and Sharma *et al*. (2003); Vidyadhar *et al*. (2007); Vinodhana *et al*. (2013) in pearl millet, Jain and Patel (2012) in fodder sorghum. Among the traits evaluated in pearl millet accessions, days to 50% flowering alone registered moderate heritability and low genetic advance as per cent of mean. High values for desirable variability, heritability, genetic advance as percent of mean were observed in the traits such as, plant height, number of tillers per plant, number of leaves per tiller, number of nodes on main tiller, leaf width, stem girth, leaf weight, stem weight, leaf to stem ratio, crude fat, crude protein, ash, dry matter yield and green fodder yield. It indicates that character-based selection might be quite effective and influenced by additive gene action. As a result, selecting these traits could help improve the yield and quality of green fodder in pearl millet.

B. Correlation

The green fodder yield, which is finally harvested in a forage crop, is influenced by a variety of vegetative plant features. Knowing the relationship between biomass yield and other biometrical features, as well as the relationship between the component qualities themselves, would substantially aid indirect selection for high green fodder yield. In the present investigation, the traits, plant height (0.9399 0.9220), number of tillers per plant (0.9458, 0.7703), number of leaves per tiller (0.9218, 0.5800), number of nodes on main tiller (0.9582, 0.7948), leaf length (0.9309, 0.7711), leaf width (0.7733, 0.6702), stem girth (0.8456, 0.7486), leaf weight (0.9450, 0.9309), stem weight (0.9517, 0.9401), leaf to stem ratio (0.6902, 0.6631), crude protein (0.7979, 0.6163), crude fat (0.2745, 0.2356) and dry matter yield (0.8582, 0.8032) were found to exhibit highly significant and positive correlation at genotypic and phenotypic level while crude fibre (-0.3483, -0.3171), dry matter content (-0.3384, -0.2800) and acid detergent fibre (-0.1963, -0.1811) have registered negative and significant correlation at genotypic and phenotypic level with green fodder yield (Table 2). The obtained result coincided with the findings of number of tillers with green fodder yield by Mangat and Satija (1991) in fodder pearl millet and Khan *et al*. (2002) in Napier grass. Vijendra Das and Ratnam Nadar (1991) remarked positive association of green fodder yield with plant height, number of tillers and leaf length.

Plant height inter-correlated positively with number of tillers per plant, number of leaves per tiller, number of nodes on main tiller, leaf length, leaf width, stem girth, leaf weight, stem weight, leaf to stem ratio, crude protein, crude fat and dry matter yield and negatively with crude fibre, dry matter content and acid detergent fibre. The positive inter-correlation between the number of tillers per plant, the number of leaves per tiller, and the leaf stem ratio suggested that indirect selection for these traits could assist in increasing green fodder yield besides providing more leaves, which would improve palatability and intake. Similar result was reported by Kumar *et al*. (2017) in fodder pearl millet. It is concluded that all the biometric traits and quality traits *viz*., crude protein, crude fat were studied in the paper are highly associated with green fodder yield. Hence, these traits are important during selection of high biomass plant.

Table 1: Variability parameters in pearl millet accessions.

Sr. No.	Traits	PV	GV	PCV	GCV	H^2	GA	GAM
1.	Days to 50% flowering	9.892	3.389	6.906	4.042	34.300	2.220	4.874
2.	Plant height(cm)	2075.887	2007.504	28.520	28.046	96.700	90.766	56.816
3.	No. of tillers per plant	2.000	1.326	28.015	22.811	66.300	1.932	38.262
4.	No. of leaves per tiller	2.729	0.565	22.365	21.900	61.700	0.704	27.404
5.	No. of nodes on main tiller	2.453	1.665	29.356	24.186	67.900	2.190	41.050
6.	Leaf length(cm)	153.317	103.121	23.119	18.960	67.300	17.156	32.033
7.	Leaf width (cm)	1.640	1.245	37.733	32.874	75.900	2.003	59.002
8.	Stem girth (cm)	2.646	2.053	40.879	36.010	77.600	2.600	65.347
9.	Leaf weight(g)	65098.059	63837.125	48.382	47.911	98.100	515.414	97.736
10.	Stem weight(g)	75773.195	74777.609	26.485	26.310	98.700	559.604	53.842
11.	Leaf to stem ratio	0.005	0.004	20.841	20.117	93.200	0.129	40.001
12.	Crude fibre content (%)	18.738	14.989	15.451	13.819	80.000	7.133	25.460
13.	Acid detergent fibre content (%)	35.051	29.678	16.300	14.999	84.700	10.326	28.431
14.	Neutral detergent fibre content (%)	48.035	42.297	14.045	13.179	88.100	12.572	25.477
15.	Crude protein content (%)	2.407	1.459	23.957	20.867	60.600	1.938	27.431
16.	Crude fat content (%)	3.920	3.094	43.006	38.208	78.900	3.219	69.926
17.	Ash content (%)	5.842	4.962	39.003	35.948	84.900	4.230	68.254
18.	Dry matter content (%)	13.082	8.882	20.308	16.734	67.900	5.059	28.404
19.	Dry matter yield(g)	8573.44 3	7490.89 6	33.007	30.853	87.400	166.657	59.409
20.	Green fodder yield per plant (g)	266370.469	263594.469	32.173	32.005	99.000	1052.108	65.586

Table 2: Genotypic (rG) and phenotypic (rP) correlation coefficients in Pearl millet germplasm accessions.

		DAYS 50%	PHT	NOT	NOL	NON	LLH	LBH	SGH	LWT	SWT	LSR	CFIB	ADF	NDF	CPN	CFAT	ASH	DMC	DMY	GFY
DAYS 50%	r_g	**1**	-0.2669**	-0.2192	-0.1632	-0.1314	-0.2318*	-0.1096	-0.2581*	-0.2119*	-0.1947*	-0.1392	0.2402**	0.4307**	0.0404	-0.3090**	-0.1035	0.0238	-0.1643	-0.2636**	-0.2025*
	r_p	**1**	-0.1681	-0.1351	-0.1064	-0.122	-0.1414	-0.1364	-0.1471	-0.1192	-0.1211	-0.0716	0.1208	0.1812*	0.0129	-0.1432	-0.0829	0.0358	-0.0526	-0.1308	-0.1121
PHT	r_g		**1**	0.8363**	0.8055**	0.9107**	0.8992**	0.7335**	0.8147**	0.9267**	0.8756**	0.6909**	-0.4367**	-0.2788**	-0.1247	0.8010**	0.3423**	-0.0791	-0.3386**	0.7835**	0.9399**
	r_p		**1**	0.7205**	0.5903**	0.7941**	0.8033**	0.6740**	0.7588**	0.9092**	0.8551**	0.6661**	-0.3876**	-0.2505**	-0.1213	0.6266**	0.3091**	-0.0676	-0.2780**	0.7233**	0.9220**
NOT	r_g			**1**	0.8981**	0.8374**	0.7723**	0.7202**	0.7668**	0.8504**	0.9293**	0.5742**	-0.3475**	-0.2298*	0.0118	0.7868**	0.2542**	-0.0004	-0.2470**	0.8527**	0.9458**
	r_p			**1**	0.6283**	0.7253**	0.7124**	0.6424**	0.6874**	0.6974**	0.7554**	0.4704**	-0.2380**	-0.1925*	0.0001	0.5203**	0.1952*	-0.0080	-0.1964*	0.6344**	0.7703**
NOL	r_g				**1**	0.9234**	0.9317**	0.8693**	0.8286**	0.2567**	0.3228**	0.9542**	-0.5819**	-0.4298**	-0.1043	0.4917**	0.4652**	-0.1157	-0.2693**	0.5828**	0.9218**
	r_p				**1**	0.6214**	0.7241**	0.5322**	0.5993**	0.5916**	0.5206**	0.4477**	-0.2995**	-0.1401	-0.0684	0.3666**	0.1608	0.0257	-0.1469	0.4594**	0.5800**
NON	r_g					**1**	0.8264**	0.7203**	0.8109**	0.9428**	0.8907**	0.7076**	-0.3266**	-0.1849*	-0.0197	0.8649**	0.2533**	-0.1722	-0.3681**	0.7933**	0.9582**
	r_p					**1**	0.7635**	0.6443**	0.7113**	0.7832**	0.7367**	0.5808**	-0.2691**	-0.1449	-0.0217	0.5433**	0.1807*	-0.1020	-0.2196*	0.6439**	0.7948**
LLH	r_g						**1**	0.7005**	0.7837**	0.9271**	0.8482**	0.6892**	-0.4791**	-0.2827**	-0.1846*	0.8738**	0.4511**	-0.0622	-0.2532**	0.8264**	0.9309**
	r_p						**1**	0.6389**	0.7582**	0.7733**	0.6955**	0.5728**	-0.3608**	-0.2129*	-0.1327	0.5763**	0.3167**	-0.0300	-0.1837*	0.6425**	0.7711**
LBH	r_g							**1**	0.6416**	0.7494**	0.7449**	0.5215**	-0.2441**	-0.1636	0.0135	0.5747**	0.0300	0.0284	-0.0526	0.7630**	0.7733**
	r_p							**1**	0.5897**	0.6725**	0.6427**	0.4840**	-0.1962*	-0.1263	0.0254	0.3874**	0.0415	0.0584	-0.0424	0.6247**	0.6702**
SGH	r_g								**1**	0.8194**	0.7969**	0.6009**	-0.3994**	-0.2965**	-0.0853	0.7460**	0.2576**	-0.1125	-0.2580**	0.7408**	0.8456**
	r_p								**1**	0.7311**	0.7027**	0.5302**	-0.3219**	-0.2335**	-0.0731	0.5465**	0.1757	-0.0630	-0.1941*	0.6194**	0.7486**
LWT	r_g									**1**	0.8105**	0.8708**	-0.4112**	-0.2542**	-0.1148	0.7140**	0.2162*	-0.0691	-0.3173**	0.8038**	0.9450**
	r_p									**1**	0.7921**	0.8643**	-0.3625**	-0.2310*	-0.1077	0.5610**	0.1986*	-0.0614	-0.2538**	0.7497**	0.9309**
SWT	r_g										**1**	0.4517**	-0.2876**	-0.1718	-0.0291	0.79710**	0.2621**	-0.0948	-0.3325**	0.8150**	0.9517**
	r_p										**1**	0.4155**	-0.2676**	-0.1595	-0.0219	0.6116**	0.2283*	-0.0800	-0.2871**	0.7464**	0.9401**
LSR	r_g											**1**	-0.3574**	-0.2238*	-0.1448	0.4102**	0.0733	-0.0320	-0.2183*	0.5926**	0.6902**
	r_p											**1**	-0.2981**	-0.1940*	-0.1341	0.3238**	0.0685	-0.0274	-0.1564	0.5482**	0.6631**
CFIB	r_g												**1**	0.6854**	0.4863**	-0.4500**	-0.3161**	-0.0209	0.0863	-0.3001**	-0.3483**
	r_p												**1**	0.5726**	0.4259**	-0.2873**	-0.2267*	-0.0736	0.0757	-0.2487**	-0.3171**
ADF	r_g													**1**	0.6395**	-0.3176**	-0.1838*	-0.0687	0.2072*	-0.0780	-0.1963*
	r_p													**1**	0.5613**	-0.2228*	-0.1700	-0.0897	0.1568	-0.0763	-0.1811*
NDF	r_g														**1**	-0.0455	-0.2753**	0.0364	0.3204**	0.1048	-0.0654
	r_p														**1**	-0.0485	-0.2286	0.0517	0.2403**	0.0859	-0.0640
CPN	r_g															**1**	0.3976**	0.0356	-0.3183**	0.6490**	0.7979**
	r_p															**1**	0.3051**	-0.0506	-0.1730	0.5005**	0.6163**
CFAT	r_g																**1**	0.1232	-0.2802**	0.1250	0.2745**
	r_p																**1**	0.1031	-0.1934*	0.1048	0.2356**
ASH	r_g																	**1**	0.0357	-0.0711	-0.0972
	r_p																	**1**	0.0112	-0.0682	-0.0792
DMC	r_g																		**1**	0.1603	-0.3384**
	r_p																		**1**	0.3111**	-0.2800**
DMY	r_g																			**1**	0.8582**
	r_p																			**1**	0.8032**

Table 3: Path coefficient analysis of different quantitative and quality characters with green fodder yield per plant in pearl millet accessions.

		DAYS 50%	PHT	NOT	NOL	NON	LLH	LBH	SGH	LWT	SWT	LSR	CFIB	ADF	NDF	CPN	CFAT	ASH	DMC	DMY
DAYS 50%	rg	**0.0021**	-0.0005	-0.0005	-0.0003	-0.0003	-0.0005	-0.0002	-0.0005	-0.0004	-0.0004	-0.0003	0.0005	0.0009	0.0001	-0.0006	-0.0002	0.0000	-0.0003	-0.0005
PHT	rg	-0.0020	**0.0076**	0.0063	0.0082	0.0069	0.0068	0.0055	0.0062	0.007	0.0066	0.0052	-0.0033	-0.002	-0.0009	0.0061	0.0026	-0.0006	-0.0026	0.0059
NOT	rg	-0.0261	0.0994	**0.1188**	0.1067	0.0995	0.0918	0.0856	0.0911	0.1011	0.1104	0.0682	-0.0413	-0.027	0.0014	0.0935	0.0302	0.0000	-0.0294	0.1013
NOL	rg	0.0000	0.0002	0.0001	**0.0002**	0.0002	0.0002	0.0001	0.0001	0.0002	0.0002	0.0002	-0.0001	-0.0001	0.0000	0.0002	0.0001	0.0000	0.0000	0.0002
NON	rg	0.0068	-0.0473	-0.0435	-0.0480	**-0.052**	-0.0429	-0.0374	-0.0421	-0.049	-0.0463	-0.0368	0.017	0.0096	0.001	-0.0449	-0.0132	0.0089	0.0191	-0.0412
LLH	rg	-0.0012	0.0045	0.0038	0.0046	0.0041	**0.005**	0.0035	0.0039	0.0046	0.0042	0.0034	-0.0024	-0.001	-0.0009	0.0044	0.0022	-0.0003	-0.0013	0.0041
LBH	rg	-0.0017	0.0112	0.0110	0.0133	0.0110	0.0107	**0.0153**	0.0098	0.0115	0.0114	0.008	-0.0037	-0.003	0.0002	0.0088	0.0005	0.0004	-0.0008	0.0117
SGH	rg	-0.0016	0.0051	0.0048	0.0052	0.0051	0.0049	0.0040	**0.0063**	0.0052	0.005	0.0038	-0.0025	-0.002	-0.0005	0.0047	0.0016	-0.0007	-0.0016	0.0047
LWT	rg	-0.0672	0.2937	0.2695	0.3983	0.2988	0.2938	0.2375	0.2597	**0.3169**	0.2569	0.276	-0.1303	-0.081	-0.0364	0.2263	0.0685	-0.0220	-0.1006	0.2547
SWT	rg	-0.0833	0.3744	0.3973	0.4801	0.3809	0.3627	0.3185	0.3407	0.3466	**0.4276**	0.1932	-0.123	-0.074	-0.0124	0.3408	0.1121	-0.0410	-0.1422	0.3485
LSR	rg	-0.0128	0.0634	0.0527	0.0875	0.0649	0.0632	0.0478	0.0551	0.0799	0.0414	**0.0917**	-0.0328	-0.021	-0.0133	0.0376	0.0067	-0.0030	-0.0200	0.0544
CFIB	rg	0.0056	-0.0101	-0.0081	-0.0135	-0.0076	-0.0111	-0.0057	-0.0093	-0.0095	-0.0067	-0.0083	**0.0232**	0.0159	0.0113	-0.0104	-0.0073	-0.0005	0.00200	-0.007
ADF	rg	0.0178	-0.0115	-0.0095	-0.0178	-0.0076	-0.0117	-0.0068	-0.0123	-0.0105	-0.0071	-0.0092	0.0283	**0.0413**	0.0264	-0.0131	-0.0076	-0.0030	0.0086	-0.0032
NDF	rg	-0.0010	0.0030	-0.0003	0.0025	0.0005	0.0044	-0.0003	0.002	0.0028	0.0007	0.0035	-0.0117	-0.015	**-0.024**	0.0011	0.0066	-0.0009	-0.0077	-0.0025
CPN	rg	-0.0186	0.0483	0.0474	0.0658	0.0521	0.0527	0.0346	0.045	0.043	0.048	0.0247	-0.0271	-0.019	-0.0027	**0.0603**	0.0240	0.0021	-0.0192	0.0391
CFAT	rg	-0.0028	0.0092	0.0069	0.0126	0.0068	0.0122	0.0008	0.007	0.0058	0.0071	0.002	-0.0085	-0.005	-0.0074	0.0107	**0.0270**	0.0033	-0.0076	0.0034
ASH	rg	-0.0008	0.0026	0.0000	0.0038	0.0056	0.002	-0.0009	0.0037	0.0023	0.0031	0.001	0.0007	0.0022	-0.0012	-0.0012	-0.004	**-0.0330**	-0.0012	0.0023
DMC	rg	0.0079	0.0163	0.0119	0.0130	0.0177	0.0122	0.0025	0.0124	0.0153	0.016	0.0105	-0.0042	-0.01	-0.0154	0.0153	0.0135	-0.002	**-0.0482**	-0.0077
DMY	rg	-0.0237	0.0706	0.0768	0.0975	0.0714	0.0744	0.0687	0.0667	0.0724	0.0734	0.0534	-0.027	-0.007	0.0094	0.0584	0.0113	-0.0060	0.0144	**0.0901**
GFY	rg	-0.2025	0.9399	0.9458	1.2198	0.9582	0.9309	0.7733	0.8456	0.945	0.9517	0.6902	-0.3483	-0.196	-0.0654	0.7979	0.2745	-0.0970	-0.3384	0.8582

DAYS 50% - Days to 50% flowering, PHT - Plant height, NOT - Number of tillers per plant, NOL - Number of leaves per tiller, NON - Number of nodes on main tiller, LLH - Leaf length, LWT - Leaf width, SGH - Stem girth, LWT - Leaf weight, SWT - Stem weight, LSR – Leaf to stem ratio, DMC - Dry matter per cent, DMY - Dry matter yield, GFY – Green fodder yield, CPN - Crude protein, CFAT - Crude fat, ASH - Ash, CFIB - Crude fibre, ADF - Acid detergent fibre, NDF - Neutral detergent fibre

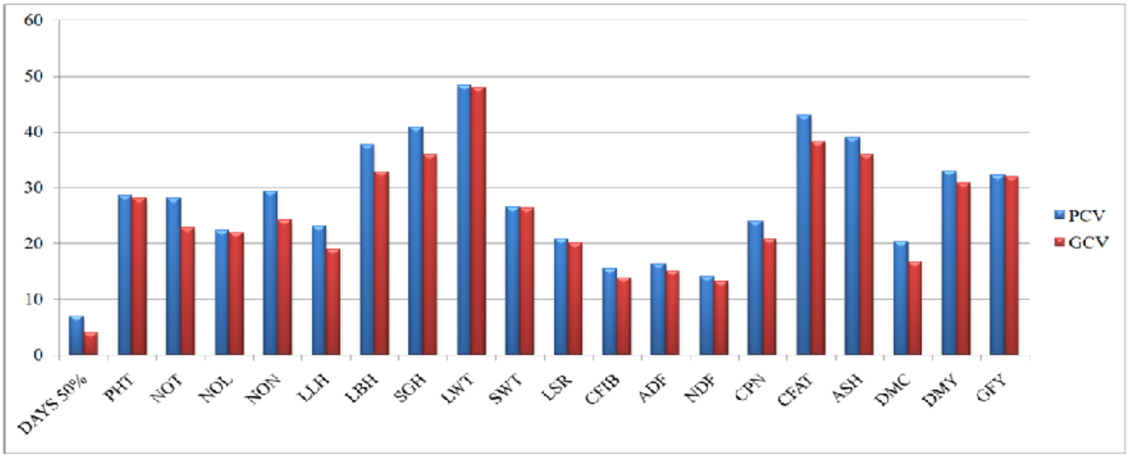

Fig. 1. Graphical representation of PCV and GCV in pearl millet accessions.

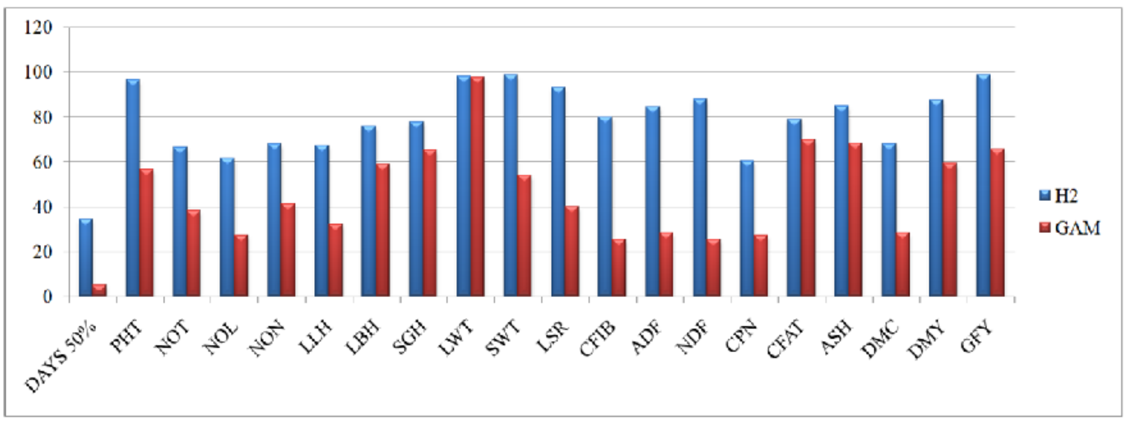

Fig. 2. Graphical representation of heritability and genetic advance as percent of mean in pearl millet accessions.

C. Path analysis

Path analysis is a statistical method for dividing the total effect into direct and indirect effects (Wright, 1921). Because the component traits are interdependent, they frequently influence their direct relationship with yield, limiting the reliability of selection indices based solely on correlation coefficient. As a result, the association between the characters was examined in order to determine the direct and indirect effects.

The stem weight (0.4276) on green fodder yield has registered highest positive direct effect on green fodder yield, followed by leaf weight (0.3169) (Table 3) (Fig. 3). The result was in accordance with the results of Iyanar *et al*. (2010); Jain and Patel (2012) in fodder sorghum traits *viz*., number of tillers per plant, stem weight on green fodder yield had high positive direct effect. Therefore, these traits expected to have a true correlation and could be taken as component traits while selection for the improvement of green fodder yield. On the other hand, the traits *viz*., number of nodes on main tiller (-0.0520), neutral detergent fibre (-0.0240), ash (-0.0330) and dry matter content (-0.0482) showed negative direct effects.

Stem weight had high positive indirect effect through plant height (0.3744), number of tillers per plant (0.3973), number of nodes on main tiller (0.3809), number of leaves per tiller (0.4801), leaf length (0.3627), leaf breath (0.3185), stem girth (0.3407), leaf weight (0.3466) and leaf weight. Stem weight had low negative indirect effect through crude fibre (-0.1303, -0.1230) and dry matter content (-0.1006, -0.1422) on green fodder yield was observed. Leaf weight had moderate positive indirect effect for plant height (0.2937), number of tillers per plant (0.2695), number of nodes on main tiller (0.2988), leaf length (0.2938), leaf width (0.2375), stem girth (0.2597), stem weight (0.2569), leaf to stem ratio (0.2760), crude protein (0.2263) and dry matter yield (0.2547). The dry matter content can be increased through the selection of high tillering, leaf and stem weight. The remaining traits had negligible inter-correlation, while green fodder yield had none. Plant height, number of tillers per plant, number of leaves per tiller, number of nodes in main stem, leaf length, leaf width, stem girth, leaf weight, stem weight, leaf to stem ratio, crude protein, and dry matter yield may be responsible for increasing green fodder yield per plant, according to correlation and path analysis studies. These traits could be used as selection criteria in future breeding programmes to improve fodder yield and quality.

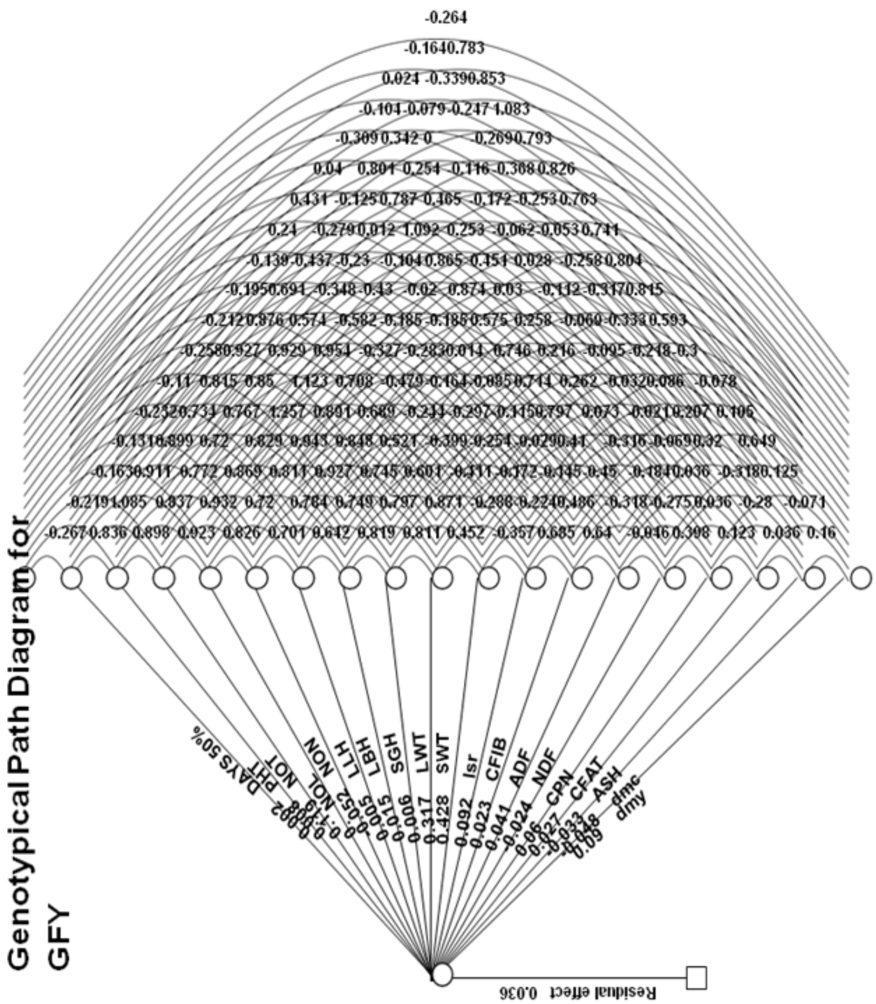

Fig. 3. Graphical representation of genotypical path diagram for GFY in pearl millet accessions.

CONCLUSION

The evaluation of pearl millet accessions revealed that the traits plant height, number of tillers per plant, number of leaves per tiller, number of nodes on main tiller, leaf length, leaf width, stem girth, leaf weight, stem weight, leaf to stem ratio, crude fibre, acid detergent fibre, neutral detergent fibre, crude protein, crude fat, ash, dry matter content, dry matter yield and green fodder yield showed high heritability with high genetic advance as per cent of mean indicating the prevalence of additive gene action in their inheritance denoting the selection based on these traits to be quite effective. In association study, the traits, plant height, number of tillers per plant, number of leaves per tiller, number of nodes in main stem, leaf length, leaf width, stem girth, leaf weight, stem weight, leaf to stem ratio, crude protein and dry matter yield being positively correlated with green fodder yield and could be used as traits of interest for indirect selection to improve green fodder yield in further breeding programme.

Conflict of Interest. None.

REFERENCES

Australian Fodder Industry Association laboratory methods manual. http://www.afia.org.au

Babu, C., Sundaramoorthi, J., Vijayakumar, G., & Ganesh Ram, S. (2009). Analysis of genetic diversity in Napier grass (*Pennisetum purpureum Schum*) as detected by RAPD and ISSR markers. *Journal of Plant Biochemistry and Biotechnology*, *18*(2), 181-187.

Bhoite, K. D., Pardeshi, S. R., Mhaske, B. M., & Wagh, M. P. (2008). Study of genetic variability in pearl millet (*Pennisetum glaucum* L.). *Agricultural Science Digest*, *28*(2), 115-117.

Burton, G. W. (1952). Quantitative inheritance in grasses. *Proc. 6th Int. Grassland Cong.*, *1*, 277-283.

Dewey, D. R. and Lu, K. M. (1959) Correlation and path coefficient analysis of crested wheat grass seed production.

Falconer, D. S. (1964). Introduction to quantitative genetics. Oliverand Boyd Ltd., London, W.I.

Govindaraj, M., Selvi, B., Rajarathinam, S., & Sumathi, P. (2011). Genetic variability and heritability of grain yield components and grain mineral concentration in India's pearl millet (*Pennisetum glaucum* (L) R. Br.)

accessions. *African Journal of Food, Agriculture, Nutrition and Development*, *11*(3).
Harinarayana, G., Melkania, N. P., Reddy, B. V. S., Gupta, S. K., Rai, K. N., & Kumar, P. S. (2005). Forage potential of sorghum and pearl millet. *Forage potential of sorghum and pearl millet*, 292-321.
Iyanar, K., Vijayakumar, G., & Khan, A. K. (2010). Correlation and path analysis in multicut fodder sorghum. *Electronic Journal of Plant Breeding*, *1*(4), 1006-1009.
Jain, S. K., & Patel, P. R. (2012). Genetic variability in land races of forage sorghum {*sorghum bicolor* (l) moench} collected from different geographical origin of India. *International Journal of Agriculture Sciences*, *4*(2), 182.
Kapoor, R. (2017). Genetic variability and association studies in Napier grass (*Pennisetum purpureum* schumach.) for green fodder yield and quality traits. *Electronic Journal of Plant Breeding*, *8*(3), 885-891.
Khan, A. K. F. and Sukumar, K. (2002) Variability heritability, genetic advance in Napier grass. *Madras Agric. J.*, *88*(7-9), 461-464.
Kumar, N., Singh, S. K., Kerkhi, S. A., Singh, B., Tanvir, H., & Lal, M. (2011). Genetic variability, heritability and genetic advance for forage yield and quality traits in sorghum. *Progressive Agriculture*, *11*(2), 479-481.
Kumar, S., Babu, C., Revathi, S., & Sumathi, P. (2017). Estimation of genetic variability, heritability and association of green fodder yield with contributing traits in fodder pearl millet [*Pennisetum glaucum* (L.)]. *International Journal of Advanced Biological Research*, *7*(1), 119-126.
Kumari, A., Sood, V., & Sharma, R. D. A. (2017). Genetic ev genetic evaluation of different frost tolerant tion of different frost tolerant bajra-napier hybrids for fora napier hybrids for forage yield and qu ge yield and qu ge yield and quality traits in nor traits in north western himala th western himala th western himalayas.
Mangat, B. K., & Satija, D. R. (1991). Influence of seed size on inter-relationships of yield and some morphological traits in pearl millet. *Crop Improvement (India)*.
Panse, V. G. and Sukhatme, P. V. (1967). Statistical methods for agricultural workers. 2nd Ed. *ICAR.*, New Delhi.
Sathya, M., Vinodhana, N. K., & Sumathi, P. (2013). Hierarchial clustering of pearl millet (*Pennisetum glaucum* (L.) R. Br) inbreeds for morpho-physiological traits. *International Journal of Current Microbiology and Applied Sciences*, *2*(12), 647-653.
Sharma, K. C., Sharma, R. K., Singhania, D. L., & Singh, D. (2003). Variation and character association in fodder yield and related traits in pearl millet [*Pennisetum glaucum* (L.) R. Br.]. *Indian Journal of Genetics and Plant Breeding (India)*.
Shashikala, T., Rai, K. N., Naik, R. B., Shanti, M., Chandrika, V., & Reddy, K. L. (2013). Fodder potential of multicut pearl millet genotypes during summer season. *International journal of Bio-resource and Stress Management*, *4*(4), 628-630.
Singh, S. K., Kerkhi, S. A., Singh, A., Kumar, M., & Kumar, V. (2010). Variability, heritability and genetic advance for forage yield and quality traits in forage sorghum (*Sorghum bicolor* L. Moench) Vedansh. *Progressive Agriculture*, *10*(2), 400-401.
Suthamathi, P., & Dorairaj, M. S. (1995). Variability, heritability and genetic advance in fodder pearl millet. *Madras Agricultural Journal*, *82*, 238-239.
Suthamathi, P., & Dorairaj, M. S. (1997). Genetic variability in napier grass (*Pennisetum purpureum* (k.) schum). *Indian journal of genetics and plant breeding*, *57*(03), 319-321.
Thomas, Anusha Mariam, C. Babu, and K. Iyanar. "Genetic variability and association studies in pearl millet for green fodder yield and quality traits." *Electronic Journal of Plant Breeding, 9.3*(2018): 1263-1271.
Vedansh, S.K., Singh, S. A., Kerkhi, A., Singh, M.K. and Vipin, K. (2010) Variability, heritability and genetic advance for forage yield and quality traits in forage sorghum [*Sorghum bicolor* (L.) Moench]. *Prog. Agric*., *10*(2), 400- 401.
Vidyadhar, B., Chand, P., Devi, I. S., Reddy, M., & Ramachandraiah, D. (2007). Genetic variability and character association in pearl millet {*Pennisetum glaucum* (L.) R. Br.} and their implications in selection. *Indian Journal of Agricultural Research*, *41*(2), 150-153.
Vijendra Das, L. D. and Ratnam Nadar, C. (1991). Correlation and path analysis in Napier grass. *J. Agric. Res., 4*(3-4), 187-191.
Vinodhana, N. K., Sathya, M. and Sumathi, P. (2013) Hierarchial clustering of pearl millet (*Pennisetum glaucum* (L.) R. Br) inbreds for morpho-physiological traits. *Int. J. Curr. Microbiol. App. Sci., 2*(12), 647-652.
Wright, S. (1921). Correlation and causation. *J. Agric. Res., 20*, 557-587.

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