Studies on Isolation of Superior Clones in Four Species of Fodder Grasses

by

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The natural variation in fodder grasses provides a wealth of material for studying the nature and origin of such variations, based on which effective breeding programmes can be formulated. The importance of species like *Cenchrus ciliaris, Chloris gayana*, *Brachiaria mutica* and species of *Setaria* in augmenting the fodder resources has been well recognised (Libenberg, 1950; Sample, 1951; White 1957). Cytomorphological investigations on clones of *Cenchrus ciliaris* and *C. setigerus* indicated the polymorphic nature of both species and occurrence of intra-specific chromosomal forms (Patel *et al.*, 1961; Ponnaiya *et al.*, 1965; Ramaswamy *et al.*, 1969; Ramaswamy and Raman, 1969) Diploid and tetraploid races of *C. gayana* are known to occur (Darlington and Wylie, 1955). No numerical variation in chromosomes was present in the clones of *B. mutica* and species of *Setaria* investigated upon. Selection of strains from the point of view of fodder development can be successful in view of the variability of the population and maintenance of constancy in the behaviour of progenies due to apomictic reproduction (Atwood, 1947; Carnhan and Helen, 1961; Raman, 1966). The results of yield trials conducted with clones of the four species of fodder grasses mentioned above for evolving high yielding genotypes are summarised below.

Material and Methods: Fifty six clonal accessions comprising 32 in *C. ciliaris;* ten in *C. gayana;* six in *B. mutica* and five in *S. sphacelata* and one each in *S. superba; S. pallidifusca* and *S. holstii* were tested for yield adopting the randomised replicated design (Table 1). The plots were manured adequately at the commencement of the experiment. Uniform sized slips were used as planting material. A single row consisting of 8 slips formed one replication of which the middle six stools alone were taken up for experimental purposes. Observations on height of the tallest tiller, number of tillers and weight of green matter produced per clump were recorded at the time of each cutting. For estimating leaf/stem value, 24 clumps were marked at random. From each clump, five tillers in bloom were cut and the weight of leaf and stem was recorded separately.

Results: I. *Evaluation of clones for yield and attributes related to fodder production:*

1. *C. ciliaris*: Thirty two clonal accessions were compared in two series of yield trials.

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TABLE 1. *Summary of data from yield trial*

	Cenchrus ciliaris Series I	*Cenchrus ciliaris* Series II	*Chloris gayana*	*Brachiaria mutica*	*Setaria* sp
No. of clones	13	19	10	6	8
No. of replications	4	4	8	6	4
Spacing (cm)	76×61	76×61	61×61	92×61	78×61
Date of planting	29-9-64	19-10-64	5-9-64	1-9-64	1-9-64
Date of first cutting	19-1-65	8-4-65	6-11-64	23-10-64	10-11-64
Date of last cutting	15-12-65	17-1-66	20-10-65	8-11-65	10-1-66
Mean No. of days/cutting	47	40	43	47	53
No. of observations made					
i. Height	6	6	6	8	6
ii. Tillers	6	6	6	8	6
iii. Stem thickness	6	6	–	8	–
iv. Yield	7	7	8	8	8

Series I: Two tetraploids (G. 444 and G. 350) recorded the minimum and maximum yields of 536 and 4901 gm respectively per clump. The type G. 444 was the shortest (50 cm) whereas the other is a tall growing one (95 cm). In respect of tillering and thickness of internode, the latter was superior to the former. The 54 and 56 (2n) chromosome races appeared to be poor yielders. The three clones with 2n = 44 chromosomes were ranked third, fifth and eighth in green matter production; the clone with 2n = 34 chromosomes occupied the fourth place. In two clones with 2n = 44 chromosomes and another with 2n = 34, tillers with maximum length were noticed. Clone G. 312 (2n = 44) which was ranked second in respect of length of culm produced the maximum number of tillers. A tetraploid and a hexaploid accession produced very low number of tillers. Clones with high yields in general, had thicker clums. A clone (G. 312) which stood first, second and third in order of merit for tillering, length and thickness of stem respectively could not give the maximum yield.

Series II: The highest yield was obtained in clones with 2n = 44 chromosomes. Two tetraploids from South Africa gave very low yields. The two 2n = 34 chromosome types also were poor yielders. A perusal of yield data would indicate that clones with 2n = 36 and 44 chromosomes overlap in respect of yield of green matter. Clones from South Africa in general, showed considerable variabilily in respect of this attribute. The height of clones ranged from 80.3 cm to 129.5 cm, the maximum being exhibited by a tetraploid (G. 349) and the minimum by a 2n = 34 race. In respect of number of tillers, a tetraploid race produced the minimum and the maximum number by a 2n = 44 race. In general, clones with high tillering gave high yield of green matter. No consistent association could be found between thickness of stem and other characters studied. The clones with 2n = 44 chromosomes in general, appear to be better yielders. Variation in respect of the characters studied was found to be greater in the tetraploid clones (Table 2).

TABLE 2. *Yield of green fodder in clones of Cenchrus ciliaris*

Accession No.	Yield of green fodder (gm)	Height of culm (cm)	No. of tillers	Thickness of stem (mm)
Series I				
444	536	49.4	37.8	2.43
418†	790	56.6	18.0	2.65
192	937	79.7	19.0	3.25
314††	1319	73.9	34.0	2.53
451**	1517	59.2	34.0	2.90
310	1551	62.2	42.3	2.70
187	2188	70.9	36.8	2.53
309	3008	88.9	61.8	2.90
195**	3308	98.0	57.5	3.25
301*	3518	95.8	44.3	3.08
312**	3572	96.8	75.0	3.10
311	4441	70.2	50.5	2.70
350	4901	95.1	58.8	3.08
C.D.	968	11.2	18.6	0.37
Series II				
294**	6066	103.0	62.8	2.80
387**	4983	115.3	55.8	3.18
319	4727	119.0	48.3	3.25
408**	4649	109.8	58.8	3.23
349	4319	129.5	62.3	3.03
316	4299	115.3	58.8	3.15
424	4267	108.0	53.5	3.05
318**	3846	126.5	48.8	3.25
11	3731	116.5	56.5	3.03
305	3689	86.0	44.8	3.00
321**	3663	111.8	49.0	3.25
426*	3581	80.3	57.8	2.73
10	3485	120.5	45.0	3.30
422*	3451	110.5	44.3	3.05
378**	3326	116.5	53.5	3.30
320**	2978	119.8	48.0	2.95
317	2766	111.5	32.8	2.80
419	2183	86.0	44.8	2.75
420	1737	93.3	38.5	2.58
C.D.	1339	13.31	Not significant	0.11

a) Somatic chromosome number of the clones * = 34, ** = 44, † = 54, †† = 56 and the rest 2n = 36.

b) Accessions, 187 and 309 are from Costa Rica; 319, 349, 424, 318, 422, 419 and 420 are of African origin and the rest from India.

The range of variation in yield of green fodder and attributes related to yield in respect of the clones of five different chromosomal forms is furnished below (Table 3).

TABLE 3. *Variation in chromosomal forms of Cenchrus ciliaris in respect of yield of green fodder and attributes associated with yield (range/mean)*

Chromosome number	Number of clones	Yield (gm)	Height (cm)	Tiller number	Internode thickness (mm)
34	3	3451–3581/3517	80–110/ 95	44–58/49	2.8–3.1/3.0
36	17	536–4901/3102	49–129/ 94	19–62/46	2.4–3.3/2.9
44	10	1551–6066/3794	62–126/106	42–75/55	2.7–3.3/3.1
54	1	790	57	18	2.6
56	1	1319	74	34	2.5

2. *Chloris gayana:* Of the ten accessions studied, one was a tetraploid (2n = 40) and the rest diploids. The tetraploid was distinct from the diploids by its taller growth, dark-green foliage, thicker stems and long and broad leaves, larger panicles and occurrence of bloom on leaf sheath and internodes. Most of the diploids were semi-erect while a few had the trailing habit also.

Eight cuttings were taken. The results indicated the existence of significant differences among the clones in respect of plant height, tillering capacity and yield of green matter. A diploid (G. 327) recorded the maximum yield. The tetraploid type (G. 328) gave poor yields next only to that of an accession of exotic origin (G. 427). With regard to plant height, the diploid clones showed variation. A few diploids, however, could not attain the same height as that of the tetraploid. The clone (G. 327) which gave the maximum yield had as many as 97 tillers. The number of tillers formed in the tetraploid was only 36. It appears that tillering and yield of green matter is closely associated. Tetraploidy noticed in this species can be profitably utilised for hybridisation of tetraploids with diploids which are highly tillering types for evolution of vigorous triploids (Table 4).

3. *Brachiaria mutica:* Six clonal accessions, all tetraploids (2n = 36) were compared. Eight cuttings were taken during the period of experimentation. Flowering was noticed in the accessions from Bihar (G. 389) and New Delhi (G. 406) during winter while nil to stray flowering occurred in types G. 76 and G. 374. Tall growing types produced fewer number of tillers than the dwarf ones. However, neither the tall growing type which produced the minimum number of tillers nor the dwarf ones possessing the maximum number of tillers have given the highest yield. The clone from Bihar combining medium height and average number of tillers produced more green matter than others. Number of tillers and thickness of stem appear to be negatively associated since highly tillering types always possessed thin stems. The yield of green matter appears to be

influenced more by number of tillers and thickness of stem than by height of culms (Table 4).

TABLE 4. *Yield of green fodder in clones of Chloris gayana, Brachiaria mutica and species of Setaria*

Accession No.	Yield of green fodder (gm)	Height (cm)	Number of tillers
Chloris gayana			
327	3808	110.5	97.0
431	3639	103.9	71.3
325	3575	109.4	77.8
429	3478	114.1	72.4
326	3023	111.9	67.3
430	2775	105.5	57.3
Local	2715	113.0	64.4
428	2629	113.6	48.2
328	2389	113.3	35.8
427	2070	101.5	45.3
C.D.	667	5.51	11.61
Brachiaria mutica			
389	4953	175.8	58.0
76	4693	154.7	76.8
384	4586	177.3	55.3
376	4460	174.3	52.2
374	4330	152.2	75.5
406	2747	187.2	27.3
C.D.	571	10.10	8.6
Species of Setaria			
345	6098	98	62.7
338	5669	132	35.0
342	6054	100	73.5
339	5361	98	46.2
340	5074	102	62.5
343	4609	127	52.7
341	4498	107	59.8
344	5022	116	55.8
C.D.	1190	8.3	12.29

Source of collection: 429 (Australia); 427, 345, 339 and 340 (Africa) and the rest from India.

4. *Species of Setaria:* Eight accessions, all tetraploids (2n = 36) comprising the species, *S. holstii* (G. 538), *S. pallidefusca* (G. 344), *S. sphacelata* (G. 339 to 343) and *S. superba* (G. 345) were compared. The resuls indicated significant clonal differences in respect of height of plants, number of tillers and weight of green matter produced. In yield, *S. superba* appears to be the best closely followed by clone G. 342 of *S. sphacelata*. No consistent relationship could

be noticed between the three characteristics. However, number of tillers appears to be more closely related to yield than height of plants (Table 4).

The frequency distribution of clones in respect of yield of green matter in the four species of grasses is given below (Table 5).

TABLE 5. ***Frequency distribution of clones in respect of yield of green matter (kg)***

	No. of clones	0.51–1.00	1.01–1.50	1.51–2.00	2.01–2.50	2.51–3.00	3.01–3.50	3.51–4.00	4.01–4.50	4.51–5.00	5.01–5.50	5.51–6.00	6.01–6.50
C. ciliaris	32	3	1	3	2	2	5	7	4	4	–	–	1
C. gayana	10	–	–	–	2	3	2	3	–	–	–	–	–
B. mutica	6	–	–	–	–	1	–	–	2	3	–	–	–
Setaria sp.	8	–	–	–	–	–	–	–	1	1	3	1	2

II. Association between yield and leaf/stem value: Among the several attributes that determine the quality of a fodder grass, the proportion of leaf to stem is an important one. An attempt was made to assess the leaf/stem values in the clones of four species of grasses (Table 6).

TABLE 6. ***Frequency distribution of clones in respect of Leaf/Stem value***

	0.41–0.50	0.51–0.60	0.61–0.70	0.71–0.80	0.81–0.90	0.91–1.00	1.01–1.10	1.11–1.20
C. ciliaris	–	2	10	8	4	4	3	1
C. gayana	–	–	–	7	3	–	–	–
B. mutica	–	1	4	1	–	–	–	–
S. sphacelata	1	1	1	–	–	2	–	–

In *C. ciliaris*, a consideration of the scatter diagram drawn to represent the association of leaf/stem value, yield of green fodder and chromosome number of 32 clones showed no close association. Clone G. 294 (2n = 36) gave high yield and high leaf/stem value of 1.16 whereas clone G. 311 (2n = 36) yielded 4440 gm of green matter, but had a low leaf/stem value of 0.56. The introduced types, in general, are better yielders with high leaf/stem values irrespective of the chromosome number. Considering the combination of these two characters, clones 294, 349 and 424 appear to be outstanding and these possess the light blue-green foliage. It is evident that the chromosome number of individual clones has very little bearing on their relative productivity or quality which appears to be governed by differences in genic combinations. The blue-green foliage types cannot be said to be superior yielders. Most of them have an intermediate position. A few, however, have high yield and high leaf/stem value.

In *C. gayana*, the values among diploids ranged from 0.73 to 0.88 and the differences were not significant. A clone (G. 327) originating from an accession collected at Ootacamund recorded the highest yield and also a high leaf/stem value. The tetraploid clone gave a low yield of fodder compared to some of the diploids and the leaf/stem value was also comparatively lower. Considering the high range of variation in diploids and the capacity of some of them to give high leaf/stem values and greater quantity of fodder, selection in diploids offers greater scope for improvement.

In *B. mutica*, among the six clones tested, no significant differences were noticed in the leaf/stem value, though they differ significantly in yielding ability.

In *S. sphacelata*, significant differences were noted both in leaf/stem value and fodder yield. An accession from Africa (G. 340) gave the maximum leaf/stem value (0.90) while the highest yield was recorded by clone G. 342 possessing a leaf/stem value of 0.61. As there does not appear to exist any close association between yield of fodder and leaf/stem value, it becomes necessary that the two characteristics should be independently weighted in selection for improvement of this species.

Summary: Attributes related to fodder production were found to be based on either chromosomal or genic differences depending upon the species concerned. Thirty two clones in *C. ciliaris*, ten in *Chloris gayana*, six in *Brachiaria mutica*, five in *Setaria sphacelata* and one in each in *S. superba*, *S. pallidefusca* and *S. holstii* were compared. Significant differences in yield were noticed among the clones in each species.

A study of the chromosomal and morphological variation in *C. ciliaris* has shown the species to form a complex with five different chromosomal forms. The pattern of morphological variation in the chromosomal groups does not indicate any strong association of any chromosomal form with a particular type of character combination. It has been found that tillering, rhizome activity, height of plant, size of leaves and thickness of stem — aspects related to yield of green matter showed considerable variation. Types with 36 or 44 chromosomes (2n) possessing active rhizomes and dark green to blue-green foliage had greater vigour and yielded better than others.

Two chromosomal forms have been isolated in *Chloris gayana*. The tetraploid in spite of its taller growth, bigger leaves and thicker stems could not out-yield the diploid because of its poor tillering capacity. The clone (diploid) from Ootacamund gave the maximum yield.

In *Brachiaria mutica*, a clone from Bihar gave the maximum yield. Clones possessing medium height and intermediate in tillering capacity have recorded more yield than either highly-tillering or tall-growing types.

Of the four species compared in *Setaria* viz., *S. sphacelata*, *S. superba*, *S. holstii* and *S. pallidefusca*, one clone in each of *S. superba* and *S. sphacelata* have given the maximum yield.

An attempt was made to correlate the leaf / stem value by weight to the gross yield of different clones. The data indicated little association between these two characteristics in *C. ciliaris.* It was evident that the chromosome number of individual clones has little bearing on their relative productivity or quality which appears to be governed by differences in genic combinations. In *B. mutica* and *C. gayana* there were no significant clonal differences in the leaf / stem value, though fodder yields were significantly different. Though morphological variation in diploids is limited, improvement in *C. gayana* by selection in the available diploid clones, emphasising a greater leaf / stem value and yield of fodder can be effective. In *S. sphacelata,* the clones did not show any strong positive correlation between yield and leaf / stem value indicating thereby that these two characteristics have to be independently weighted in selection for improvement of this species. Based on yield trials, superior clones of four species of grasses were isolated and multiplied.

Acknowledgements: The investigations reported herein were undertaken under a scheme jointly financed by the State Government and the Indian Council of Agricultural Research.

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