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Estimation of *per se* Performance of Yield Traits in Fodder Pearl Millet [*Pennisetum glaucum* (L.) R. Br.]

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Abstract The 54 pearl millet accessions consisting of 35 inbreds and 19 and B lines were raised during *kharif,* 2015 for characterization of eleven quantitative characters (plant height, number of nodes in main stem, number of tillers per plant, number of leaves per tillers, leaf length, leaf width, leaf weight, stem weight, leaf/stem ratio, green fodder yield per plant, dry matter) withal nutrient quality (crude protein, crude fat and crude fiber content) estimation. Among the genotypes studied, two genotypes viz., GP 16021 and IP 22269 had high green fodder yield with higher leaf weight (>500 g) and leaf stem ratio (>0.50)ensuring lesser rejection by animal and better palatability. In addition to the desirable features, the genotypes viz., ICMB 04444, RFBJ 89 and PT 5382 recorded high crude protein with low fiber content indicating it to be nutritious and easily digestible. These genotypes may be utilized effectively in the future breeding program to develop highly productive as well as nutritious fodder pearl millet varieties as well as may be used as female parent with Napier grass to develop high yielding pearl millet Napier hybrid.

Keywords Crude protein, Leaf stem ratio, Dry matter per cent, Pearl millet Napier hybrid.

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Introduction

Pearl millet [*Pennisetum glaucum* (L.) R. Br.], a dual purpose crop is a monocot species which belong to the Poaceae family and has a relatively small diploid genome (2n=2x=14) with a dan content of IC=2.36 pg [1]. It is a highly cross-pollinated crop and possesses abundant phenotypic variation with a number of wild relatives (n=5, 7, 8 and 9)including large group with 2n=14 with which it can be intercrossed [1]. Globally, pearl millet is the fifth most important food grain crop following rice, wheat, maize and sorghum. It is probably the world's hardiest crop and holds great potential because of its suitability to the extreme limits of agriculture and is grown on more than 26 million ha in the arid and semi-arid regions of Asia and Africa [2] and 7 to 9 million ha with production of 9.25 million tonnes in India [3]. Pearl millet has great importance as forage and stover crop also and its vegetative matter provides excellent forage because of low hydrocyanic acid content. It is rich in protein calcium, phosphorus and other minerals even though very little attention has been given towards development of pearl millet varieties with regard to green fodder yield and other fodder favorable traits. The production potential of green fodder of pearl millet at present is very low. To improve productivity of the animal population, high fodder yielding pearl millet varieties need to be developed. The present study was therefore under taken to assess accession of paramount performance in terms of green fodder yield and other fetching fodder properties withal nutrient content.

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Materials and Methods

The experimental material for the present study consists of the pearl millet accessions of 24 inbreds collected from Department of Forage Crops, TNAU, Coimbatore, while 11 inbreds and 19 CMS lines (A and B) obtained from ICRISAT, Hyderabad. The 54 pearl millet accessions consisting of 35 inbreds and 19 A and B lines were laid out in randomised block design (RBD) with two replications in the F block of the New Area farm of Department of Forage Crops, CPBG, TNAU during *kharif,* 2015 for characterization of various quantitative and qualitative characters, based on the pearl millet descriptor list published by Bioversity International. Each accessions of pearl millet was grown in two rows of four meter length with a spacing of 45 cm × 15 cm and all the recommended agronomic package of practices were followed to raise a good crop. The observations for different quantitative traits (plant height, number of nodes in main stem, number of tillers per plant, number of leaves per tiller, leaf length, leaf width, leaf weight, stem weight, leaf/stem ratio, green fodder yield per plant, dry matter) were recorded at different stages on five randomly selected competitive plants of each line in each replication as per standard pearl millet descriptors. For biochemical i.e. nutrient quality (crude protein, crude fat and crude fiber content) analysis, the plant samples were collected at the time of panicle initiation and were chopped, air dried and finally oven dried at 60^0C for two days. The oven dried samples were ground and sieved using different sieve sizes. Sieve size of 0.5 mm was used for estimation of crude fiber and 0.1 mm sieve size was used for crude protein and crude fat estimation. Crude protein was estimated by Kjeldahl's method and crude fat was estimated with soxhlet method using petroleum ether while crude fiber estimation was done through digestion with sulfuric acid and sodium hydroxide solution. Mean values were used to determine the paramountcy of accessions over others and to compute the genetic parameters and statistical analysis of data was carried out for each trait as described by Panse and Sukhatme [4].

Results and Discussion

Per se performance is one of the relevant benchmark being used since the start of breeding practices for the selection of noble genotypes [5]. The genotypes with high *per se* performance are selected to forward it in the future breeding program for the development of out performing varieties. The analysis of variance among the genotypes studied showed highly significant differences for all the characters studied, indicating the presence of sufficient variability in the experimental materials of pearl millet. In pearl millet, the highest mean value for green fodder yield per plant (>1.5 kg) was recorded by 15 genotypes viz., GP 16021, IP 20350, RFBJ 16, CO 8, IP 20840/I, IP 20840, RFBJ 10, CO 7, PT 5382, IP 22269, IP 10077, PT 5826, ICMV 05555, RFBJ 3 and IP 18308 (Table 1). Therefore, selection among these genotypes may be adopted in future for improvement of green fodder yield in order to overcome fodder shortage. Genotypes with high mean performance for green fodder yield per plant in guinea grass was reported by Ramakrishnan [6]. Among these, two of the above 15 genotypes viz., GP 16021 and IP 22269 had high leaf weight (>500 g) and leaf stem ratio (>0.50). Higher leaf stem ratio is an important quality indication of palatability of the fodder. When a fodder variety has a higher leafy content, there is lesser rejection by the animals and the total digestible nutrients will also be more [7]. Hence, these genotypes in pearl millet with high leaf weight and leaf stem ratio may be utilized in breeding program for enhancement of green fodder yield and better palatability. The accessions with highest *per se* performance for leaf weight and leaf stem ratio were reported in pearl millet [8]. Dry matter content, which is the actual portion of the feed remaining after all the water has been removed, is the most important fodder quality characteristics. The genotypes viz., PT 5752, ICMB 10999, IP 15564, IP 20840, A5/B1,A5/B5 and IP 13150 recorded high dry matter per cent. Therefore these genotypes could be used in future breeding program for improving dry matter content in pearl millet for fodder purpose. In addition to the above desirable features inpearl millet, the genotypes viz., ICMB 04444, IP 11431, IP 22269/1, RFBJ 89, A5/B4,

Table 1. *Per se* performance of pearl millet genotypes. Highest and lowest mean values are indicated in bold.

Sl. No.	Genotypes	Plant height (cm)	Number of nodes in main culm	Number of tillers / plant	Number of leaves/ tiller	Leaf length (cm)	Leaf width (cm)	Leaf weight (g)
1.	PT 5382	211.38	6.88	4.88	9.70	55.50	4.08	419.36
2.	IP 20350	262.43	9.25	6.75	10.25	61.67	4.94	560.34
3.	GP 16021	242.60	9.38	7.00	10.00	68.67	4.55	1021.06
4.	IP 22269	256.50	7.25	4.33	8.63	61.84	4.55	579.67
5.	IP 20840	240.25	7.63	5.15	10.05	49.67	4.57	437.23
6.	PT 5826	220.88	9.00	6.65	9.25	66.50	5.59	496.26
7.	IP 20379	194.88	5.75	7.50	8.45	61.00	3.92	373.39
8.	DRSB-4	190.90	6.38	3.25	7.95	64.12	3.48	331.31
9.	CO 7	244.38	6.13	4.80	9.90	60.15	4.05	519.23
10.	CO 8	270.63	9.38	6.85	10.30	71.84	4.16	506.38
11.	REBJ	247.13	9.50	2.75	13.25	62.85	4.84	409.54
12.	RFBJ 2	199.80	6.88	3.00	7.25	62.17	4.22	282.18
13	RFBJ 3	200.13	5.53	3.58	9.38	74.17	4.59	348.10
14.	RFBJ 10	214.38	5.40	4.00	7.63	78.34	3.30	556.99
15.	RFBJ 16	244.88	9.00	5.13	9.88	70.50	4.45	512.08
16.	BFBJ 89	186.85	5.50	2.95	7.70	72.67	4.45	241.43
17.	RFBJ 116	229.25	7.05	4.20	10.75	63.67	4.02	465.36
18.	PT 5140	205.63	6.50	4.75	8.25	73.00	3.94	472.70
19.	PT 5749	149.88	5.13	3.05	6.45	62.44	3.32	211.39
20.	PT 5627	180.38	7.23	3.13	8.35	65.50	4.05	295.69
21.	PT 5752	196.50	6.20	2.05	8.15	60.84	4.34	390.86
22.	IP 18308	196.13	6.25	5.38	8.45	73.80	4.92	381.10
23	IP 20840/1	219.75	5.35	4.05	8.75	68.17	5.54	374.24
24.	IP 9445	201.13	5.25	3.20	9.13	62.33	4.05	405.41
25.	IP 10077	201.13	6.20	4.63	9.10	63.17	4.30	398.39
26.	ICMV 05555	226.38	7.25	3.50	9.50	61.17	3.92	303.64
27.	ICMV 05666	193.00	5.83	2.85	7.50	68.34	3.75	274.42
28	ICMV 05777	164.75	5.11	4.75	7.33	69.34	3.12	316.07
29.	IP 11431	181.88	7.38	2.85	8.25	58.17	4.85	520.27
30.	IP 13150	190.00	6.75	3.45	8.63	67.89	3.48	225.68
31.	IP 22269/1	188.75	6.63	2.30	7.70	76.33	3.04	269.35
32.	IP 6140	168.00	6.63	3.25	9.20	54.67	3.07	256.64
33.	IP 6202	163.13	6.50	2.50	7.10	68.34	3.20	310.92
34.	IP 15564	182.63	7.95	3.38	8.55	67.84	3.15	351.81
35.	ICMV 05222	174.38	6.75	6.05	8.88	63.67	3.83	402.30
36.	A5/B1	145.25	3.98	4.25	6.05	40.17	1.95	252.82
37.	A5/B2	150.63	4.38	2.45	6.63	49.00	2.71	191.29
38.	A5/B3	135.00	4.15	1.70	7.55	43.17	3.24	171.09
39.	A5/B4	140.75	4.10	3.40	6.95	40.17	3.42	227.46
40.	A5/D5	153.19	7.13	2.80	7.63	42.33	2.75	295.42
41	A5/B6	118.06	2.60	3.38	4.75	53.00	4.34	239.51
42.	ICMB 01888	61.00	1.63	2.25	4.35	42.50	3.45	143.81
43.	ICMB 03222	135.38	4.23	3.63	8.00	38.34	2.54	139.01
44.	ICMB 02666	80.00	2.50	3.88	3.63	49.17	2.05	140.55
45.	ICMB 03333	93.63	2.85	3.38	6.50	39.17	2.35	239.56
46.	ICMB 09888	115.70	3.58	3.70	5.75	34.85	3.02	167.45
47.	ICMB 09999	108.00	4.53	3.50	6.83	37.92	3.87	217.94
48.	ICMB 10999	111.38	5.50	2.50	7.40	42.50	2.67	165.36
49.	ICMB 00999	119.13	5.88	3.45	5.65	38.67	1.94	166.16
50.	ICMB 02555	137.50	4.25	3.85	7.00	45.84	3.12	283.94
51.	ICMB 04444	142.43	6.00	2.90	6.50	57.25	3.87	169.75
52	ICMB 07999	109.23	3.70	3.50	4.30	41.17	3.25	192.66
53.	ICMB 08999	120.88	6.38	3.50	6.35	32.17	2.62	181.02
54.	ICMB 93222	116.73	4.25	5.88	7.63	46.44	2.89	264.51

Table 1. Continued.

Sl. No.	Genotypes	Plant height (cm)	Number of nodes in main culm	Number of tillers / plant	Number of leaves / tiller	Leaf length (cm)	Leaf weight (cm)	Leaf weidth (g)
	Mean	176.56	5.97	3.92	7.94	57.48	3.70	334.64
	CV	7.43	15.12	21.00	12.40	2.64	10.04	11.30
	CD (0.05)	26.30	1.81	1.65	1.98	3.04	0.74	75.84
	Maxiimum	270.63	9.50	7.50	13.25	78.34	5.59	1021.06
	Minimum	61.00	1.63	1.70	3.63	32.17	1.94	139.01

Table 1. Continued.

Sl. No.	Genotypes	Stem weight (g)	L/S ratio	Dry mater (%)	Green fodder yield/ plant (g)	Crude protein (%)	Crude fat (%)	Crude filter (%)
1.	PT 5382	1182.68	0.39	22.19	1641.42	13.26	6.93	24.52
2.	IP 20350	1307.66	0.43	22.03	1868.00	9.15	4.55	27.01
3.	GP16021	1569.83	0.66	19.63	2590.89	11.09	3.45	22.79
4.	IP 22269	1042.26	0.56	22.44	1621.92	13.29	3.15	27.01
5.	IP 20840	1248.59	0.38	29.52	1717.44	11.75	1.96	27.40
6.	PT 5826	1070.25	0.47	21.77	1566.51	8.92	4.95	27.81
7.	IP 20379	1090.49	0.35	21.68	1463.87	8.23	2.78	28.61
8.	DRSB-4	1094.39	0.31	19.44	1475.71	10.99	4.76	30.74
9.	CO 7	1153.51	9.45	16.21	1672.74	10.87	5.13	25.72
10.	CO 8	1281.18	0.40	16.57	1787.56	10.76	2.44	25.75
11.	RFBJ 1	1041.31	0.40	22.45	1450.86	10.11	2.67	24.97
12	RFBJ 2	952.28	0.30	19.47	1234.46	11.04	4.14	29.23
13	RFBJ 3	1188.10	0.30	24.81	1517.39	12.61	3.62	26.50
14.	RFBJ 10	1135.72	0.49	21.52	1687.11	9.48	4.66	26.42
15.	RFBJ 16	1285.59	0.40	24.53	1797.67	10.61	2.88	30.84
16	RFBJ 89	779.32	0.32	26.22	1020.75	13.51	3.37	23.59
17	RFBJ 116	833.55	0.57	24.10	1298.90	12.69	7.22	27.23
18.	PT 5140	1017.42	0.47	16.84	1490.12	12.81	4.10	30.03
19.	PT 5749	728.47	0.29	23.09	939.85	12.41	4.25	28.10
20.	PT5627	889.88	0.34	21.35	1185.56	11.86	7.22	26.81
21.	PT 5752	855.08	0.45	32.01	1242.10	9.10	4.62	26.47
22.	IP 18308	1123.06	0.34	21.93	1504.16	11.36	6.42	24.15
23.	IP 20840/1	1383.12	0.27	19.99	1757.36	11.16	3.64	25.13
24.	IP 9445	1027.45	0.40	20.09	1432.86	10.62	1.87	26.85
25.	IP 10077	1165.21	0.35	24.72	1576.25	11.69	2.02	27.42
26	ICMV 05555	1252.12	0.24	26.49	1555.75	10.87	2.86	29.82
27.	ICMV 05666	675.36	0.41	22.85	949.78	12.26	4.54	26.00
28.	ICMV 05777	862.72	0.37	22.55	1178.79	10.42	7.26	29.31
29.	IP 11431	945.96	0.55	27.68	1466.23	14.48	3.18	26.46
30.	IP 13150	868.86	0.26	28.05	1094.54	12.74	5.63	27.61
31.	IP 22269/1	814.88	0.33	24.25	1084.23	13.73	4.10	25.77
32.	IP 6140	596.16	0.43	24.95	852.79	12.70	3.08	30.71
33.	IP 6202	791.01	0.40	26.57	1101.93	10.67	7.12	24.36
34.	IP 15564	652.75	0.52	30.23	987.52	12.57	3.21	27.24
35.	ICMV 05222	1001.75	0.39	18.57	1388.33	13.05	3.69	29.67
36.	A1/B1	548.77	0.44	29.33	791.37	12.95	2.95	32.19
37.	A5/B2	698.62	0.28	19.06	889.91	11.21	5.85	25.45
38.	A5/B3	613.04	0.28	19.46	784.13	13.41	4.48	29.82
39.	A5/B4	680.55	0.34	20.54	908.01	13.44	3.65	25.30
40.	A5/B5	590.35	0.51	28.60	885.77	10.78	4.94	26.80
41.	A5/B6	457.50	0.52	23.43	697.01	10.52	7.08	28.81

Table 1. Continued.

Sl. No.	Genotypes	Stem weight (%)	L/S ratio	Dry matter (%)	Green fodder yield/ plant (g)	Crode protein (%)	Crude fat (%)	Crude filter (%)
42.	ICMB 01888	367.83	0.39	22.37	511.64	11.15	8.19	25.29
43.	ICMB 03222	517.25	0.27	24.63	656.26	10.26	3.37	22.61
44.	ICMB 02666	501.81	0.29	26.85	642.36	12.90	3.10	26.90
45.	ICMB 03333	535.46	0.45	22.32	775.02	12.05	4.91	24.67
46.	ICMB 09888	505.25	0.33	25.58	672.70	11.09	5.94	31.22
47	ICMB 09999	545.96	0.40	22.77	761.90	12.26	4.34	25.67
48.	ICMB 10999	591.22	0.27	10.41	751.25	9.95	3.68	25.74
49.	ICMB 00999	622.90	0.27	22.20	789.06	10.70	2.38	26.88
50.	ICMB 02555	609.26	0.47	22.50	892.30	12.84	6.78	24.57
51.	ICMB 04444	651.70	0.26	23.20	821.45	14.65	3.43	23.23
52.	ICMB 07999	457.56	0.42	25.79	650.22	13.11	5.23	26.44
53.	ICMB 08999	515.48	0.35	23.31	696.50	12.23	3.40	28.49
54.	ICMB 93222	602.25	0.42	21.97	854.62	9.80	7.71	24.82
	Mean	861.50	0.39	23.35	1196.36	11.63	4.42	27.00
	CV	8.37	7.82	5.68	8.22	1.59	8.79	3.90
	CD (0.05)	144.57	0.06	2.66	197.29	0.37	0.78	2.11
	Maximum	1569.83	0.66	32.01	2590.89	14.65	8.19	32.19
	Minimun	367.83	0.24	16.21	511.64	8.23	1.87	22.79

A5/B3, IP 22269/1, PT 5382, ICMB 07999 and ICMV 05222 recorded high crude protein content (>13.0%) and among the three genotypes namely, ICMB 04444, RFBJ 89 and PT 5382 recorded high crude protein with low crude fibre content. As the crude fiber content should be low so as to ensure higher digestibility, therefore, the above genotypes with higher crude protein content and lower crude fiber content may be concentrated for the development of nutritive and palatable fodder varieties in pearl millet to escape malnutrition among the animals. Crude protein range of 7.09 to 13.53% and crude fiber range from 23.00 to 33.50% were reported by Ramakrishnan [6] in guinea grass and Satapute et al. [9] obtained crude protein range of 6.79 to 10.97% in pearl millet Napier hybrids. Number of tillers per plant in the most important fodder yield component in forage crops. The effective formation of tillers plays an important role in enhancing the fodder yield in pearl millet [10]. With regard to number of tillers per plant, IP 20379, GP 16021, CO 8, IP 20350, PT 5826 and ICMV 05222 exhibited higher mean values (> 6.0 tillers per plant) for number of tillers per plant in pearl millet accessions. Among 54 genotypes in pearl millet, RFBJ 1, RFBJ 116, CO 8, IP 20350, IP 20840, GP 16021, CO 7, RFBJ 16, PT 5382 and ICMV 05555 recorded maximum number of leaves per tiller. These genotypes have greatest impact on fodder yield, hence due importance may be given among these genotypes for obtaining higher fodder yield in selection program. The superior genotypes identified based on the *per se* performance for different characters are presented in Table 2.

Table 2. Superior genotypes identified based on *per se* performane.

Characters	Name of the accessions
Green fodder yield plant, leaf weight and leaf stem ratio	GP 16021, IP 22269
Dry matter (%)	PT 5752, ICMB 10999, IP 15564, IP 20840, AS/B1, A5/B5, IP 13150
Crude protein (%) with low crude fiber per cent	ICMB 04444, RFBJ 89, PT 5382
Number of tillers per plant	IP 20379, GP 16021, CO 8, IP 20350, PT 5826, ICMV 05222
Number of leaves per tiller	RFBJ 1, RFBJ 116, CO 8, IP 20350, IP 20840, GP 16021, CO 7, RFBJ 16, PT 5382, ICMV 05555

Conclusion

In the above study, based on the per se performance of genotypes with respect to desirable traits, pearl millet genotype GP 16021 was found to be superior in terms of green fodder yield, number of tillers per plant, number of leaves per tiller, leaf weight and leaf stem ratio. This genotype along with other superior genotypes for the specific trait may be utilized effectively in the future breeding program to develop highly productive as well as nutritious fodder pearl millet varieties as well as may be used as female parent with Napier grass to develop high yielding pearl millet Napier hybrid.

References

1. Budak H, Pedraza F, Cregan PB, Beaenziger PS, Dweikat I (2003) Crop Sci 43 : 2284.
2. Gupta SK, Bhattacharjee R, Rai KN, Suresh Kumar M (2011) Characterization of ICRISAT-bred restorer parents of pearl millet. J SAT Agric Res, pp 9.
3. http://www.indiastat.com
4. Panse VG, Sukhatme PV (1967) Statistical methods for agricultural workers. 2nd edn. ICAR, New Delhi.
5. Zaidi PH, Srinivasan G, Sanchez C (2003) Relationship between line *per se* and cross performance under low nitrogen fertility in tropical maize (*Zea mays* L.). Maydica 48 :221—231.
6. Ramakrishnan P (2013) Genetic divergence and analysis of yield components in Guinea grass. MSc (Ag.) thesis. Tamil Nadu Agric Univ, Coimbatore.
7. Ball DM, Collins M, Lacefield GD, Martin NP, Mertens DA, Olson KE, Putnam DH, Undersander DJ, Wolf MW (2003) Understanding forage quality. Am Farm Bureau Fed Publ, pp 1—10.
8. Poorani A (2009) Genetic analysis and heterosis studies for development of dual purpose pearl millet (*Pennisetum glaucum* (L.). R. Br.) MSc (Ag.) thesis. Tamil Nadu Agric Univ, Coimbatore.
9. Satapute SM, Mali AR, Jibhakate PP (2014) Genetic analysis of forage yield and its component traits in bajra × Napier hybrids. Forage Res 40 : 106—108.
10. Zhang X, Gu HR, Ding CL, Ran JS, Xu NX (2009) Relation analysis between yield and morphological traits in *Pennisetum purpureum* Schum. Acta Agrestia Sinica 5 : 020.