



## RESEARCH ARTICLE

### CYTOLOGICAL INVESTIGATIONS IN SOME SPECIES OF *CENCHRUS* L. (PANICEAE, POACEAE) FROM THAR DESERT, RAJASTHAN, INDIA

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#### ABSTRACT

In present Study an attempt has been made to describe mitotic and meiotic behavior in some species of *Cenchrus* L. (Poaceae) from Thar Desert, Rajasthan. The name *Cenchrus* comes from the Greek word “Kenchrus” meaning millet. *Cenchrus* L. is an extremely variable genus having both annual and perennial species. Morphologically *Cenchrus* is very similar to *Pennisetum*. All species of *Cenchrus* are very much similar in their morphology except few micromorphological variations. It is a xerophytic C<sub>4</sub> grass, which grows in bunches and more often with creeping rhizomes. These grasses can exist under minimal level of precipitation ranging from as low as 95 mm to 1000 mm. *Cenchrus* is very efficient in water usages as its root draws soil moisture rapidly as compared to other plants. Various traits are known to wild species of genus *Cenchrus* but due to lack of enough studies their full potential has not been exercised. Chromosomal homology is observed amongst the species under study. The most common zygotic number amongst them is 34 and 36. Cytologically *Cenchrus biflorus* and *C. setigerus* seems to be more closer but as per their habitat *C. ciliaris* and *C. setigerus* leave closer. As per reports, *C. setigerus* shows highest amount of polyploidy that is most probably linked with its stunted growth with smallest size of panicle as compared to *C. ciliaris* and *C. biflorus*. An attempt has been made to study chromosomal behavior of three species common in our region so that these details can further be utilized to exploit these species for their full potential.

**Key words:** Aneuploidy, Biodiversity, *Cenchrus* L., Mitosis, Meiosis, Thar Desert

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#### INTRODUCTION

The grass family is of particular interest to humans. Most people on earth rely on grasses, including rice, wheat and maize for a major portion of their diet. Domestic animals are raised on diets partly or wholly of grasses (Shantz, 1954). The grass family includes approximately 10,000 species classified into 600 to 700 genera (Clayton and Renvoize, 1986; Watson and Dallwitz, 1999). Panicoideae includes 3,560 species in 12 tribes. The species are predominantly distributed in tropical to warm-temperate habitats with summer precipitation and in tropical forests and savannas. Important genera include *Zea mays* L. (corn or mays), *Saccharum officinarum* L. (sugarcane), *Sorghum bicolor* L. (sorghum), *Cenchrus* L., *Penicum* L., and *Setaria* P. Beauv. The tribe Paniceae R.Br. (Subfamily Panicoideae) includes 84 genera and nearly 1500 species of grasses (Morrone *et al.*, 2012; Soreng *et al.*, 2015). The tribe’s members exist mainly in tropical and subtropical areas around the globe but also have limited distributions in cooler climates (Morrone *et al.*, 2012). “Thar Desert” is characterized by low rainfall with erratic distribution, extremes

of diurnal and annual temperatures, low humidity and high wind velocity. The arid climate has marked variations in diurnal and seasonal ranges of temperature characteristic of warm-dry continental climate (Sharma and Mehra, 2009). “Thar desert” is occupied either by dry open grassland or by grassland interspersed with trees and thorny bushes (Gupta, 1975). The vegetation falls under the category ‘thorn forest type’ or ‘scrub forest type’ (Champion and Seth, 1968). The most common grass species of the Thar occur as a *Dicanthium-Lasiurus-Cenchrus* association (Dabadghao and Shankarnarayanan, 1973). Most of the other vegetation consists of stunted, thorny or prickly shrubs and perennial herbs which are resistant to drought. The genus *Cenchrus* has been studied comprehensively because of its economic value as forage and world-wide geographic distribution (Visser *et al.*, 1998). The first somatic chromosome counts for this genus was reported by Avdulov (1931). Brown (1948) speculated that the loss of a single chromosome pair in *Cenchrus* from 2n=36 and 2n=72 could have resulted in 2n=34 and 2n=70. Due to this hypothesis *Cenchrus* was considered to be an aneuploid genus. *Cenchrus* is an apomictic grass species as it is well adapted to a wide range of soil types and grown as rain fed and as an irrigated crop for forage (Geetha, 2001). The genus is well

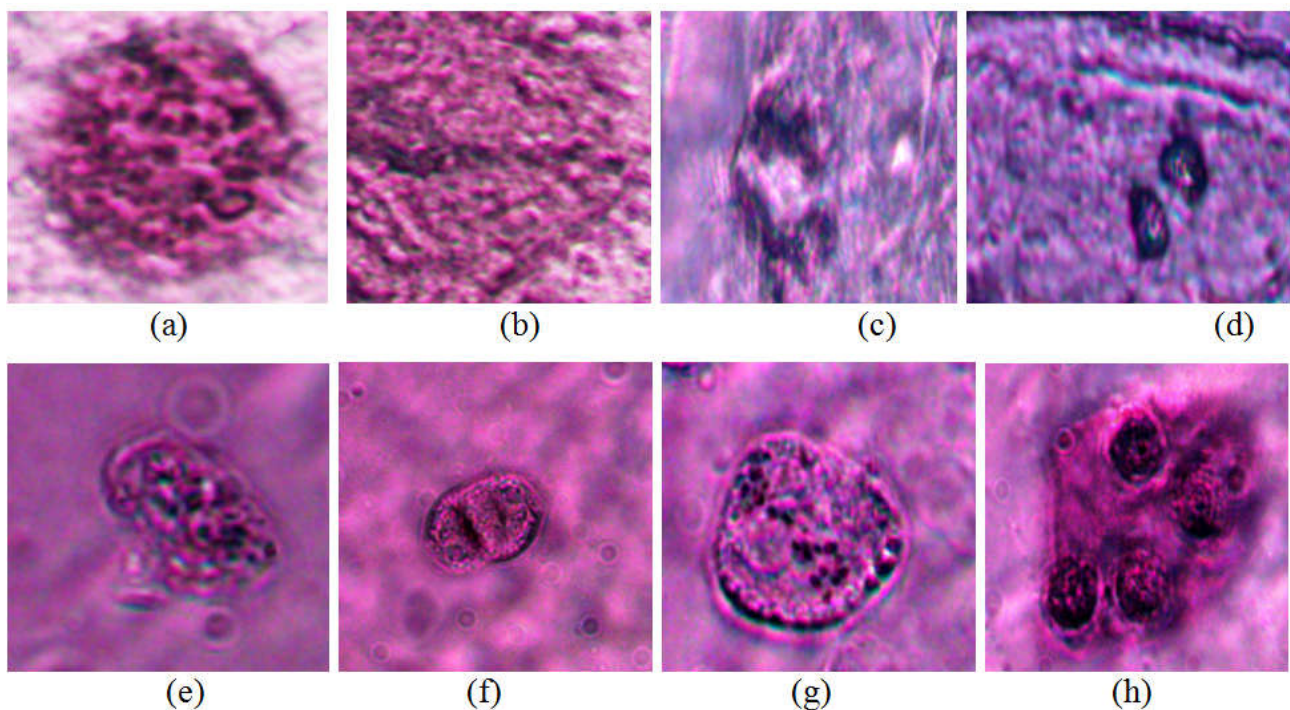
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known for having a wide range of discordant chromosome number. Chromosome numbers in *Cenchrus ciliaris* L.  $2n=18$  (Mehra *et al.*, 1968), 32 (Fisher *et al.*, 1954; Nath and swaminathan, 1957), 34 (De Lisle, 1963; Mehra, 1982), 36 (Bir and Sahni, 1984), 38 (Patil *et al.*, 1961), 40 (Nath and swaminathan, 1957), 44 (Nath and swaminathan, 1957; Mehra *et al.*, 1968), 48 (Snyder *et al.*, 1955), 50 (Miege, 1962), 52 (Nath and swaminathan, 1957), 54 (Nath and swaminathan, 1957; Miege, 1962) and 56 (Ramaswamy *et al.*, 1969; Jagannath and Raman, 1974) have been reported. Chromosome numbers in *Cenchrus setigerus* Vahl.  $2n=34$  (Vij and Chaudhary, 1981; Bir and Sahni, 1983), 36 (Sharma and Sharma, 1979; Bir and Sahni, 1983), 37 (Patil *et al.*, 1961), 54 (Ramaswami *et al.*, 1969) and 72 (Bir and Sahni, 1984) have been reported.  $2n=30$  (Meige, 1962; Mehra *et al.*, 1968), 32 (Vij and Chaudhary, 1981), 34 (De Lisle, 1963; Gupta and Yashvir, 1971) and 36 (Vij and Chaudhary, 1981) have been reported in *Cenchrus biflorus* Roxb.

grass in the tropics mainly because of its low cost of establishment, high yield with more nutrients, tolerance to drought conditions and crop pests and its ability to withstand heavy grazing and trampling by livestock (Duke, 1983). In present study an effort has been made to describe cytological behavior of three species of *Cenchrus*.

## MATERIALS AND METHODS

Somatic chromosome studies were carried out using root tips taken on bright sunny days from vigorously growing plants between 8:30 am to 9:30 am. Root tips were washed in tap water and fixed in Carnoy's fluid (1: 3 acetic-alcohol). The fixative was changed at an interval of two days. One drop of ferric acetate was added to get better staining of the chromosomes. Micro preparations were made using the standard acetocarmine squash technique after a fixation period of about 10 days.



**Fig. 1. Mitotic behavior of *Cenchrus ciliaris* L. (a) prophase showing chromosomes  $2n=34$ , (b) metaphase (c) anaphase and (d) telophase; meiotic behavior (e) diakinesis showing bivalents  $n=17$ , (f) metaphase II, (g) chromatid laggards and unequal distribution of chromosomes observed during anaphase II and (h) formation of four daughter cells during telophase II**

*Cenchrus ciliaris* L. (Buffel grass) is grown widely in tropical and sub-tropical arid rangelands around the globe because of its high drought tolerance and capacity to withstand heavy grazing. Buffel grass has the ability to rapidly invade the surrounding environment (Marshall *et al.*, 2012). *Cenchrus setigerus* Vahl, commonly known as “Bird wood grass” is a highly nutritious grass treated as an excellent pasture for animal husbandry (Arora and Kumar, 2018). *Cenchrus biflorus*, commonly known as “Indian Sandbur” or “Bhurat” is very much used at the time of food scarcity as “famine food”. The grains of it is pounded and mixed with Bajra flour to make a roti known as “Sogra” consumed by villagers and local persons (Arora *et al.*, 2017). Decoction of roots of Buffel grass is given to children suffering from intestinal worms (Katewa *et al.*, 2001). *C. ciliaris* has also been used as folk remedies for kidney pain, tumors, sores and wounds. It can be used as an anodyne (pain reliever), lactagogue (increased milk flow) and diuretic and as an emollient. *Cenchrus* is an important pasture

Root tips were treated with colchicines (0.02%) for 2:30- 3:00 hrs time to capture metaphase. For meiotic studies, young inflorescences were fixed in Carnoy's fixative (alcohol: chloroform: acetic acid in 6:3:1) for 24 h and were transferred to 70% alcohol for preservation at 4°C. Meiotic studies were carried out by preparing smears of pollen mother cells (PMCs) in 1% acetocarmine. Photomicrographs of chromosome counts were made from freshly prepared slides using microscope digital camera Dewinter DIGI 1400 attached with Olympus microscope BX-60.

## RESULTS AND DISCUSSION

### *Cenchrus ciliaris* L.

*Cenchrus ciliaris* L. is one of the important forage plant commonly known as “Buffel grass or Dhaman grass”. It is perennial grass with a deep, adventitious root system and tough



culms that are erect to somewhat prostrate, branched with swollen bases. Leaves are basal, cauline with sharp blades arranged at nodes, rough textured and blades have prominent midribs with keeled leaf sheaths. The inflorescence is erect, dense, cylindrical and spike-like. The rachis bears lanceolate spikelets enclosed by diamond-shaped involucre of prickly bristles. Caryopsis is oblong, glabrous and dorsally compressed (Arora *et al.*, 2017). During this investigation similar chromosome numbers were observed in all accessions of *Cenchrus ciliaris*.  $n=17$  is commonly observed in all accessions. The result suggests that chromosomes have a basic number of  $x=8$  or  $9$ .  $2n=34$  in all accessions might be due to the loss or gain of a single chromosome hence regarded as an aneuploid species (De Lisle, 1963; Mehra, 1982). These results are in accordance with the earlier reports of  $2n=34$  for this species. With a basic chromosome no. of  $x=8$  or  $9$  showing tetraploid nature in *Cenchrus ciliaris* (Fig. 1a-h).

### *Cenchrus setigerus* Vahl

*Cenchrus setigerus* Vahl. commonly known as “Kala Dhaman” is a highly nutritious grass. It is best suited for desert environmental conditions, considered as an excellent pasture for cattle’s. This grass fed green turned into silage or made into hay is said to increase flow of milk in cattle and impart a sleek and glossy appearance (Singariya *et al.*, 2012). In extreme conditions when food is in scarce seeds of this grass are consumed by tribal’s or originals as famine food. This grass has a potential of excellent soil binding capacity due to adventitious root system which goes deeper below the soil and helps to conserve soil in dry areas (Arora and Kumar, 2017). Similar chromosomal behavior is observed. There is no difference except distribution of chromosome an anaphase showing laggards.

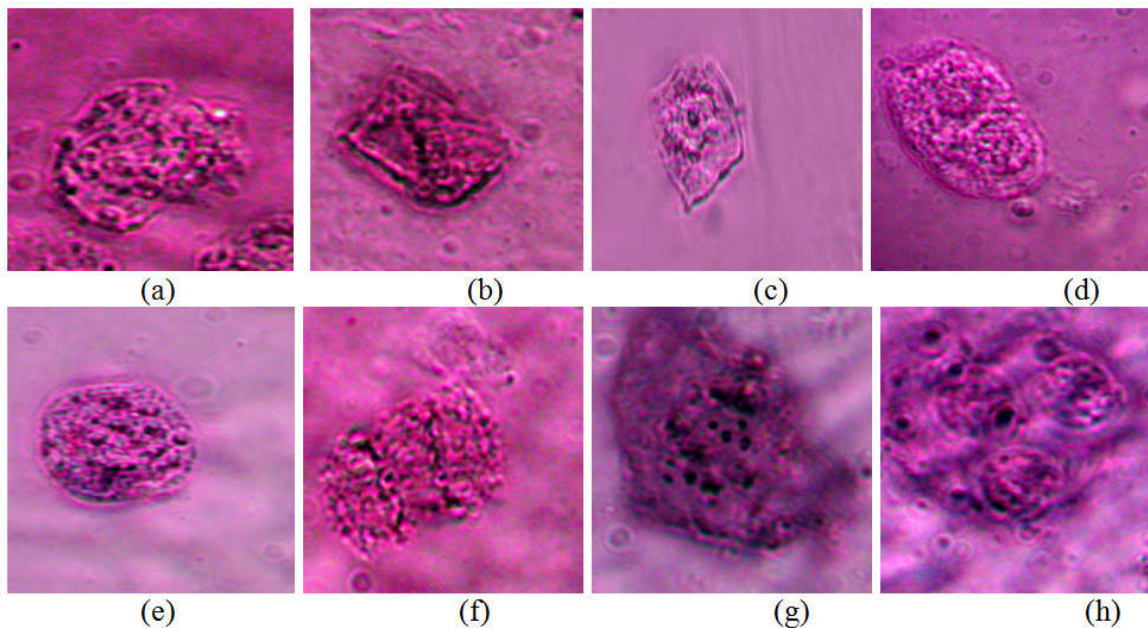


Fig. 2. Mitotic behavior of *Cenchrus setigerus* Vahl. (a) prophase showing chromosomes  $2n=34$ , (b) metaphase, (c) anaphase and (d) telophase; meiotic behavior (e) diakinesis showing bivalents  $n=17$ , (f) metaphase II, (g) chromatid laggards and unequal distribution of chromosomes observed during anaphase II and (h) formation of three daughter cells during telophase II

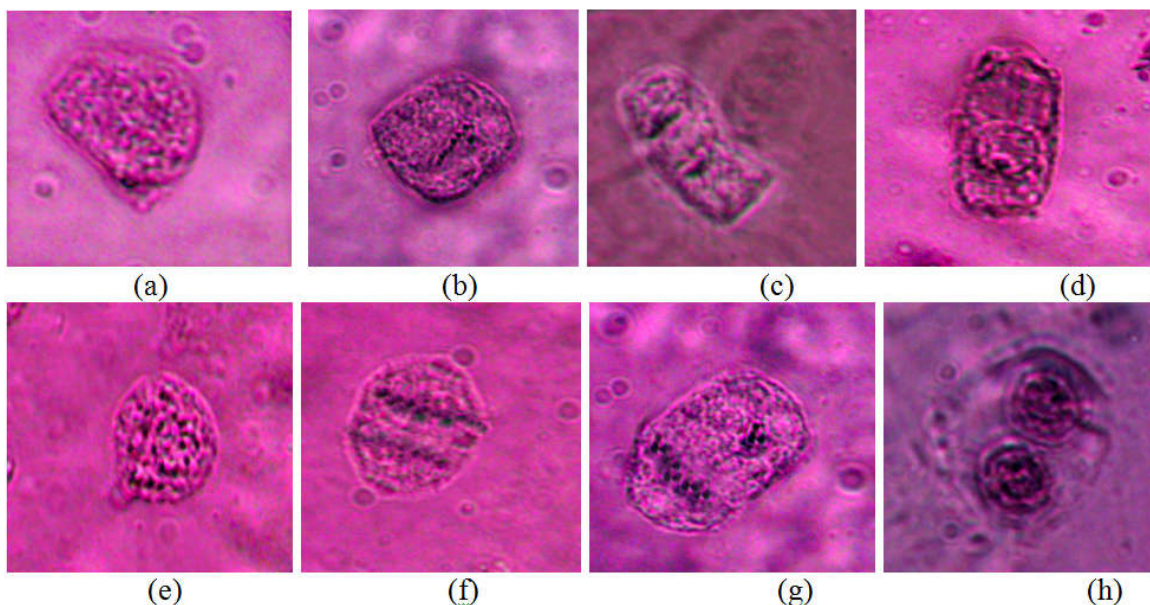


Fig.3. Mitotic behavior of *Cenchrus biflorus* Roxb. (a) prophase showing chromosomes  $2n=36$ , (b) metaphase, (c) anaphase and (d) formation of two daughter cells during telophase; meiotic behavior (e) diakinesis showing bivalents  $n=18$ , (f) metaphase II, (g) unequal distribution of chromosomes observed during anaphase II and (h) formation of two daughter cells during telophase I.

### ***Cenchrus biflorus* Roxb.**

*Cenchrus biflorus* Roxb. commonly known as “Indian Sandbur or Bhurat”. It is most common and abundant grass distributed throughout tropical Africa, Arabia, Pakistan, India and Australia grows mostly on sandy soil. It is extremely drought and heat tolerant species. It is a tufted, annual and erect; rooting at lower nodes with slender branches more often arises from lower nodes. Leaves are linear, acuminate with smooth surface. Inflorescence is a dense raceme with purplish flower that bears 1-3 deciduous involucre. The rachis is not straight it shows angular deviations throughout the length. The burs (spiny projections) can strongly adhere to any object for dissemination (Arora and Kumar, 2018). All accessions show  $n=18$  with a basic chromosome number  $x=9$ . Irregular distribution of chromosomes was observed in anaphase. Laggards have not been observed. Tetraploidy was observed in all accessions instead of aneuploidy.

### **Conclusion**

With the aid of mitotic and meiotic investigations, a basic chromosome number  $x=8$  and  $9$  has established for genus *Cenchrus* L. Various abnormal features were observed in meiotic behavior i.e. Aneuploidy was observed in *Cenchrus ciliaris* L. ( $2n=34$ ) and in *Cenchrus setigerus* Vahl. ( $2n=34$ ) while tetraploidy was observed in *Cenchrus biflorus* Roxb ( $2n=36$ ). Aneuploidy in *Cenchrus ciliaris* L. and in *Cenchrus setigerus* Vahl. Was due to loss or gain of a single chromosome. Meiotic abnormalities may provoke formation of sterile pollen and diploid gametes accompanied by polyploidy that will be a future threat. High frequency of polyploidy has made *Cenchrus ciliaris* more vigorous and octaploid behavior of *Cenchrus setigerus* made it more stunted with compressed internode. Still further research is required to study impact of apomictic behavior in its progenies.

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