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B.Sc. III, (Botany Honours)
Paper - VI, Group 'B'
(Plant Breeding)

Cytoplasmic inheritance

The inheritance of most of the characters of an individual is governed by nuclear genes. But in some cases, the inheritance is governed by cytoplasmic factors or genes. When the transmission of characters from parents to offspring is governed by cytoplasmic genes, it it known as cytoplasmic inheritance or extrachromosomal inheritance or non-mendelian inheritance or organellar inheritance.

The first case of cytoplasmic inheritance was reported by Correns 1909 in four 'o' clock (Mirabilis jalapa) for leaf colour.

The true cytoplasmic is one which involves plastids (chloroplasts) and mitochondria. Thus, cytoplasmic inheritance is again of two types, viz., (1) Plastid inheritance and (2) mitochondrial inheritance. The former is applicable to plants only because plastids are found only in plants. The mitochondrial inheritance is common for both plants and animals. The cytoplasmic inheritance is governed by genes which are found in chloroplasts and mitochondria. The genes which govern cytoplasmic inheritance are called plasma genes or cytoplasmic genes or cytogenes or extranuclear genes. These genes are made up of DNA found in chloroplasts

Rastogi

(CP-DNA) and mitochondria (mt-DNA).

1. PLASTID INHERITANCE

Chloroplasts are the important plastids. Plastids have green pigments called chloroplasts. Plastids self duplicate, have some amount of DNA and play an important role in cytoplasmic inheritance. Some examples of plastid inheritance are given below:

Mirabilis jalapa

The first conclusive evidence of cytoplasmic inheritance was reported by Correns in 1909 for leaf colour in four 'o' clock plant (Mirabilis jalapa). This plant has 3 types of leaves, viz., green, white and variegated. Three types of results were obtained from crosses between these genotypes as given below.

1. When green was used as female and either green, white or variegated as male, all individuals in F_1 were green.
2. When white was used as female and either green, white or variegated as male, all individuals in F_1 were White

3. When variegated was used as female and either green, white or variegated as male, various proportions of green, white and variegated individuals were obtained in F_1 (Table-1).

Table-1. Inheritance of leaf colour in Mirabilis Jalapa.

Crosses between three leaf colours			Expression of leaf colour in
Female		Male	F_1
Green	×	Green	Green
	×	White	Green
	×	Variegated	Green
White	×	Green	White
	×	White	White
	×	Variegated	White
Variegated	×	Green	Green White and variegated in various ratios in each cross.
	×	White	
	×	Variegated	

2. Mitochondrial Inheritance

The inheritance of some characters is governed by mitochondrial DNA. The examples of mitochondrial inheritance include cytoplasmic male sterility in plants, Pokynoss in Neurospora, ~~Rastogi~~ Petite in yeast, etc.

Date .....
Page No. .....

Cytoplasmic male sterility

There are three types of male sterility in crop plants, viz., genetic (controlled by nuclear genes), cytoplasmic (controlled by plasma genes). The C.M.S. is controlled by plasma genes associated with mt DNA or CP DNA. The CMS lines are maintained by crossing them with a fertile line known as maintainer line. Three types of CMS lines, viz., CMS-T, CMS-C, and CMS-S have been studied in maize. It is believed that C.M.S. is controlled by plasma genes which are part of mt-DNA. In other words, in maize cytoplasmic sterility is governed by mitochondrial DNA. Cytoplasmic sterility is found in several other crop plants, viz., pearlmillet, Sorghum, cotton etc.

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