Meiotic abnormalities in some members of the Poaceae collected in District Kinnaur, Himachal Pradesh, India

Kamlesh Kumar¹ and Manjit Inder Singh Saggoo

Department of Botany, Punjabi University, Patiala-147002, India

¹Author for Correspondence: kamlesh12negi@gmail.com
Received November 13, 2014; accepted May 5, 2015

ABSTRACT: Male meiotic studies in ten species of grasses (Poaceae) were carried out from District Kinnaur, Himachal Pradesh, India, between the altitudinal ranges of 2000 to 3080 m. All the species were worked out cytologically for the first time from the study area. The hexaploid cytotype in Thysanolaena agrostis (n=33) made new addition for the species on a worldwide basis, supplementing the earlier report of n=11 and 12. The meiotic course in all the species studied was found to be abnormal. Cytomixis in two species, Apluda mutica and Elymus dahuricus was reported here for the first time. Besides abnormal meiotic course the microsporogenesis was found to be normal in all the species but these abnormalities results in the reduction of pollen fertility in the plants.

KEYWORDS: Chromosome number, cytomixis, meiotic abnormalities, pollen fertility, Kinnaur, Himachal Pradesh

Kinnaur is a region of high mountain ranges with narrow valleys of the River Satluj and its tributaries. Most of Kinnaur enjoys a temperate climate due to its high elevation with long winters from October to May and Short summers from June to September. Portions of Kinnaur are situated high in the Himalayas, where vegetation is sparse and consists primarily of hardy grasses. Alpine species such as juniper, pine, fir, cypress and rhododendron can be found at elevations between 3,500 and 5,000 m, primarily in middle Kinnaur. At lower altitudes temperate-climate trees are found, including oak, chestnut, maple, birch, alder, apple and apricot. Based on the classification given by Champion and Seth (1968), the vegetation of this region can be classified into 29 types which belong to Himalayan moist and dry temperate forests, sub-alpine forests, dry and moist alpine scrub and meadows. In the Western Himalayan region, the prominent angiosperm families are Asteraceae, Rosaceae, Poaceae, Ranunculaceae and Brassicaceae (Rau 1975). As prominent angiosperm families are Asteraceae, Rosaceae, Poaceae, Ranunculaceae and Brassicaceae (Rau 1975). As prominent angiosperm families are Asteraceae, Rosaceae, Poaceae, Ranunculaceae and Brassicaceae (Rau 1975).

RESULTS AND DISCUSSION

Tribe Thysanolaeneae
1. Thysanolaena agrostis Nees.
Commonly known as Brooms grass is a tall, tufted, reed like perennial grass, its inflorescence is made in to broom which is locally known as Phool jhadu. Young leaves and stem tips are used to feed cattle and buffaloes. Its large inflorescences are used in making brooms. The grass is occasionally planted for ornamental purposes and as a hedge. Presently, the species has been studied chromosomally on the basis of plants collected from Baba Nagar (2000m). The hexaploid chromosome count of n=33 (based on X=11, 12), represents a new cytotype, supplementing the earlier report of diploid (n=12) cytotype as reported by Kalia (1978) from North Eastern India and Tetraploid (n=22) cytotype as reported by Mehra and Sunder (1969) from North India. Meiotic course included the phenomenon of out of plate bivalents (33.33%) and late disjunction (30%), laggards (37.5%) and bridges (40%) and consequently reduced pollen fertility (89.51%) and pollen grains of variable sizes.

Tribe Andropogoneae
2. Apluda mutica Linn.
Apluda mutica is s perennial grass usually occurs along the edges of fields, in moist places along streams and...
Fig. 1. a. *Thysanolaena agrostis* (n=33) A PMC showing 33 bivalents at M-I, b. A PMC showing 33:33 distribution of chromosome at mixed anaphase-I, c. A PMC showing late disjunction at A-I, d. A PMC showing Unoriented bivalents at M-I, e. A PMC showing laggards at A-I, f. A PMC showing a chromatin bridge at A-I, g. Sterile and fertile pollen grains, h-i. *Apluda mutica* (n=10) A PMC showing 10 bivalents at Diakinesis and M-I, j. A PMC showing 10:10 distribution of chromosomes at A-I, k. A PMC showing cytomixis at T-I, l. A PMC showing unoriented bivalents at M-I, m. heterogeneous sized pollen grains, n. *Capillipedium parviflorum* (n=20) A PMC showing 20 bivalents at M-I, o. A PMC showing 20:20 chromosomes at A-I, p. A PMC showing laggards at A-I, q. Sterile and fertile pollen grains, r. *Elymus dahuricus* (n=21) A PMC showing 21 bivalents at M-I, s. A PMC showing 21:21 chromosomes at A-I, t. A PMC showing cytomixis at M-I.
Fig. 2. a. A PMC showing late disjunction at A-I. b. A PMC showing laggard at A-I. c. A PMC showing bridge at A-I. d. Sterile and fertile pollen grains. e-f. Elymus semicostatus (n=14) A PMC showing 14 bivalents at Diakinesis and M-I. g. A PMC showing 14:14 chromosomes at A-I. h. A PMC showing laggards at A-I. i. Sterile and fertile pollen grains. j-k. Dactylis glomerata (n=7) A PMC showing 7 bivalents at Diakinesis and M-I. l. A PMC showing 7:7 chromosomes at A-I. m. A PMC showing cytomixis at Diakinesis. n. A PMC showing laggard at A-I. o. A PMC showing bridge at A-I. p. Sterile and fertile pollen grains. q. Poa jaunsarensis (n=14) A PMC showing 14:14 chromosomes at A-I. r. A PMC showing laggard at A-I. s. A PMC showing Bridge at T-I. t. Sterile and fertile pollen grains.
meadows on slopes below 2000m. The young plants can be used as forage grass. Meiotic chromosome count of n=10 is confirmed on the basis of plant collected from Baba Nagar (2,000 m) which is in conformity with the previous reports from Central India by Gill et al. (1980). Cytomixis was reported for the first time in this species, earlier Sahni and Bir (1985) recorded abnormalities such as irregular distribution of chromosomes at anaphase. B-chromosomes had been reported by Saxena and Gupta 1970 and Kalia 1978. Subsequent course of meiosis is abnormal with the presence of cytomixis at Telophase-I (33.33%), out of plate bivalents at metaphase-I (30%) and reduced pollen fertility (81.39%).

Fig. 3. a-b. Brachiaria villosa (n=18) A PMC showing 18 bivalents at Diakinesis and M-I, c. A PMC showing laggard at A-I, d. Sterile and fertile pollen grains, e. Eleusine coracana (n=18) A PMC showing 18 bivalents at Diakinesis, f. A PMC showing cytomixis at Diakinesis, g. A PMC showing laggard at A-I, h. A PMC showing bridge at A-I, i. Sterile and fertile pollen grains, j. Polypogon monspeliensis (n=21) A PMC showing 21 bivalents at Diakinesis, k. A PMC showing 21:21 chromosomes at A-I, l. A PMC showing Unoriented bivalents at M-I, m. A PMC showing cytomixis at M-I, n. A PMC showing laggard at A-I, o. A PMC showing bridge at A-I, p. Sterile and fertile pollen grains.
# Meiotic Abnormalities in Some Members of the Poaceae

Table. Data showing Taxa with Accession number (PUN), Locality with altitude, meiotic chromosome number, Ploidy number, previous reports and remarks.

| Sr. No. | Taxa/Accession number(PUN) | Locality with altitude (m) | Meiotic chromosome number (n) | Ploidy level (x) | Pollen fertility (%) | Previous reports*** | Remarks |
|---------|---------------------------|---------------------------|-------------------------------|-----------------|----------------------|---------------------|---------|
| 1.      | Tribe: Thysanolaeneae Thysanolaena agrostis Nees. (58696) | Nigulsari 2050 | 33 | 6x | 89.51 | 2n=22,24 | First ever chromosome report of 6x cytotype with 2n=66 for the species. |
| 2.      | Tribe: Andropogoneae Apluda mutica Linn. (58706) | Baba Nagar 2000 | 10 | 2x | 81.39 | 2n=20,20+2B, 40, 60,70 | Previous report of 2x cytotype with 2n=20 is confirmed. |
| 3.      | Capillipedium parviflorum (R. Br.) Stapf (58702) | Baba Nagar 2000 | 20 | 4x | 80.29 | 2n=20, 20+1B, 20+2-4B, 40,22 | Previous report of 4x cytotype with 2n=40 is confirmed. |
| 4.      | Tribe: Triticeae Elymus dahuricus Turcz. ex Grieseb. (58698) | Hango 3080 | 21 | 6x | 79.87 | 2n=28,42 | Previous report of 6x cytotype with 2n=42 is confirmed. |
| 5.      | Elymus semicostatus (Nees ex Steud.) Meld. (58699) | Chitkul 3450 | 14 | 4x | 83.23 | 2n=28 | Previous report of 2n=28 is confirmed. |
| 6.      | Tribe: Poeae Dactylis glomerata Linn. (58511) | Pooh 2662 | 7 | 2x | 88.94 | 2n=14, 14+1-3B, 14+2-4B, 28,21,27, 42 | Previous report of 2x cytotype with 2n=14 is confirmed. |
| 7.      | Poa jaunsarensis Bor. (58711) | Chuling 3000 | 14 | 4x | 64.19 | 2n=28 | Previous report of 2n=28 is confirmed. |
| 8.      | Tribe: Paniceae Brachiaria villosa (Lam.) A. Camus (58688) | Chora 2050 | 18 | 4x | 85.38 | 2n=36,36+1B | Previous report of 4x cytotype with 2n=36 is confirmed. |
| 9.      | Tribe: Eragrostideae Eleusine coracana (Linn.) Gaertn. (58709) | Baba Nagar 2000 | 18 | 4x | 75.96 | 2n=18,27,36,36+1-2B,37, 38, 39,43 | Previous report of 4x cytotype with 2n=36 is confirmed. |
| 10.     | Tribe: Aveneae Polypogon monspeliensis (Linn.) Desf (58509) | Reckong Peo 2670 | 21 | 6x | 67.82 | 2n=14, 28,28+0-1B,42,35 | Previous report of 6x cytotype with 2n=42 is confirmed. |
3. Capillipedium parviflorum (R. Br.) Stapf

*Capillipedium* is a tufted perennial grass with erect, slender culms and Spikelets are present in pairs. Inflorescence is purplish in color. This grass grows on hills and mountain slopes. This grass is eaten by cattle and buffaloes. Presently the species for meiotic study has been collected from Baba Nagar (2000m). Meiotic course of the species shows n=20 bivalents at metaphase-I which is in conformity with the previous report by Ahsan et al. (1994) from Pakistan and Mehra (1982) from India. Further the species is found to have abnormal meiotic course with the presence of laggards at anaphase-I which ultimately leads to reduced pollen fertility (80.29%).

**Tribe Triticeae**

4. *Elymus dahuricus* Turcz. ex Grieseb.

Commonly known as Dahurian wildrye is said to have high saline tolerance and is adapted to all soil textures (Dobb and Burton 2013). It is a tall plant with leaves growing high up on the stem providing excellent forage for pasture. It is a short lived perennial with quick establishment and is used as an early forage component with other slower growing species. The hexaploid chromosome count of n=21 (based on x=7) is confirmed on the basis of plant collected from Hango (3080m), which is in conformity with the previous reports by Von Bothmer et al. (2005) from Japan and Gohil and Koul (1986) from India. Phenomenon of cytomixis (38.46%) was reported for the first time in the species. Other meiotic abnormalities include laggards (16.12%), bridges (23.07%) which ultimately leads to reduced Pollen fertility (79.87%).

5. *Elymus semicostatus* (Nees ex Steud.) Meld.

*Elymus* is a genus of tufted perennial grasses which contains many of the main cereal grains. Plants of this genus are generally known as wheatgrass. A very variable species ranging from small slender plants to tall robust ones. Presently the species has been collected from Chitkul (3450m). Meiotic studies of the species shows the presence of 14 bivalents at Diakinesis and metaphase-I which is in conformity with the previous report by Salomon and Lu (1992). Further meiotic course is abnormal with the presence of laggards (25%) at anaphase I which ultimately leads to reduced pollen fertility (83.23%).

**Tribe Poeae**

6. *Dactylis glomerata* Linn.

Commonly known as orchard grass is widely used as a hay grass and for pastures because of its high yields and sugar content, which makes it sweeter than most other temperate grasses. It is distributed in temperate and subtropical regions throughout the world. The present meiotic study carried out on plants collected from Pooh (2662m) reveals the presence of n=14 bivalents at diakinesis and metaphase-I. Earlier reports reveals the existence of n=14 by Petrova and Stoyanova (1997) from outside India and n=7 by Koul and Gohil (1990) from India. Further meiotic course is observed to be abnormal due to the presence of cytomixis (22.85%), laggards (9.52%) and bridges (9.09%) which ultimately leads to reduced pollen fertility (88.94%).

7. *Poa jaunsarensis* Bor.

*Poa jaunsarensis* is a perennial plant with elongated rhizomes, usually found on the bank of rivers or shady places. Leaves are mostly basal. Spikelets comprising 2-3 fertile florets. Meiotic chromosome count of n=14 on the basis of plant collected from Chuling (3000m) is confirmed by the presence of 14 :14 chromosomal distribution during A-I and is in conformity with the previous report of Mehra and Sunder (1969). Further the species is found to have abnormal meiotic course with the presence of laggards (27.05%) and bridges (21.42%) and reduced pollen fertility of (64.19%).

**Tribe Paniceae**

8. *Brachiaria villosa* (Lam.) A. Camus

This is an annual weedy species recognized by its short, broad, usually soft hairy leaf blades and small spikelets. It is found on hilly slopes, fields, roadsides and other weedy places. Presently the species has been studied chromosomally on the basis of plant collected from Chora (2050m). Further meiotic study of the species reveals n=18 bivalents at Diakinesis and metaphase-I and is in conformity with the previous report by Basappa and Muniyamma (1981) from outside India and Mehra (1982) from Eastern India. Meiotic course is abnormal with the presence of laggards at anaphase-I and reduced pollen fertility (85.38%).

**Tribe Eragrostideae**

9. *Eleusine coracana* (Linn.) Gaertn.

*Eleusine coracana* is an annual plant commonly known as African finger millet. It is adaptable to higher elevations and is grown in Himalayas up to 2,300 m elevation. Finger millet straw makes good fodder and is used in traditional medicine as an internal remedy for leprosy or liver disease (Van Wyk and Gericke 2000). Finger millets are also rich in dietary fibre hence help in easy digeston. Finger millet is rich in essential amino acids and contains a higher level of calcium and iron than other cereals (Pore and Magar 1979, Shukla et al. 1985, Babu et al. 1987). Presently the chromosome number in the species is determined on the basis of plants collected from Baba Nagar (2000m). Meiotic studies reveals the presence of n=18 bivalents at diakinesis which is in conformity with the previous report by Devarumath et al. (2005) and Mehra (1982). Further meiotic course is abnormal with the presence of cytomixis (26.92%), laggards (14.81%) and bridges (15%) which ultimately leads to reduced pollen fertility (75.96%).

**Tribe Aveneae**

10. *Paspalum monspeliensis* (Linn.) Desf.
**Polygono...**

*Polygono...* commonly known as annual rabbits foot grass is an annual grass growing to heights between 5 centimeters to one meter. The soft, fluffy inflorescence is greenish in color, sometimes divided in to lobes. The spikelets have long, thin, whitish awns, which give the inflorescence its texture. This grass is usually found in moist places and streambeds below 3000m. For the present studies the material was collected from Reckong Peo (2670m) and meiotic studies revealed n=21 bivalents at diakinesis and 20:20 distribution of chromosomes at anaphase-I. Earlier reports reveals the existence of n=14 by Ghukasyan (2004) from outside India and n=21 by Koul and Gohil (1991) from India. Further meiotic course is abnormal with formation of out of plate bivalent (13.63%), cytomixis (24%), laggards (12.90%), bridges (11.11%) which ultimately leads to reduced pollen fertility (67.82%).

**ACKNOWLEDGMENTS**

The authors are thankful to UGC, New Delhi for financial assistance under DRS-SAP II, ASIST programme and to DST for grant under FIST programme. Thanks are also due to the Director Botanical Survey of India (Dehradun) for identification of the species and Head, Department of Botany, Punjabi University, Patiala for providing the necessary laboratory and library facilities.

**LITERATURE CITED**

Ahsan, S. M. N., Vahidy, A. A. and Ali, S. I. 1994. Chromosome numbers and incidence of polyploidy in Panicoideae (Poaceae) from Pakistan. Ann. Missouri Bot. Gard. 81(4):775-783.

Aswal, B. S. and Mehrotra, B. N. 1994. Flora of Lahaul-Spiti. Dehradun: Bishen Singh Mahendra Pal Singh.

Babu, B.V., Ramana, T. and Radhakrishanan, T. 1987. Chemical composition and protein content in hybrid varieties of finger millet. Indian J. Agric. Sci. 57:520-522.

Basappa, G. P. and Muniyamma, M. 1981. In chromosome number reports LXXII. Taxon 30:703.

Champion, H. G. and Seth, S. K. 1968. A revised survey of the forest types of India. Delhi, India: Manager of Publications, Govt. of India Press.

Chowdhery, H. J. and Wadhwa, B. M. 1984. Flora of Himachal Pradesh analysis. 3 vols. Cutcutia: Botanical Survey of India.

Devarumath, R. M., Hiremath, S. C., Rao, S. R., Kumar, A. and Bewal. 2005. Genome analysis of finger millet *E. coracana* by interspecific hybridization among diploid wild species of *Eleusine* (Poaceae). Cytologia 70: 427-434.