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Polyhaploidy in *Cenchrus setigerus*

by

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Cenchrus setigerus is a polymorphic species comprising four chromosomal forms viz., 2n=34, 36, 37 and 54 (Darlington and Wylie, 1955; Patil *et al.* 1961; Jagannath, 1963). The 54-chromosome form is distinct from the rest in being more vigorous, taller, highly tillering with dense setting of spikelets on thick, long peduncles. Meiosis is characterised by multivalent associations and aberrations of chromosomal behaviour usually associated with apomicts. A cytological study of accessions which appeared to be on morphological grounds hexaploids, has confirmed their hexaploid status. During observations on the breeding behaviour of hexaploids in a population of plants resulting from the cross of *C.setigerus* (2n : 54) × *Pennisetum squamulatum* (2n : 54) as well as in selfed progenies, haploid plants were detected. The morphological characteristics and cytological behaviour of these polyhaploids are presented below:

Materials and Methods: Twenty two plants were raised from seeds obtained under bagging from a hexaploid plant, of which one was found to be reduced in height and on examination was found to be a haploid. This is referred to in the text as polyhaploid No. 1.

The second haploid plant was detected in the progenies raised from seeds gathered after dusting pollen of *Pennisetum squamulatum* (2n=54) on a 54-chromosome plant of *C.setigerus*. This polyhaploid No. 2 was similar in characteristics to the first plant. Young panicles were fixed in Carnoy's fluid and meiosis was studied in temporary acetocarmine smears of p. m. cells.

Observations: Both the haploids exhibited significant reduction in height, tillering, number of internodes per tiller, length and thickness of internode and peduncle. size of leaf and panicle, percentage of fertile pollen and seed

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setting compared to the progenitors (Table 1). The colour of foliage was light green in the haploids while in the hexaploid it was dark green, which was a distinctive feature. The chromosome associations ranged from quadrivalents

TABLE 1. *Morphological characteristics of the hexaploid and its haploid and pentaploid derivatives*

Characters	Hexaploid (2n=54)	Haploid (2n=27)	Pentaploid (2n=45)
Foliage	Dark green	Green	Green
Height (cm)	135	59	51
Number of tillers	37	6	3
Nnmber of internode/tiller	14	12	13
3rd internode length (cm)	4.12	0.95	2.0
4th leaf length (cm)	29.60	12.70	14.1
4th leaf breadth (cm)	0.76	0.41	0.40
Peduncle length (cm)	23.56	14.83	8.30
Exsertion (cm)	13.78	9.20	8.20
Panicle length (cm)	11.29	4.66	9.20
Panicle width (cm)	1.32	0.95	0.97
Number of spikelets per panicle	103	24	96
Density of spikelets/cm	9.36	4.32	10.12
Pollen fertility (%)	66.80	1.80	87.50
Seed fertility (%)	63.00	1.00	62.30

to univalents at diakinesis and metaphase I. Twenty P. M. cells in each of the haploids were examined and the behaviour of the two was essentially similar. The associations noted were as follows :

Chromosome associations at diakinesis and metaphase I.

	IV	III	II	I
Range	1 – 2	2 – 8	1 – 9	0 – 7
Mean	1.27	4.0	4.29	1.50

The maximum association was represented by $2_{IV} + 3_{III} + 4_{II} + 2_{I}$. Formation of 1 – 3 autosyndetic pairs was evident from the following associations. $3_{III}+7_{II}+4_{I}$, $4_{III}+6_{II}+3_{I}$, $6_{III}+4_{II}+1_{I}$, $7_{III}+2_{II}+2_{I}$, $4_{III}+7_{II}+1_{I}$, $5_{III}+6_{II}$, $4_{III}+7_{II}+1_{I}$, $5_{III}+6_{II}$, $3_{III}+9_{II}$, $1_{IV}+5_{III}+4_{II}$, $2_{IV}+2_{III}+6_{II}+1_{I}$ and $1_{IV}+2_{III}+8_{II}+1_{I}$. The univalents passed at anaphase to the poles forming, by random distribution, groups of 14/13, 12/15, 11/16, 10/17 and 9/18. The disjunction of bivalents and quadrivalents was normal, while the bivalents exhibited a 2/1 separation. Laggards upto a maximum of 7 was noticed due to delayed movement of univalents. Bridges were also frequent. The second division was characterised by lethargic movement of chromosomes and non-synchronisation in the division of daughter nuclei. Spindle abnormalities were rare. Because of lagging chromosomes, micronuclei were also frequently seen.

Microspores of varying sizes were noticed which underwent early degeneration. The maximum pollen and seed fertility was 4%.

Of the six seedling progenies of the haploid raised from open pollinated spikelets, five were found to be haploids. The haploids like the maternal parent were reduced in size of plant parts compared to the normal form. The sixth plant was distinct in vigour, tillering and other morphological characters from the normal tetraploid forms and was found to have 45 (2n) chromosomes as revealed from a study of its meiosis. The maximum association of chromosomes noticed was $2_{V}+5_{IV}+2_{III}+3_{II}+3_{I}$. The association indicated that the pentaploid could have originated by the fusion of an unreduced egg with a haploid sperm of the tetraploid (2n=36). The haploid thus offers scope for producing new forms by outcrosses. It is evident that functioning of unreduced egg is a common feature which contributed to the apomictic phenomenon in this species (Snyder *et al.* 1958), which is here noticed to occur even at the haploid level.

Discussion: The haploids have probably arisen parthenogenetically either by delayed pollination or by the stimulation provided by the foreign pollen. The frequency of occurrence was 4.5%. They were somewhat weaker than the normal diploids (2n=36) and reduced in size of plant parts as other haploids. However, they possessed denser setting of spikelets and longer bristles,—features of an allied species, *C.ciliaris.* Similar new expressions have been reported in haploids of rice (Katayama, 1954), *Dactylis glomerata* (Muntzing, 1943) and *Crepis capillaris* (Hollingshead, 1928).

The high frequency of trivalents, bivalents and univalents indicate that out of the three genomes two are more closely related and the third is partially homologous to the rest. A significant feature is the formation of quadrivalents and autosyndetic bivalents indicating internal homologies within a genome.

Fisher *et al.* (1954) and Brown (1948) suggested the basic number of the genus *Cenchrus* as x=9. Jagannath (1963) contended 8 as the basic number and the secondary basic number of 17 could have developed by hybridisation between x=8 and x=9 forms. The inference from the chromosome pairing in the haploids studied herein would be that the basic number is lower than nine for the genus.

The morphological characters of the polyhaploid of *C. setigerus* as well as its cytological behaviour at meiosis points to introgression from the sympatric species, *C. ciliaris.* On hybridisation of tetraploid forms of the two species, the hexaploid resulting from the fusion of an unreduced gamete of one parent and a reduced gamete of the other, is likely to be cytologically stable and capable of forming a higher frequency of quadrivalents than hexavalents (Table 2). New combination of morphological characters unnoticed in the parental species will also be expressed. The genomic constitution of the hexaploid may be represented as AAA'A' A'A".

TABLE 2. *Chromosome associations in tetraploid and hexaploid forms of Cenchrus setigerus and C. ciliaris*

	Maximum						Mean					
	VI	V	IV	III	II	I	VI	V	IV	III	II	I
C. ciliaris 2n : 36	—	—	8	—	2	—	—	—	3.64	—	10.70	—
C. setigerus 2n : 36	—	—	8	—	2	—	—	—	3.48	—	11.04	—
C. setigerus 2n : 54	2	—	6	1	7	1	0.75	0.07	4.61	0.11	11.01	2.0

Summary: Two polyhaploids were detected in *Cenchrus setigerus*, one on selfing the hexaploid form (2n:54) and the other in the progeny resulting from pollination of a hexaploid with pollen of *Pennisetum squamulatum*. The two haploids resembled each other in morphological and cytological features. A maximum association of $2_{IV}+3_{III}+4_{II}+2_{I}$ was noticed at metaphase I. However, the maximum frequency of multivalent associations noticed was $8_{III}+1_{II}+1_{I}$, which indicated the homology of the three genomes involved in the polyhaploid. Yet the association of $1_{III}+8_{II}+8_{I}$ would suggest the closer homology of two of the three genomes.

The haploids in their morphological attributes resembled the maternal parents except for a reduction in the size of plant parts. Of the six seedling progenies examined, five were haploids but the sixth one had 2n:45 chromosomes and was distinctly superior in vigour and tillering from the normal tetraploid form. The haploid offers scope for producing new forms by outcrosses.

From the morphological features and cytological behaviour of the polyhaploid it could be said that the hexaploid forms have arisen directly by hybridisation between tetraploid forms of *C. setigerus* and *C. ciliaris*. The two species being sympatric and highly cross-pollinated, the formation of hexaploid hybrid forms through (2n)×(n) gametic fusion can be prevalent in nature, as noticed in *C. ciliaris*.

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Studies on the Erodibility of Ootacamund Soils

by

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Introduction: Large scale accelerated soil erosion was taking place in the Nilgiris, till the State Government launched the Soil Conservation Scheme in the District (Krishnamoorthy 1965). Heavy and erratic rainfall, steepness of slopes in the undulating topography and clay loam texture of soils were considered as the main causes of this erosion. The soils of upper Nilgiris plateau are lateritic in their origin (Raychaudhuri *et al* 1963, John Durairaj, 1964). The present study was taken up to evaluate them for their erodibility, to aid in making suitable recommendations for effective soil conservation planning.

Material and Methods: The upper plateau of Nilgiris having an elevation of 1050 to 2400 metres above M.S.L. is characterised by undulating hills, divided by narrow valleys and streams. The hill tops and the sloping lands are covered with grass vegetation and the hollows of the hill sides nestle 'sholas' or evergreen forests. It is the hill slopes that are mainly used for

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