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Meiotic studies in some population of *Nicotiana plumbaginifolia* from Bodh- Gaya

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Key words: *Nicotiana plumbaginifolia, Meiosis, Population, Chiasma Frequency*
Six populations of the weed Nicotiana plumbaginifolia, a member of the solanaceae family, were examined meiotically from several sites in Bodh-Gaya. The reported gametic number in each of the six populations is n=10. However, other chromosomal aberrations have been noted, including chromosome clumping, univalents, and multivalents at metaphase I, chromosomal bridges, laggards, and uneven chromosome segregation during anaphase I. Different populations were found to have rather considerable variations in chiasma frequency. Meiotic behavior of all the populations has been found to be more or less similar, however there are significant differences between them in terms of chiasma frequency.

I. Introduction

The study of population genetics similarly revolves around constructing and testing expectations for genetics variation in populations of individual organisms. Expectation attempt to predict things like how much genetic variation is present in a population, how genetic variation in a population changes overtime, and the pattern variation that might be left behind by a given biological process that acts over time or through space. Building these expectations involves the use of first principles or the set of very basic rules and assumptions that define how natural systems works at their lowest, most basic levels. In population genetics ,first principles are very basic mechanisms of Mendelian particulate inheritance and processes such as mutation , mating patterns, gene flow, and natural selection that increases, decreases , and shape genetic variation. These foundational rules and processes are used and combined in population genetics with the ultimate goal of building a comprehensive set of predictions that can be applied to any species and any genetic system.(1)

Population studies reflect the genetic architecture of plants, which consists of all the internal genetic mechanisms that influence genetic recombination in a population. The arrangement of the chromosomes and how they behave during meiosis are the main elements of the genetic system (2). Meiotic research has been done on six different populations of the weed *Nicotiana plumbaginifolia,* which belongs to the Solanaceae family, taking these factors into account. Meiotic studies have been conducted on this group from Bodh-Gaya, and the discovered chromosomal aberrations have been interpreted.

II. Material and Methods

From a meiotic perspective, six distinct populations of *Nicotiana plumbaginifolia* from various ecological settings in the town of Bodh- Gaya were studied. Six populations from Bodh-Gaya were chosen, and their names are Np0222, Np'0222, Np"0222, and Np0422, Np'0422, Np"0422. Buds were fixed in 1:3 aceto-alcohol and squased in 2% aceto-carmine for meiotic experiments. The slides were mounted on euparol and permanently fixed using the Clearier (1956) procedure(3).

III. Observations

Np0222- Materials for the meiotic investigation were gathered in Bodh Gaya from plants growing next to the P.G. Department of Botany. Due of their proximity to water sources, plants grew well. There are only fifteen plants in the population.

The meiotic behavior was found to be of non-synchronized type. The gametic number was recorded as n=10. At diakinesis, ten bivalents were observed with one bivalent attached with the nucleolus (fig. 1). Clumping of chromosomes and precocious separation of chromosomes were recorded at this stage. Besides these anomalies, some of the pollen mother cells revealed different types of multivalents. Details of chromosomal association and chiasma frequency have been summarized in Table-1 and 2.

Chromosomal bridges, laggards, and clumping of chromosomes were the aberrations noted at anaphase I. These consists of clumping of chromosomes at four poles and chromosomal laggards. These cells formed micronuclei at the quartet stage. Pollen sterility was calculated to be 14 per cent (Table – 3).

Np'0222- Flower buds were collected from plants growing in social science campus of Magadh university. Ten bivalents were recorded both at diakinesis and metaphase I stages. PMC at anaphase I showed equal distribution of chromosomes at both poles(fig-2). Multivalent, univalent, chromosomal clumping, and premature chromosome separation were all noted as abnormalities. Tables 1 and 2 contain information on chromosomal association and chiasma frequency. Approximately 7% of pollen was determined to be sterile (Table 3).

Np"0222- Flower buds foe meiotic study were collected from plants growing in and around the administrative building of Magadh University in Bodh-Gaya.

In this population also the chromosome number were found to be n= 10. Abnormalities like multivalent formation was recorded in some of the pollen mother cells. At anaphase I some of the pollen mother cells showed clumping of chromosomes (Fig-3). Details of chromosome pairing and chiasma frequency are summarized in Tables 1 and 2 respectively. Pollen sterility was calculated to be 12 per cent.

Np0422- Flower buds for meiotic studies were collected from plants growing in Teacher's quarter in Magadh-University campus in Bodh-Gaya.

The gametic number in these population was found to be n= 10. At diakinesis , intermingled chromosomes were observed in a few pollen mother cells. Besides observing normal metaphase I , this stage was characterized by presence of multivalent, univalents, clumping of chromosomes and two groups of bivalents scattered in a few pollen mother cells. Some PMCs at anaphase I showed chromosomal laggard (Fig-4). Details of chromosomal association and chiasma frequency have been summarized in Table 1 and 2 respectively. Pollen sterility was observed to be eight per cent (Table-3).

Np'0422- Materials foe meiosis were collected from plants growing from near the field around the guest house of Magadh University campus in Bodh-Gaya. In this population at metaphase I, n=10 was observed in most of the pollen mother cells. Anomalies included clumping of chromosomes and precocious separation of chromosomes at metaphase I stage. At anaphase I, besides equal distribution of chromosomes, some abnormally dividing pollen mother cells were also recovered. The abnormalities observed were chromosomal bridge (Fig.- 5), laggard and unequal separation of chromosomes. Few PMC are showing unique cytoplasmic connections and transmigration of chromatin (fig.- 6). Cytomixis is promiscuous intercellular interaction for exchange of nuclear material, dividing chromosomal bodies and other integral cytoplasmic organelle(3). Cytoplasmic and chromatin transmigration were discernible among contiguous or slightly distant PMCs through recreation of passage via direct cell-to-cell fusion or channel formation (4).

Details of chromosomal association and chiasma frequency are summarized in table1 and 2 respectively. Pollen sterility was calculated to be 14 percent (Table-3).

Np"0422- In this population collected from botanical garden of P.G. Department of Botany, Magadh University, very few samples showed presence of multivalent, univalents and clumping of chromosomes. Details of chromosomal association and chiasma frequency have been summarized in Table ! and 2 respectively.

Anaphase I was characterized by equal distribution of chromosomes at both the poles. However, chromosomal bridge , clumping of chromosomes and chromosomal laggards were observed in a few pollen mother cells. Subsequent stages were found to be normal. Pollen sterility was observed to be six per cent (Table-3).

IV. Discussion

Six different populations of Nicotiana plumbaginifolia of the family Solanaceae have been studied from different places in Magadh University campus. The gametic number was found to be n=10 in all the populations. Meiotic anomalies observed included clumping of chromosomes, precocious separation of chromosomes, formation of univalents and multivalent at metaphase I, chromosomal bridges, laggards and clumping of chromosomes at anaphase I. Among the vital steps of chromosomal behavior during Meiosis, pairing of homologous chromosomes is very essential for completion of this important event in sexual reproduction. Chromosomes may fail to pair either due to asynapsis or desynapsis, resulting in the presence of univalents(5) . These univalents not only interfere with the completion of meiosis, but the very survival of the individuals through sexual propagation is greatly impaired(6). The presence of such univalent chromosomes resulted in a decrease in chiasma frequency. Chiasma formation in the most sensitive and delicate stage in the meiotic process and in most cases reduced pairing of chromosomes and consequently the presence of univalents during the meiosis process influence chiasma frequency(7). Reduced chiasma frequency in turn considerably lower gametic fertility. Pollen sterility varied from seven to fourteen per cent in the first population studied in February, while in the populations studied in April it varies from six to fourteen per cent. Half chiasma per chromosome was found to vary from 0.75 to 0.85 in populations studied in February. In the population studied in April, this variation was very much significant. Half chiasma per chromosome varied from 0.55 to 0.95 (table-2).

A comparative analysis of the chiasma frequency of the populations studied in February revealed that half chiasma per chromosome decreases gradually from the first population to the third population. But there were not much variations in the presence of rod and ring bivalents of the three populations. It can be said that the gradual decrease in the half chiasma per chromosome reveals more degree of heterozygosity. The degree of heterozygosity resulting from random mating decreases if inbreeding is pracitised. In the small populations, individuals got more and more related to each other in course of generation, if mating is random. This may lead to increase in homozygosity. This fact is of utmost significance in cross fertilizing species as revealed in different populations of *Nicotiana plumbaginifolia(8)(9)*. Comparative meiotic features in the populations of Nicotiana plumbaginifolia indicates that the meiotic behavior is more or less similar in the populations of both the populations studied in February and April respectively. However, these populations are contradistinctive in terms of chiasms frequency.

Table- 1: Nature and Frequency of chromosomal association at metaphase I of different populations of *Nicotiana plumbaginifolia*

Population	Frequency of PMC	Chromosomal Association					
		I	II	III	IV	V	VI
Np 0222	30	0	10	0	0	0	0
	8	4	8	0	0	0	0
	6	0	8	0	1	0	0
	4	1	2	1	3	0	0
	2	1	6	1	1	0	0
Np ‘0222	32	0	10	0	0	0	0
	6	2	9	0	0	0	0
	4	0	6	0	2	0	0
	5	0	8	0	1	0	0
	3	3	7	1	0	0	0
Np”0222	40	0	10	0	0	0	0
	5	3	7	1	0	0	0
	3	1	6	1	1	0	0
	2	0	8	0	1	0	0
Np 0422	26	0	10	0	0	0	0
	14	2	9	0	0	0	0
	5	1	8	1	0	0	0
	3	3	7	1	0	0	0
	2	2	6	2	0	0	0
Np’0422	30	0	10	0	0	0	0
	8	4	8	0	0	0	0
	6	0	8	0	1	0	0
	4	1	6	1	1	0	0
	2	0	7	2	0	0	0
Np”0422	33	0	10	0	0	0	0
	7	2	9	0	0	0	0
	4	1	2	1	3	0	0
	5	0	6	0	2	0	0
	1	0	8	0	1	0	0

Table-2: Chromosomal pairing and chiasma frequency at metaphase I of different populations of *Nicotiana plumbaginifolia*

Population	No. of PMCS Studied	No. of bivalent per PMC				Total	Chiasma per PMC		Terminalised chiasma		½ chiasma per chromosome	Term. Coeff.
		Ring		Rod								
		Range	Mean	Range	Mean		Range	Mean	Range	Mean		
Np 0222	50	4-6	5.0	4-6	5.0	10	14-16	15.0	9-12	10.5	0.75	0.70
Np' 0222	50	4-7	5.5	3-6	4.5	10	16-18	17.0	10-12	11.0	0.85	0.64
Np" 0222	50	4-6	5.0	4-6	5.0	10	14-18	16.0	10-14	12.0	0.80	0.75
Np 0422	50	5-7	6.0	3-5	4.0	10	18-20	19.0	14-16	15.0	0.95	0.78
Np' 0422	50	5-6	5.5	4-5	4.5	10	14-16	15.0	10-12	11.0	0.75	0.73
Np"0422	50	4-5	4.5	5-6	5.5	10	10-12	11.o	6-8	7.0	0.55	0.63

Table-3: Pollen analysis of different populations of *Nicotiana plumbaginifolia*

Population	No. of Pollen Studied	No. of Normal Pollen	No. of Sterile Pollen	Percentage of Sterile pollen
Np 0222	1000	860	140	14
Np' 0222	1000	930	70	07
Np" 0222	1000	880	120	12
Np 0422	1000	920	80	08
Np' 0422	1000	860	140	14
Np" 0422	1000	940	60	06

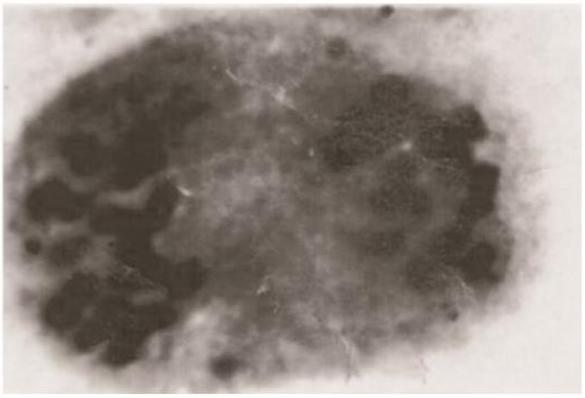

Fig.1: PMC at diakinesis showing one bivalent attached with the nucleolus

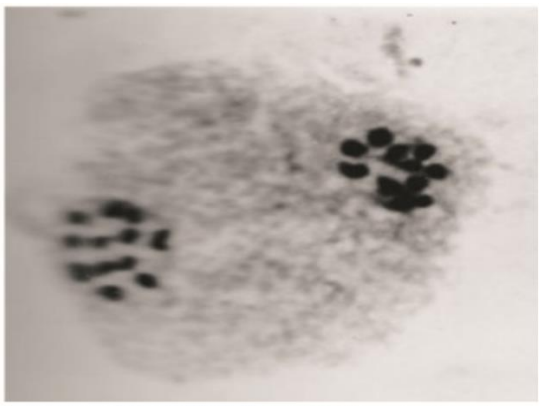

Fig.2: PMC at anaphase I showing equal distribution at both poles

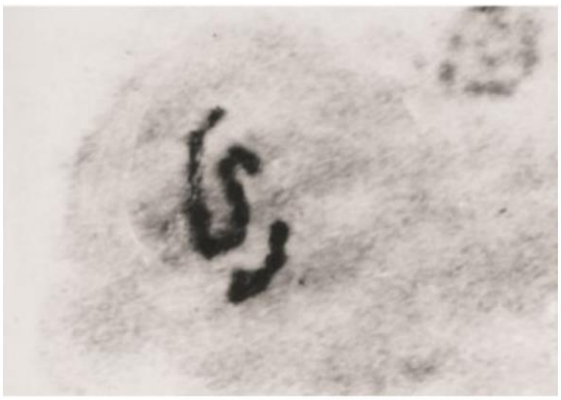

Fig.3: PMC at anaphase I showing clumping of chromosomes

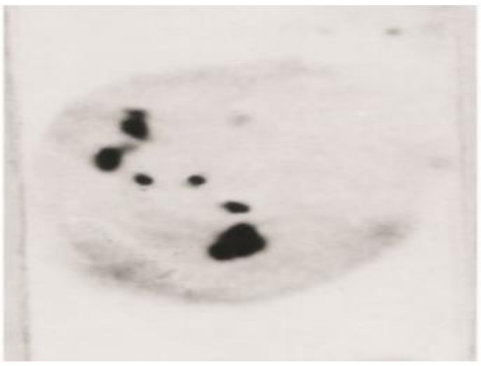

Fig.4: PMC at anaphase I showing chromosomal laggard

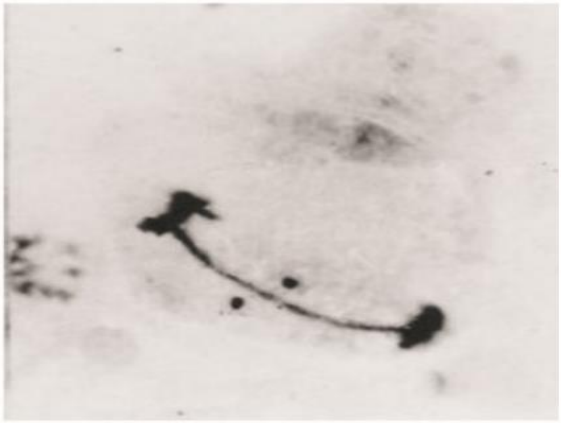

Fig.5: PMC at anaphase I showing chromosomal bridge

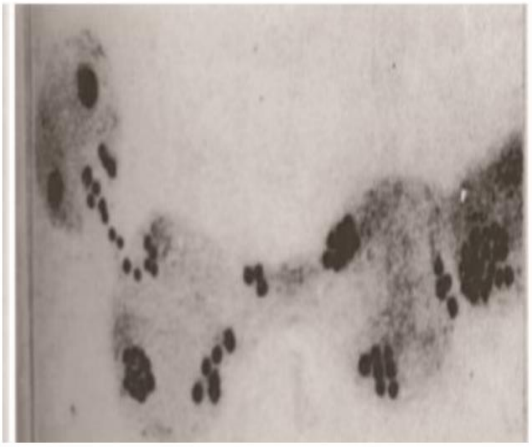

Fig.6: PMC showing transmigration of chromosomes

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