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STRATEGIES FOR UTILIZATION OF THE GERMPLASM OF A TROPICAL APOMICTIC BUFFEL GRASS

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A global germplasm collection of 372 accessions of *Cenchrus* have been characterised for their morphological, phenological and reproductive parameters. This germplasm comprised eight species of *Cenchrus, viz., C. ciliaris, C. setigerus, C. glaucus, C. pennesetiformis, C. prieurii, C. biflorus, C. echinatus and C. myosuroides* along with some putative natural hybrids. These accessions were collected from more than 30 countries, majority of them from African countries. Range of variation recorded among these accessions for 21 parameters exhibited high amount of diversity. Based on the yield analysis eleven superior accessions were identified for further evaluation in All India Co-ordinated Trials. The results will be presented in detail and the strategies for conservation and utilization of this predominantly apomictic forage grass will be discussed.

Key words : Buffel grass, *Cenchrus*, apomixis, genetic divergence, ecotypes

The genus *Cenchrus* is distributed in subtropical arid and semi-arid regions comprising northern portion of Gujarat, the whole of Rajasthan, western U.P, Delhi and Punjab with a potential coverage of more than 4,36,000 sq km. It is a major component of *Dichanthium-Cenchrus-Lasiurus* grass cover and entire tract has been known for its livestock industry (Dabadghao and Shankaranarayanan, 1973). Of the 22 species recognised by Clayton and Renvoize (1982) only three have been used as sown pastures (*C. ciliaris, C. setigerus* and *C. pennesetiformis*) with the first being the most important. The genetic improvement in these species so far has been restricted only to selection methods, since the development of germplasm and procedures for hybridization and gene transfer are the greater challenges in breeding apomictic grasses.

A global germplasm of 372 accessions had been collected under an Indo-UK project on forage production. This diverse germplasm consists of eight species of *Cenchrus*, viz. *C. ciliaris, C. setigerus, C. perieurii, C. myosuroides, C. pennesetiformis, C. biflorus, C. echinatus, C. glaucus* and a few accessions of natural hybrids. During 1996, these accessions with a popular cultivar, IGFRI-S-3108 were grown at IGFRI Research farm for characterization, description and classification. The accessions that are agronomically superior are further evaluated to identify the most superior accession to be released as a cultivar on all India basis.

MATERIALS AND METHODS

Seeds of all accessions were raised in polythene bags during 1996 and the seedlings were transplanted into the field after about 5 weeks. Ten plants of each accession were planted with a spacing of 0.5 × 0.5m. Data on fourteen quantitative traits were recorded at fifty per cent

bloom stage on randomly selected 5 plants and averaged, while, data on seven qualitative traits were ranked under different classes. A complete list of attributes used in the analysis is given in Table 1.

Table 1. Attributes measured for 372 accessions of *Cenchrus* species

1.	Dry matter yeild	g/plant
2.	Dry matter content	in per cent
3.	Green Fodder yield	g/plant
4.	Number of days to 50% flowering	1 to 5 scale (Early to Late)
5.	Plant height	1 to 5 scale (Low to high)
6.	No. of tillers per plant	No./plant
7.	No. of leaves per plant	No./plant
8.	Leaf length	cm
9.	Leaf breadth	cm
10.	Peduncle length	cm
11.	Spike length	cm
12,.	Spike width	cm
13.	No. of spikelets per spike	No./spike
14.	Wt. of 100 fascicles	g
15.	Early vigour	Excellent, Very good, Good, Poor, Very poor
16.	Growth habit	Erect, Semi-erect, Prostrate
17.	Leaf type	Rough, Smooth
18.	Plant/Leaf colour	Dark green, Light green
19.	Culm formation	Very low
20.	Bur colour	Black Brown, Purple straw, Purple Green straw
21.	Spine arrangement	Highly spined long, Highly spined short, Moderately spined, Less spined long, Less spined short and Spineless

The selected superior accessions with a popular cultivar as a check were evaluated in a randomised complete block design with 3 replications. Each replication consisted of 12 blocks of 40 plants each. Observations on ten agronomically important traits were recorded. The data on twenty one traits of the germplasm were tabulated as a frequency distribution in 5 groups for quantitative traits and under respective classes as measured for qualitative traits. The analysis of variance was carried out for ten agronomic traits using the statistical package SPAR1.

RESULTS AND DISCUSSON

The results of the analysis on the range of variation and the frequency distribution of accessions is presented in Table 2a and 2b. A wide range of variation was observed in both quantitative and qualitative traits. Morphotypes in the study demonstrated the vast diversity found in natural populations of apomictic *Cenchrus*. Wide differences were observed among accessions in plant height, number of tillers per plant, leaf characteristics, number of spikelets per spike, 100 fascicle weight, dry matter percentage, growth habit, culm formation and spine arrangement. These differences suggested the possibility of different apomictic taxa in the population. Many accessions were found to be either early maturing or late maturing. Hignight *et al.*, (1991) had also observed vast diversity in the natural populations of *Cenchrus ciliaris* in plant height, leaf characteristics, growth habit and foliage colour. In another study, Pengelly *et al.*, (1992) found no variation in caryopsis weight, whereas maturity and plant height contributed the most to delineate the groups. In Australia, a large collection of *C. ciliaris* and *C. setigerus*, including some hybrid accessions has been characterized on the basis of physiological, morphological and agronomic features of four plants of each accession (Eagles *et al.*, 1992). There was no consistent relationship between both country of origin and the six groupings based on 16 traits. They found that some of the measured traits were mutually

Tabl 2a. Range of variation and frequency distribution for 14 quantitative characters in *Cenchrus* species

S.No.	Characters	Range of variation in each of 5 groups and number of cultivars in each group				
		1	2	3	4	5
1.	Dry matter yeild (g/pl)	10-96 **148**	96.1-182 104	182.1-268 **29**	268.1- 354 **6**	354.1-440 **2**
2.	Dry matter %	18.8-23.9 **22**	23.93-29 **97**	29.07-34 **128**	34.2-39 **33**	39.3- 44.4 **8**
3.	Green Fodder yield (g/pl)	15-3021 **32**	302.7-590 **117**	590.5- 878 **32**	878-1166 **9**	1166-1450 **2**
4.	Number of days to 50% flowering	16-44 **220**	44.4-72 **15**	72.9- 101 **2**	10.4,129 77	129.9-158 **40**
5.	Plant height	21.6-41 **70**	41.1-60 **149**	60.5-80 **89**	80.1-99 **35**	99.5-118 **16**
6.	No. of tillers per plant	7.2-55 **68**	55.6-104 **152**	104.1-152 **98**	152.6-201 **38**	201.1-249 **3**
7.	No. of leaves per plant	0.46-3 **1**	3.2-6 **21**	6.1-8 **163**	8.9-11 **153**	11.7-14.5 **21**
8.	Leaf length (cms)	5.2-1.0 **52**	10.8-16 **165**	16.4-22 **115**	22.1- 27 **21**	27.6-33.2 **6**
9.	Leaf breadth (cms)	0.4-0.5 **42**	0.53-0.6 **141**	0.67-0.8 **132**	0.81-0.9 **35**	0.94-1.08 **9**
10.	Peduncle length (cms)	2.8-9 **101**	9.6-16 **166**	16.5-23 **79**	23.3- 30 **11**	30.2-37 **2**
11.	Spike length (cms)	2.5-5 **55**	5.04-7 **190**	7.5-10.1 **105**	10.1- 12 **8**	12.6-15.2 **1**
12.	Spike width (cms)	0.42-0.9 **79**	0.98-1.5 **252**	1.54-2 **25**	2.1- 2.5 **1**	2.66-3.22 **1**
13.	No. of spikelets per spike	11.0-49.0 **92**	49.9-88 **166**	88.8127 **87**	127.7-166 **8**	166.6-205 **2**
14.	Wt. of 100 fascicles	0.053-0.2 **96**	0.21-0.3 **161**	0.36-0.5 **41**	0.52-0.6 **20**	0.68-0.83 **4**

antagonistic and there was no indication of phenotypic plasticity. Nicholson *et al.* (1985) included rhizome number and growth habit in their list of attributes most useful in distinguishing between cultivars of *C. ciliaris*. Our collection is dominated by *C. ciliaris* followed by *C. setigerus* and *C. preieurii* with only one accession of *C. echinatus, C. glaucus* and *C. biflorus* and two accessions of *C. myosuroides* and *C. pennesetiformis*. Hence, there is some merging of these species in different groups indicating *C. ciliaris* as a most widespread and diverse species.

Based on the results of analysis of germplasm for agronomic traits, eleven superior accessions were identified and were further evaluated along with a check variety IGFRI 3108 for yield and related agronomic traits. The mean performance of these twelve accessions for ten traits with their analysis of variance is shown in Table 3. These selected accessions differed significantly among

Table 2b. Range of variation and frequency distribution for seven qualitative traits

1.	Early vigour	Excellent	Very good	Good	Poor	Very poor		
		7	69	154	131	10		
2.	Growth habit	Erect	Semi erect	Prostrate				
		67	137	155				
3.	Leaf type	Rough	Smooth					
		302	57					
4.	Plant/Leaf colour	DG	DGP	G	G	LG	LGP	PG
		29	16	142	P42	97	18	5
5.	Culm formation	Very low	Low	Moderate	High	Very High		
		19	86	121	88	45		
6.	Bur colour	Black	Brown	Purple	Straw purple	Green	Straw	
		1	8	63	134	2	118	
7.	Spine arrangement	1	2	3	4	5		
		73	61	78	63	50		

Table 3. Mean performance of 12 accessions of *C. ciliaris* for ten agronomic traits

Accession Number	Plant height	Number of leaves	Leaf length	Leaf length	Leaf breadth	Number of tillers	Leaf/stem FW	Leaf/stem DW	GFY	DMY	Seed no./100 burs
1. EC 397712	97.33	10.77	33.77	33.77	0.81	27.43	0.7	0.67	22.9	44.68	98
2. EC 397707	106.43	11.9	35.13	35.13	0.8	24	0.66	0.73	20.93	41.42	77.67
3. EC 397692	114.9	12.1	33.47	33.47	0.79	31.13	0.56	0.6	25.53	46.16	68.33
4. EC 397631	118.87	11.03	38	38	1.08	41	0.8	0.,81	29.97	64.14	25
5. EC 397497	122	11.77	34.37	34.37	0.97	39.33	0.57	0.56	27.4	57.65	36.67
6. EC 397490	80.23	11.1	25.63	25.63	0.75	42.57	0.75	0.81	18.27	33.98	34.67
7. EC 397488	110.23	12.1	39.57	39.57	0.8	28.77	0.69	0.67	25.07	50.65	77.33
8. EC 397486	108.9	11.77	39	39	0.8	32.8	0.65	0.82	29.1	50.31	57.67
9. EC 397434	108	13.1	40.57	40.57	0.89	35.23	0.71	0.74	27.13	44.88	52
10. EC 397410	130.33	12.77	42.67	42.67	0.94	38.43	0.57	0.56	31.97	65.85	69.33
11. EC 3108	123.57	12.57	37.43	1.17	35	0.58	0.51	26.6	60.17	43	
12. EC 397327	126.43	11.8	34.1	34.1	0.97	32.57	0.53	0.48	27.03	55.8	43.33
Mean	112.27	11.89	36.14	0.89	34.02	0.65	0.66	25.99	51.31	56.92	
F'value	2.58*	1.08	2.02	2.02	3.99**	1.82	2.43*	2.88*	2.25*	2.43*	2.86*

*Significant at 5%level **Significant at 1% level

themselves for green fodder yield, dry matter yield, number of caryopsis per 100 fascicles, plant height, leaf width, leaf to stem fresh and dry weight. Whereas, there was no significant difference for traits such as number of leaves, leaf width and number of tillers. This once again confirmed the presence of high amount of variation for most of the characters in the germplasm. Thus, six

superior accessions *viz.*, ECS 397497, 397631, 397434, 397410, 397327 and 397490 that performed better than the check variety for yield (Green fodder yeild and dry matter yield) were entered into All India Co-ordinated trials for multi-locational testing during 1998. Performance of eight strains of *C. ciliaris* was studied by Rai *et al.*, (1982) under rain-fed conditions. They also observed significant variations in forage yield of these strains. They found that two cultivars, namely IGFRI-S-3108 and S-357 were equally good for quality forage production.

The results of this study provide a better understanding of the nature of morphological differences among native apomictic *Cenchrus* accessions and help to clarify relationships among a selected group of diverse apomictic ecotypes of this species. Although most *Cenchrus* ecotypes reproduce by obligate apomixis, completely sexual plants are very rare in the native habitat. Based on the information obtained in this study it is postulated that the investigated divergent ecotypes represent a primary gene pool to improve this speices.

The range of variation recorded was significant for its ultimate use in breeding. Where sexual material is available, manipulation by breeders may be done through direct hybridization between parents for recombination and selection of desirable traits. Thus, screening of the collection for the mode of reproduction would, however, first be necessary. A rapid practical approach to exploit this high level of variability found would be to multiply seed stocks and construct a series of composite cultivars. These should be assessed in different environments. Artificial selection of adapted strains would in times lead to the establishment of cultivars with a wide genetic base. This has obvious advantage in stress environments.

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