Available online at www.ijpab.com

ISSN: 2320 – 7051
Int. J. Pure App. Biosci. **1 (3):** 17-22 (2013)
Research Article

International Journal of Pure & Applied Bioscience

Meiotic Exploration of *Plantago major* Linn. –Whiteman's Footprint

Deepu Pandita[1]*, Anu Pandita[2] & Shanu Pandita[3]

[1]Government School Education Department, Jammu, Jammu & Kashmir, India
[2]Bee Enn College of Nursing, Talab Tillo, Jammu, Jammu & Kashmir, India
[3]Govt. General Zorawar Singh Memorial Degree College Reasi, Jammu, Jammu & Kashmir, India
*Corresponding Author Email: deepupandita@gmail.com

ABSTRACT

Plantago major belongs to the genus Plantago and family Plantaginaceae. Plantago major is extensively naturalized all through much of the globe.

The name Plantago comes from Latin word "planta", meaning "sole of the foot" which refers to the broad leaves in the basal rosettes, often touching the ground in some species. The meiotic studies of Plantago major plants revealed 12 chromosomes. The various stages of meiosis viz; Pachytene, Diplotene, Diakinesis, Metaphase and Anaphase were observed. The number of Rod Bivalents was 05, Ring Bivalent (01) & Nucleolar Chromosomes were 02 in P.major. The Chiasmata Frequency was calculated at Metaphase-I (/PMC=04, /II=1-2) and at Diakinesis was (/PMC=11, /II=02). The other parameters studied included Recombination Index and Terminalization Coefficient. The Recombination Index at Diakinesis of P. major was 17 and at Metaphase was 7-8 respectively. The Terminalization Coefficient was 0.25 in P. major. The Anaphase-I was regular in all of the PMCs. The number of late separating bivalents was 01.

Key words: *Plantaginaceae, Plantago major, Meiosis, Recombination Index, Terminalization Coefficient, Chromosome number.*

INTRODUCTION

Plantago major is a temperate-zone herbaceous plant with tremendous ranges to the north and south, approximately from pole to pole, though very infrequent in lowland tropics. According to Sagar & Harper[1] in feral form, it nurtures from sea level to 3500 m altitude. The species develops best in moist areas such as river beds, seepage vicinity on hillsides, drains, area subjected to water runoff from buildings, besides road sides and in coastal zones[2].

Plantago major originated in Eurasia but currently is naturalized nearly all over the globe. The Palynological Research has revealed that this species was established to the Nordic countries before 4000 years[3]. The Indians named it **'White Man's Footprint'** as being instituted ubiquitously where the Europeans have been[4]. It is widespread wild plant in the majority of the agricultural regions of the planet plus the places where tropical crops are grown. It is usually distributed in America, Europe, Turkey, Afghanistan, Pakistan and Palestine [5]. In India, it is found in the temperate and alpine Himalayas from Kashmir to Bhutan at altitudes of 600-3,500m [6].

The species of genus *Plantago* differ from spring annuals to summer annuals, biennials, and perennials. There are recurring evolutionary shifts in mutual directions involving annual and perennial habit[7]. *Plantago major* occurs equally as a perennial & annual. *Plantago major* has a petite, stout and vertical herbaceous stem. Leaves form a basal rosette, mature up to 30 cm length 1 & are ovate to elliptic in silhouette with parallel venation (5–9 veins). Leaf blade is entire or irregularly toothed, and narrows into a

petiole which is of almost equal length as blade (Fig 1 (a). Leaves are glabrous or hairy, generally green in color, with occasional purple shading [4]. Total leaf number and biomass quantity is affected by growth pattern of the plant. Warwick [8] reported that prostrate plants of *P. major* produce a drastically lower number of leaves in contrast to the erect plants.

Flowering time for *P. major* is from May to September in the temperate zone which can vary depending on the habitat of plants [9]. First flowering normally occurs after 13 weeks of plant growth [10] but flowering may also start setting seeds just 6 weeks after germination [1]. Inflorescence of *P. major* is a spike of 1–30 cm length, typically simple but rarely branched, (Fig 1 (b), (c)). According to [11], spikes bear yellowish white protogynous flowers of 2–4 mm diameter.

A great deal of ecology, genetics, and reproductive biology of the cosmopolitan weed, *Plantago major* is acknowledged [12, 13, 14, 15, 16, 17, 18, 19]. *Plantago major* is a highly inbreeding species with very low out crossing rate; consequently each population is an inbred line, highly adapted to its specific habitat [17].

The leaves and the seeds of *Plantago major* have been employed for centuries to cure maladies related to skin, digestive organs and blood circulation like wounds, inflammation and hypertension.

Some of the medicinal properties and the phytochemical details of *P.major* are listed in Table 1.

TABLE 1. SOME OF THE PHYTOCHEMICAL DETAILS OF *P. MAJOR* AND THEIR ACTIVITIES

S.No.	MEDICINAL ACTIVITY	PHYTOCHEMICALS	PLANT PARTS
1.	Antiradicular; Antiulcer; Immunostimulant; Keratolytic, Anti-inflammatory; Antioxidant; Antiseptic	Allantoin	Plant
2.	Antiaggregant; Antiangiogenic; Antiaging; Antiallergic	Apigenin	Leaf
3.	Anticlastogen; Anti-inflammatory; Antimutagenic; Antineoplastic	Asperuloside	Flower
4.	Antileukemic, Paralytic	Aucubin	Leaf , Plant, Seed
5.	Antimutagenic; Antiproliferative; Antipyretic; Antiretroviral; Antithrombotic, Neuroprotective	Baicalein	Leaf
6.	Antiatherogenic; Antibacterial; Anticancer; Anticarcinogenic, Antileukemic; Antileukotriene; Antimelanogenic; Antiophidic; Antimutagenic; Antinitrosaminic; Antioxidant	Caffeic-Acid	Plant
7.	Antispasmodic; Cancer-Preventive; Choleretic; Dermatitigenic	Cinnamic-Acid	Plant
8.	Antiseborrheic; Antiseptic; Antitubercular; Antitumor; Disinfectant	Citric-Acid	Plant
9.	Antidepressant; Antiencephalopathic; Antiparkinsonian	Tyrosine	Plant
10.	Antitrypanosomic; Antitumor; Antitumor (Brain); Antitumor (Breast) ; Leucocytogenic; Hypotensive; Immunomodulator; Lipoxygenase	Ursolic-Acid	Plant
11.	Antisickling; Antitumor; Antitumor-Promoter; Ascaricide; Cancer-Preventive; Choleretic	Vanillic-Acid	Plant
12.	Antioxidant; Antiperiodic; Antipodagric; Antitumor; Antipsoriac; Antitympanitic; Antirheumatic; Antiseborrheic; Antiseptic; Antipyretic; Anticancer	Salicylic-Acid	Plant
13.	Antibacterial; Antimutagenic; Antioxidant; Antiradicular; Antisickling, Immunosuppressant; Pesticide; Phytoalexin; Prostaglandigenic	P-Hydroxy-Benzoic-Acid	Plant
14.	Antiseptic; Antispasmodic; Antitumor; Choleretic; Cancer-Preventive; Chemo preventive; Cytotoxic; Diaphoretic	P-Coumaric-Acid	Plant
15.	Percutaneostimulant, Anemiagenic; Antialopecic; Antiandrogenic; Anti-inflammatory	Oleic-Acid	Seed
16.	Antidysmenorrheic; Antiherpetic; Antiestrogenic; Antihepatotoxic; Anti-inflammatory; Antileukemic	Ferulic-Acid	Plant

20: **Source: (http: //www. ars-grin. gov/duke/)**

MATERIALS & METHODS

The plants of *P. major* were collected from different parts of Jammu & Kashmir and transplanted/maintained in pots in the School of Biotechnology, University of Jammu, Jammu.

For studying meiosis in anthers, the young spikes of the plant were fixed at early morning for 24 hours at RT in a mixture of 4 parts chloroform, 3 parts ethyl alcohol, and 1 part acetic acid and a pinch of ferric chloride. Subsequently, the spikes were washed in tap water and stored in 70% ethyl alcohol inside refrigerator at 4º C. The details of the meiosis in pollen mother cells were studied by squashing the

anthers in 1% acetocarmine and then the observations and photography was performed under the light microscope.

During meiotic studies, Chiasmata frequency & Recombination index was calculated at Diakinesis and Metaphase- I. The Terminalization coefficient was also calculated. These were calculated by applying the following formulae:

Recombination index= n+Chiasmata frequency/cell,

Where n is the number of bivalents.

$$\text{Terminalization coefficient} = \frac{\text{Average number of terminalized chiasmata per PMC}}{\text{Average number of total chiasmata per PMC}}$$

All the cytological observations were made from temporary mounts and observations were noted down.

RESULTS & DISCUSSION

Genetics is the discipline of heredity and variation. All the biotic organisms inherit traits from their parents which have been used since antediluvian times to modify the plants through breeding [21]. Genetic variation is a prerequisite for breeding. Mutation, recombination and hybridization lead to genetic variation, whilst recombination is the focal basis of variation in most sexually reproducing species. Breeding and meiotic systems in concert compose the "genetic system" and determine the nature and rate of recombination [22, 23]. The various stages of meiosis viz; Diakinesis, Metaphase and Anaphase were observed. The Nucleolus was prominent at Prophase-I stage of meiosis. Chromosomes at metaphase stage were present on Metaphase plate. During Anaphase-I regular chromosome segregation (06< >06) was observed.

The number of Rod Bivalents was 05 and Ring Bivalent was 01 & Nucleolar Chromosomes were 02 in *P.major*. The Chiasmata Frequency was calculated at Metaphase-I as 04/PMC & 1-2/Bivalent and at Diakinesis was 11/PMC & 02/Bivalent. The other parameters studied included Recombination Index and Terminalization Coefficient. The Recombination Index at Diakinesis of *P. major* was 17 and at Metaphase was 7-8. The Terminalization Coefficient was 0.25 in *P. major*. The Anaphase-I was regular in all the PMCs (Figure 2). The number of late separating bivalents was 01 (Table 2). The chromosome complements of *P.major* reported earlier are, 2*n* = 12, 18, 24. Current chromosome count of *P. major* L. 2n=12 agrees with that given by McCullag [24], Briggs [25], Fujiwara [26, 27], Bassett & Crompton [28], Zohary [29], Badr & El-Kholy [30], Mastuo & Noguchi [31], Badr [32], Sharma [33], Sharma & Koul [34], Koul & Sharma[35], Dhar & Sharma [36], Dhar *et al* [37] & Murray *et al*, [38].

TABLE 2:DETAILS OF PMC MEIOSIS IN DIPLOID CYTOTYPE OF *PLANTAGO MAJOR*

GAMETIC NUMBER OF CHROMOSOMES			06
NUMBER OF NUCLEOLAR CHROMOSOMES			**02**
NUMBER OF RING BIVALENTS			**01**
NUMBER OF ROD BIVALENTS			**05**
DIAKINESIS	NUMBER OF CHIASMATA	PER PMC	**11**
		PER BIVALENT	**02**
		RECOMBINATION INDEX	**17**
METAPHASE- I		PER PMC	**04**
		PER BIVALENT	**01-02**
		RECOMBINATION INDEX	**07-08**
		TERMINALIZATION COEFFICIENT	**0.25**
ANAPHASE -I	REGULAR/IRREGULAR		**REGULAR**
	NUMBER OF LATE SEPARATING IIS		**01**

Figure1(a): *Plantago major,*

Figure1(b): Flowering *Plantago major,*

Figure1(c): Spikes of *Plantago major*

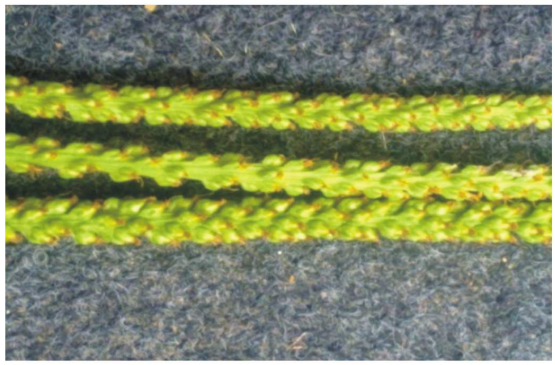

Figure 2: VARIOUS STAGES OF MEIOSIS IN *PLANTAGO MAJOR*

CONCLUSION

Genetic organization of natural populations impacts on studies of differentiation, speciation, adaptation, the evolution of mating systems and the tracing of population history. Polyphenols extracted from leaves and seeds of *P. major* have been reported to have bioactive effects especially on wound healing, are antiulcerogenic, Hepatoprotective & anti-inflammatory, antioxidant, anticarcinogenic and antiviral [39]. The regulation of immunity parameters induced by *P. major* may be clinically relevant in numerous disease processes including tuberculosis, AIDS and cancer [40].

ACKNOWLEDGMENT

Deepu Pandita, is thankful to Prof. M.K. Dhar, Director School of Biotechnology, University of Jammu, Jammu for his invariable encouragement and laboratory facilities. The Council of Scientific and Industrial Research, India is acknowledged for the financial assistance.

REFERENCES

1. Sagar G.R., Harper J.L. The Journal of Ecology **52**: 189–221. (1964)
2. Webb C.J. Sykes W.R. Garnock-Jones P.J. Flora of New Zealand, Volume IV: Botany Division, DSIR, Christchurch pp. 1365. (1988)
3. Jonsson S. Blomsterbroken. Markens Urter, Lyng og Traer. Teknologisk Forlag. Oslo. (1983)
4. Samuelsen A.B. Journal of Ethnopharmacology **71**: 1–21. (2000)
5. Janighorban, M. Flora of Iran -Research Institute of Forests and Rangelands, **14**: 1-53 (1995)
6. Anonymous. The Wealth of India. Raw Materials. Vol. VIII. New Delhi: Publications and Information Directorate, CSIR, Pp.146-154. (1969)
7. Primack R. B. Ph.D. diss. Duke University. (1976)
8. Warwick S.I. New Phytologists **85**: 461–469. (1980)
9. Long H.C. MAFF Bulletin 108, 2nd edition. HMSO, London, UK. (1938)
10. Warwick S.I. & Briggs D. New Phytologist **85**: 289–300. (1980)
11. Sharma N., Koul P., Koul, A.K. Plant Systematics and Evolution **181**: 1–9. (1992)
12. Molgaard P. Botanisk Tidsskrift **71**: 31–56. (1976)
13. Van Dijk H, Van Delden W. Theoretical and Applied Genetics, **60**, 285–290. (1981)
14. Van Dijk H. Theoretical and Applied Genetics, **68**, 43–52. (1984)
15. Van Dijk H., Wolff K., De Vries A. Theory and Applied Genetics **75**: 518–528. (1988)
16. Wolff K. Theoretical and Applied Genetics, **81**, 111–118. (1991a)
17. Wolff K. Theoretical and Applied Genetics, **81**, 119–126. (1991b)
18. Wolff K, Schaal B. Journal of Evolutionary Biology, **5**, 325–344. (1992)
19. Wolff K, Rogstad SH, Schaal B. Theoretical and Applied Genetics, **87**, 733–740. (1994)
20. http:/ /www. ars- grin. Gov/duke
21. Weiling F. American Journal of Medical Genetics **40**: 1–25. (1991)
22. Darlington C.D. Cambridge: Cambridge University Press. (1939)
23. Stebbins G.L. Calcutta: Oxford & IBH Publishing Co. (1950)
24. McCullagh, D. -Gentica **16**: 1-44. (1934)
25. Briggs, B. D. New, Wales, Nation Herb **4**:3.399-405. (1973)
26. Fujiwara, I. Lakromosome **27**-28: 962-962. (1956a)
27. Fujiwara, I. Jap. Jour. Genet. **31**: 184-191. (1956b)
28. Bassett, I. J. & Crompton, C. W. Cand. J.Bot. **46**: 349-361. (1967)
29. Zohary, M. Vol. **3**: 220-232. -The Israel Academy of Sciences and Humanities. (1972)
30. Badr, A. & El-Kholy, M. A. Cytologia **52**: 725-731. (1978)
31. Matsuo, K. & Noguchi, J. J. Phytogeogr. & Taxon. **37** (1): 27-35. (1989)
32. Badr, S. F. Taeckholmia **19** (1): 27-36. (1999)

33. Sharma, P.K. PhD thesis, University of Jammu, Jammu. (1984)
34. Sharma, P. K. and Koul, A. K. Genetica, August, Volume **64**, Issue 2, pp 135-138. (1984)
35. Koul, A.K. and Sharma, P.K. Genetics and Crop Improvement. Meerut India: Rastogi and co., pp 359-366. (1986)
36. Dhar, M.K. and Sharma, P.K.. Kachroo, P. (Ed.). Bishen Singh Mahendra Pal Singh, Dehradun, India. (1999)
37. Dhar, M.K., Kaul, S., Sareen, S., & Koul, A.K. Plant Genetic Resources: Cultivation and Utilization, **3**:252-263. (2005)
38. Murray, BG, Meudt, HM, Tay, ML and Garnock-Jones, PJ. New Zealand Journal of Botany, **48**: 3, 197 - 204. (2010)
39. Turel, I. Ozbek, H, Erten, R.,Oner, A. C., Cengiz, N.,Yilmaz, O. Indian Journal of Pharmacology, **41:(3)** 120-124. (2009)
40. Flores R.G., Calderon C.L., Scheibel L.W., Guerra P.T., Padilla C.R., Guerra R.T., Weber R.J. Phytotheropy Research **14:** 617–622. (2000)