Bulletin of Pure and Applied Sciences.
Vol.40 B (Botany), No.1.
January-June 2021: P.13-18
Original Research Article

Print version ISSN 0970 4612
Online version ISSN 2320 3196
DOI: 10.5958/2320-3196.2021.00003.3
Available online at www.bpasjournals.com

The Cyto-morphological Studies in *Physalis minima* Linn.

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Received on 13.02.2021
Accepted on 17.05.2021

Keywords:
Cytomorphology, *Physalis*, Gametic, Sterility.

Abstract

Cyto-morphological studies in a diploid natural population of *Physalis minima* Linn were done. It was a diploid natural population recorded behind Jal Mandir on Parasnath hills. Qualitative and quantitative parameters were investigated. Ten morphological characters like height of the plant, number of branches per plant, number of branches from main stem, number of nodes, length of internodes, number of heads per plant, length of leaf, breadth of leaf, length/breadth ratio of leaf andlength of petiole were recorded and statistically analyzed. Cytologically, the population showed, gametic number as *n*= 12. Most of the pollen mother cells were found to be normal; however, some abnormalities were also recorded. Clumping of chromosomes recorded in both meiotic phases i,e. metaphase-I and anaphase-I. Along with it, at metaphase-I, the anomalies recorded as formation of univalents, multivalents and precocious separation of chromosomes. Anaphase-I showed chromosomal laggards, simple chromosomal bridges and unequal separation of chromosomes as anomalies. The half chiasma per chromosome was 0.87. Pollen sterility was 6.00 percentages.

How to cite this article: Choudhary, RK. (2021). The Cyto-morphological Studies in *Physalis minima* Linn.*Bulletin of Pure and Applied Sciences-Botany,* 40B (1), 13-18.

INTRODUCTION

The highest point in old Bihar (presently Jharkhand and Bihar) is formed by isolated conical hill of Parasnath rising to 4490 ft above sea level. The hill belongs to Chhotanagpur plateau covering the extreme northeast part of Madhya Pradesh and Jharkhand.

The *Physalis*have berry fruit, enclosed by inflated calyces (Ganapathi *et al*., 1991). It has represented by *Physalisperuviana* L., *P. minima* L., *P angulata* L., *P ixocarpa*Brot. ex. DC. *P longifolia* Nutt. and *P alkekengi* L. in India.

The *Physalis minima* (Ground cherry or Sunberry) are a common, mesophytic, annual, Solanaceous herb grown in disturbed habitats. It is an annual herb 0.5-1.5 m in height having dark green dorsal and light green ventral, ovate leaves (9.7 cm. long and 8.1 cm broad) (Figure 1). Phyllotaxy is alternate. Two leaves present at one node in upper region. Leaf is simple, cauline, exstipulate, dorsiventral, petiolated, green with sinuate ovate shape. Base of leaf is obtuse and margin is serrate/ entire with acute tip and reticulate (unicostate) venation. Inflorescense is solitary cymose. It has solitary, yellow, complete, bisexual, heteromerous and hypogynous flowers.

Stamens are epipetalous and number is five. Gynoecium is bicarpellary, syncarpous and superior. Ovary is oblong, bilocular and superior with axile placentation. The fruit is yellow coloured glabrous berry, enclosed in the calyx, which is 5.1 cm long and 2.5 cm broad and matured in autumn. (Sharma *et al.,* 2015).Seed is white.

Taxonomic position

Kingdom	–	Plantae
Subkindom	-	Viridiplantae
Infrakingdom	-	Streptophyta
Superdivision	-	Embryophyta
Division	-	Tracheophyta
Subdivision	-	Spermatophytina
Class	-	Magnoliopsida
Superorder	-	Asteranae
Order	-	Solanales
Family	-	Solanaceae
Genus	-	Physalis
Species	-	*P. minima* L

A Physalis minimum is a medicinal plant, considered as a potential candidate for bioactivity –guided isolation of natural anti-inflammatory and analgesic agents. It is used as diuretic, purgative, analgesic (Khan *et al.,* 2009) anthelmintic, febrifuge, vermifuge, abortificient etc. It possess antifertility, hypoglycemic, cytotoxic, antiulcer, antibacterial, antimalarial, amylase, lipase and alpha glucosidase inhibitor activity and antigonorrhoeal activity (Chothani and Vaghasiya, 2012).Root extract taken for treatment of fevers. Root decoction is drunk to treat diabetes and hypertension. Pounded leaves cures headache and itches. Mundas of Chhotanagpur uses the mixture of leaves juice, mustard oil and water for treatment of earache (Parmar and Kaushal, 1982, Gansau, 2001). Fruit is appetizer, laxative, diuretic tonic.

Cytological studies of *Physalis minima* L. indicate that it is a tetraploid species with 2*n*=4x=48 chromosomes (Bhaduri, 1933, 1951). Diploid cytotype is not recorded from the natural Indian populations (Ganapathi *et. al.,* 1991) In the course of investigations, in different regions of Parasnath hills, diploid taxon (2*n* = 24) of *Physalis minima* was recorded. The present investigation deals with the cyto-morphological studies in the diploid natural population of *Physalis minima* Linn.

MATERIAL AND METHODS

For morphological analysis, the plant materials were collected in the form of twig, leaves, flower, buds, fruits and seeds.Random sampling of the characters were made and co-variance, standard deviation and standard error were calculated by following formula:-

$$\text{Variance } (S^2) \quad \frac{N \sum f(x)^2 - \sum (fx)^2}{N(N-1)}$$

Where
N= Number of observations
F= Frequency
X = Class

$$\text{Standard deviation } (S) = \sqrt{S^2}$$

$$\text{Standard error} = \sqrt{\frac{S^2}{N}}$$

Meiotic behavior of chromosome was studied from anther squash preparations. The time for obtaining suitable buds varied from 10.30 am to 11.00 am. Fixation of flower buds and staining was done in 1:3 aceto-alcohol. Study of pollen grains in respect of fertility and sterility were made based on their stainability in acetocarmine. The slides were made permanent according to the method of Celarier (1956).

Observations

Locality: - Jal Mandir (Parasnath)

Jal Mandir is situated on the top of Parasnath hill. It is the most important Jain tirth. From Madhuban, its distance is 23 Kms by walk (approximately to climb up and down the hill).

Population: -*Pm0286*

This was a small population consisting of about 15 plants and all the plants were directly exposed to sunlight .Ten morphological characters shown in Table-I have been studied and verified statistically.

Table 1: Morphological characters

S. No	Name of Character	Range	Mean	Co-Variance	Standard deviation	Standard error
1	Height of Plant (Cm)	16-41	27.8	52.62	7.25	2.29
2	Number of branches / plant	1-7	4.11	4.61	2.14	0.71
3	Number of branches from main stem	1-4	2.44	1.02	1.01	0.33
4	Number of Nodes	5-14	7.00	64.05	8.00	2.53
5	Length of Internodes (Cm)	3-7	4.66	1.33	1.15	0.33
6	Number of heads / plant	1-7	3.90	2.76	1.66	0.52
7	Length of leaf (Cm)	4-13	8.10	7.21	2.68	0.84
8	Breadth of leaf (Cm)	2-5	3.70	1.34	1.59	0.36
9	Length / Breadth ratio of leaf (Cm)	1.60-2.49	2.08	0.07	0.26	0.08
10	Length of petiole (Cm)	1-7	3.32	2.94	1.71	0.57

Meiotic studies revealed the gametic chromosome number as *n*=12. Meiosis was highly non-synchronized. At diakinesis and metaphase I stages, twelve bivalents were recorded. Anomalies at metaphase I was prominent. Clumping of chromosomes, precocious separation of chromosomes and univalent and multivalent formation (Fig. 2) were found in some of the pollen mother cells. Details of chromosomal association and chiasma frequency have been given in Table-2 and 3 respectively.

Table 2: Nature and frequency of chromosome association at metaphase I

Population	Chromosomal association						Frequency of PMCs
Pm0286	VI	V	IV	III	II	I	
	0	0	0	0	12	0	25
	0	0	0	0	10	4	10
	1	0	1	0	7	0	5
	0	1	0	1	7	2	4
	0	0	1	0	10	0	6

Table 3: Chromosome pairing and chiasma frequency at metaphase I

Population	No. of PMCs studied	No. of bivalents per PMC				TOTAL	Chiasmata per PMC		Terminalised Chiasmata		1 / 2 chiasma per chromosome	Terminalization coefficient
		Ring		Rod								
		Range	Mean	Range	Mean		Range	Mean	Range	Mean		
Pm 0286	50	6-8	7.0	4-6	5.0	12	20-22	21.0	18.22	20.0	0.87	0.95

Table 4: Pollen analysis

Population	No. of Pollen Studied	No. of Normal Pollen	No. of Sterile Pollen	% of Sterile Pollen
Pm 0286	900	846	54	6.0

At anaphase I, 12:12 chromosomes were recorded in most of the pollen mother cells. However, abnormalities like clumping of chromosomes, chromosomal laggards, chromosomal simple bridges and unequal separation of chromosomes were noticed in the studied pollen mother cells. Later stages were more or less normal except the formation of tripolarity and multipolarity in some of the pollen mother cells. Pollen sterility was found to be about 6.00% (Table-4)

Table 5: Meiotic anomalies

Population	Number of PMCs studies	% of Clumping at metaphase-1	% of Multivalents at metaphase-1	% of Univalents at metaphase-1	% of precocious separation at metaphase-1	Translocation chain & rings at metaphase-1	% of laggards at anaphase-1	% of inversion bridges at anaphase-1	% of simple bridge at anaphase-1	% of unequal separation of chromosomes at anaphase-1	% of Clumping of chromosomes at anaphase-1	% of other anomalies
Pm 0286	1000	6.00%	7.00%	2.00%	2.80%	-	1.00%	-	2.82%	1.00%	3.00%	2.00%

Figure 1: Plant of *Physalis minima* Linn

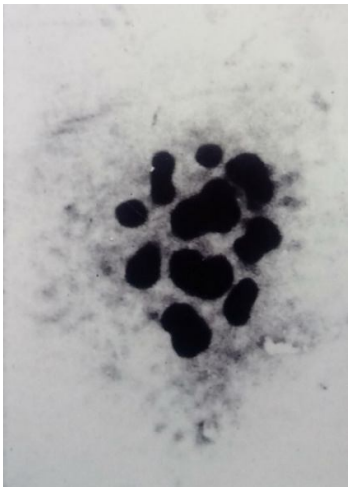

Figure 2: PMC at metaphase-I showing multivalents and univalent. 1400X

RESULT AND DISCUSSIONS

Cyto-morphological analyses were carried out in a population of *Physalis minima* L. growing behind Jal Mandir on Parasnath hills. The study revealed the gametic number as $n = 12$. Meiosis was highly non-synchronized and the anomalies recorded included multivalents, univalents, clumping of chromosomes and precocious separation of chromosomes at metaphase I stage. Half chiasma per chromosome was 0.87. At anaphase I chromosomal laggards, chromosomal bridges, clumping of chromosomes and unequal separation of chromosomes were reported. Pollen sterility was 6.00%.

Formation of univalents is due to precocious separation of chromosomes (Sinha *et al.,* 2019) and failure of the chromosome pairing (Sinha, 2002, Sinha *et al*., 2019) Chromosomal laggards and unequal distribution of chromosome at anaphase-I may be the result of desynaptic effect in meiosis. It could attribute to the action of different genetic factors, which inhibit chromosome-pairing (Srivastava and Tripathi, 1988). The cryptic structural differences leading to the formation of ring may be accounted as the case of translocation. This condition may lead to a high proportion of gametic inviability (Choudhary and Sinha, 1990).

Clumping of chromosomes may be due to interconnections and stickiness and is under genetic control. Clumped chromosome of *Trilobachne cookie* either formed ball or sticky metaphases or formed exploded groups of chromosomes and remained suspended in the cytoplasm. Multivalent formation is due to breakage in chromosomes and their reunion through reciprocal translocation. The formation of multivalent will be attributed to the irregular pairing and breakage followed by translocation and inversion, abnormal pairing and non-junction of bivalents.

The early terminalization of chromosomes and / or movement of chromosomes, ahead of the rest during anaphase, might have caused the precocious separation of chromosomes. It may also be due to the disturbed homology for chromosome pairing or disturbed spindle mechanism. The fragments, which appeared on the breakages of bridges, because of spindle fibers, functioning to pull the chromosome towards poles, formed laggards. Asynapticcondition, which results in abnormal meiosis in later stages, may also lead to laggard formation.

Anaphasic bridge may be formed due to unequal exchange or dicentric chromosomes. The occurrence of breaks at the same locus and their lateral fusion leads to the formation of dicentric chromosomes, which are pulled equally to both the poles at anaphase and a bridge is formed. Chromosomal stickiness, subsequent failure of anaphase separation and unequal translocation or inversion of chromosome segments are the main reasons for the formation of chromosomal bridges. Bridges might have occurred because of delayed terminalisation, stickiness of chromosome ends and failure of chromosome movement.

The population shows more number of ring bivalents, which is supposed to have established itself at the particular habitat (Sinha, 2017).

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