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Research Article

CYTOMEIOTIC ANALYSIS OF *PLANTAGO OVATA* FORSK–AN INDIAN RESTORATIVE PLANT

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ABSTRACT: The genus Plantago of family Plantaginaceae includes about 275 species. These are small, annual or perennial herbs with various medicinal properties. The word Plantago is taken from the "planta" which means "sole of the foot". *Plantago ovata* is the only cultivated and economically important species of the monotypic genus *Plantago* and yields Isabgol- a very effective laxative and its export earns India foreign exchange worth INR 2.5 billion.

P. ovata is generally an in-breeder and is characterized with narrow genetic base, because of low chromosome number, chromosome size, chiasmata frequency, recombination index and abundance of heterochromatin in chromatin material. The various stages of meiosis viz; Pachytene, Diplotene, Diakinesis, Metaphase and Anaphase were observed. The number of rod bivalents was 04 in *P. ovata.* The chiasmata frequency was calculated at Diakinesis (/PMC=06, /II=1.5) and Metaphase-I (/PMC=03,/II=1.0). The other parameters studied included Recombination index and terminalization coefficient. The recombination index at Diakinesis of *P. ovata* 10 and at Metaphase was 07 respectively. The terminalization coefficient was 0.33 in *P. ovata.* The Anaphase was regular in all PMCs.

Key words: *Plantago ovata*, Meiosis, Recombination Index, Terminalization Coefficient, Chromosomes

INTRODUCTION

The genus Plantago of family Plantaginaceae comprises about about 483 species [11]. The genus is the prevalent of the three genera on which family plantaginaceae is based. Although the centre of diversity of plantagos is deemed to be positioned somewhere in central Asia, some species have now become widespread far and wide with utmost concentration in temperate areas. A few species proliferate even in tropical zones where they either grow wild or are cultivated. Plantagos are small, annual and perennial herbs of warm temperate, sandy provinces and are widely allocated. In India about 10 species are recorded of which *P.ovata* is of economic and therapeutic significance [1]. The Seed is known in trading circles as White or Blonde Psyllium or Indian Plantago in English and Isabgol in Hindi. Even though, Plantago species are exploited in varied modes in local medicines, two taxa namely *P. ovata* Forsk. & *P. psyllium* L. is economically imperative. These are cultivated for their mucilaginous seed which is pharmaceutically rated among the most effective laxatives. In India, the only species cultivated for the purpose is *P. ovata* Forsk. Whose seed husk is called Blonde psyllium in English and Isabgol in Hindi [8]. *Plantago ovata* is a stemless annual [6] 8mm long herb [1].

P. ovata is indigenous to Mediterranean province and west Asia expanding upto Sutlej and Sind in West Pakistan [10]. Muslims originally pioneered it as a medicinal plant in India at some point in Mughal period [5]. The plant is cultivated on a hefty scale in western India. In Gujarat it is cultivated in about 144,000 ha of land, yielding 720 kg/ha. India holds domination in the global trade of Isabgol and is a dollar earner for India. Its export earns India foreign exchange worth INR2.5 billion [4]. The revenue can be supplementary however, the production falls short of global demand, and consequently, enhancement in the crop yield is the need of the hour. The United States is the largest Importer of Psyllium husk with over 60% of total imports going to Pharmaceutical firms for use in products such as, Metamucil, Effersyllium and Feberall.

Plantago ovata is an in breeder and has a narrow genetic base on account of low chromosome number (2n=2x=8), small chromosome size (2.5-2.9um), presence of lot of heterochromatin (constitutive) in all its chromosomes, low chiasmata frequency, low recombination index and high selfing rates [3, 7].

Table-1: Some of the Photochemical Details of *p. ovata* and Their Activities
Source: (http://www. ars-grin. gov/duke/)

S.No	Activity name	Name of the Phytochemcial
1	Allergenic	Oleic acid
2	Anti HIV	Luteolin
3	Anti Alopecia	Linoleic Acid, Oleic Acid
4	Anti arthritic	Linolenic acid
5	Anti cancer (Breast)	Beta Sitosterol
6	Anti caner (Cervix)	Beta Sitosterol
7	Anti Cancer (lung)	Beta Sitosterol
8	Anti Carcinogenic	Luteolin
9	Anti Diabetic	Fructos, Xylose
10	Anti hepatotoxic	Glucose, Lignoseric Acid,
11	Anti leukemic	Aucubin, Luteolin, Betasitosterol
12	Anti mutagenic	Beta Sitosterol, Luteolin, N-Nonacosan
13	Anti oxidant	Aucubin, Lutolin, Campesterol,Sucrose
14	Anti tumor	Alpha amyrin, Luteolin
15	Cytotoxic	Alpha amyrin, Luteolin
16	Hemolytic	Palmitic acid
17	Hyperglycemic	Glucose
18	Memory – Enchancer	Glucose

MATERIALS & METHODS

MEIOTIC STUDIES:

For studying meiosis in male tract, young spikes were fixed at 8am at RT for 24 hours in a mixture of 4 parts chloroform,3 parts ethyl alcohol, and 1 part acetic acid and a pinch of ferric chloride. Thereafter, they were washed in tap water and stored in 70% ethyl alcohol inside refrigerator at 4ºC. The meiotic details in pollen mother cells were studied by squashing anthers in 1% acetocarmine and observations were made under the light microscope.

During meiotic studies, Chiasmata Frequency was calculated at Diakinesis and Metaphase- I. The Terminalization Coefficient was also observed. These were calculated by applying the following formulae:

Recombination index= n+Chiasmata frequency/cell,

Where n is the number of bivalents.

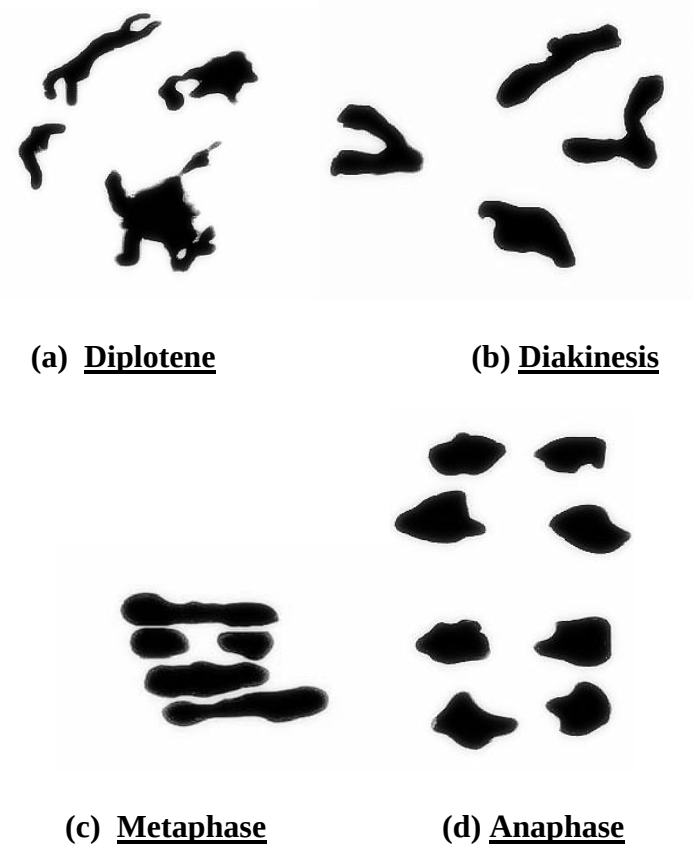
$$\text{Terminalization coefficient} = \frac{\text{Average number of terminalized chiasmata per PMC}}{\text{Average number of total chiasmata per PMC}}$$

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

RESULTS AND DISCUSSION

The seeds are pinkish brown in color with boat shaped concave side and cymbiform concavo-convex side. The convex side is covered with thin and white membranous papery covering known as Husk which is odorless and tasteless (Figure-1) and contains mucilage which swells on soaking of seeds in water.

Figure-1: The Seeds of Plantago Ovata



(a) Diplotene **(b) Diakinesis**

(c) Metaphase **(d) Anaphase**

Figure-2: Various stages of Meiosis in *plantago ovata*

The meiotic chromosomes of these plants revealed 08 chromosomes. The various stages of meiosis viz; Pachytene, Diplotene, Diakinesis, Metaphase and Anaphase were observed (Figure-2). The number of Rod Bivalents was 4 in *P. ovata*. The Chiasmata Frequency was calculated at Metaphase I and Diakinesis. The other parameters studied included Recombination index and terminalization coefficient. The Recombination Index at Diakinesis of *P. ovata* was 10 and at Metaphase were 7. The Terminalization Coefficient was 0.33 in *P. ovata*. The Anaphase-I was regular in all the PMCs (Table-2).

Table-2: Details of PMC Meiosis in *Plantago Ovata*

<table>
<tr><td colspan="3">Number of Nucleolar Chromosomes</td><td>02</td></tr>
<tr><td colspan="3">Number of Ring Bivalents</td><td>00</td></tr>
<tr><td colspan="3">Number of Rod Bivalents</td><td>04</td></tr>
<tr><td rowspan="3">Diakinesis</td><td rowspan="6">Number of Chiasmata</td><td>Per PMC</td><td>06</td></tr>
<tr><td>Per Bivalent</td><td>1.5</td></tr>
<tr><td>Recombination Index</td><td>10</td></tr>
<tr><td rowspan="4">Anaphase -I</td><td>Per PMC</td><td>03</td></tr>
<tr><td>Per Bivalent</td><td>01</td></tr>
<tr><td>Recombination Index</td><td>07</td></tr>
<tr><td>Terminalization Coefficient</td><td>0.33</td></tr>
<tr><td rowspan="2">Anaphase -I</td><td colspan="2">Regular/Irregular</td><td>Regular</td></tr>
<tr><td colspan="2">Number of Late Separating Bivalents</td><td>01</td></tr>
</table>

The genus Plantago is tribasic; X=4,5 and 6 [2] with X=06 as the primary base number and others as the secondary derivatives of it.The genus represents unique group of plants whose phylogenetic relationships are still under investigations. The outcome of research work is identical with the results reported by the earlier workers from time to time [9, 8, 4]. According to Sharma [9], the Chiasmata Frequency at Metaphase-I is low i.e., 1.4 /bivalent and 5.6/PMC while in this study it is 01/bivalent and 03/PMC respectively. Low Chiasmata Frequency and Recombination Index account for the narrow genetic base of this plant.

CONCLUSION

This investigation conclusively proved the presence of 02 Nucleolar Chromosomes, 04 Rod Bivalents, absence of Ring Bivalents, 01 Late Separating Bivalent, 10 Recombination Index at Daikinesis, 07 Recombination Index & 0.33 Terminalization Coefficient at Metaphase –I and Regular Anaphase. The *Plantago ovata* with medicinal and therapeutic properties like Anti HIV, Anti Alopecia, Anti arthritic, Anti cancer, Anti Carcinogenic, Anti Diabetic, Anti hepatotoxic, Anti leukemic, Anti mutagenic, Anti oxidant, Anti tumor, Cytotoxic, Hemolytic, Hyperglycemic, Memory – Enchancer, has huge international market for India, hence need of the hour is increase in production of this medicinal crop.

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