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Polyploidy, Mutation and Hybridization in Cultivation of Medicinal Plants; a review

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ABSTRACT:

Growing medicinal plants is now much easier thanks to new methods of plant breeding, such as polyploidy induction, mutation breeding, and hybridization. The goal of these methods is to make good traits better, such as the amount of alkaloids, volatile oils, disease resistance, and ability to adapt to different environments. These methods work together to make high-quality, high-yielding, and disease-resistant medicinal plants. This makes sure that production is both sustainable and useful for medicine.

Introduction:

Medicinal plants have been important in healthcare systems all over the world, both in the past and now. More and more people around the world want drugs and phytochemicals made from plants. This means that it is becoming more and more important to use scientific methods to grow medicinal plants that are more productive, higher quality, and more resistant to disease. Traditional breeding methods alone often don't work when there are environmental stresses and diseases that change over time.

To get around these problems, modern plant breeding tools like polyploidy induction, mutation breeding, and hybridization have been used to improve the genetic traits and biochemical profiles of medicinal plants. These techniques let you make new kinds of plants that have more alkaloids, more volatile oils, are better at fighting pests and diseases, and can better handle changes in the environment.

POLYPLOIDY:

- "Poly" and "Ploidy" are the two words that make up the word "polyploidy." "Poly" means "many" or "more," and "Ploidy" tells us how many pairs or sets of chromosomes are in the cell of any living thing.
- Polyploidy is when a cell has more than two pairs or sets of chromosomes. In which one set comes from each parent or more than the diploid number.
- The number "2n" shows that a plant has two sets of chromosomes in its cells. One set comes from the pollen and the other comes from the egg cells.
- Polyploidy is the name for plants that have more than two sets of chromosomes in their cells. The letter "4n" stands for tetraploids, which means that the plants have four sets of chromosomes. .

Factors Promoting Polyploidy

• There are three factors which promotes the polyploidy which are as follows:

1. Physical factor
2. Chemical factor
3. Biological factor

1 Physical factor:

I. Temperature :- heat temperature & cold temperature
II. Centrifugation
III. X-rays
IV. Gamma rays
V. Cosmic rays
VI. Ionizing & non-ionizing radiations
VII. UV-radiations

2. Chemical factor:

I. Alkylating agents:- nitrogen & sulphur mustard
II. Acridines

III. Proflavins
IV. Nitrous acid
V. Colchicines

3. Biological factor

I. Mode of reproduction
II. Mode of fertilization
III. Breeding system present (Hybridization)
IV. Growth habit of the plant
V. Size of chromosomes

- Colchicine stops spindle formation during cell division, which leads to tetraploidy. This means that the chromosomes that have been split can't move to the daughter cells and separate.
- The two sets of chromosomes stay in the same cell, which becomes a tetraploid plant.
- There are many ways to use colchicine, but they all depend on how it affects the meristem.
- You can soak the seeds in a weak solution of colchicine, or you can treat the seedlings, the soil around them, or the young shoots with colchicine solution. .
- You can soak the seeds in a weak solution of colchicine, or you can treat the seedlings, the soil around them, or the young shoots with colchicine solution. We got seeds that could grow and tetraploid plants that were strong and healthy. The pollen grains and stomata were bigger, and chromosome counts in root-tip preparations confirmed the tetraploid condition. .

Examples:

- For instance, the average increase in alkaloids content in Datura stromonium and Datura tatula plants that were diploid was 68%, with the highest increase being 211.6%.
- Belladonna grew by an average of 93%, and the same thing happened with Atropa belladonna and Hyoscyamus niger.
- Datura stromonium and Datura tatula are two types of tetraploid plants that have been shown to have more alkaloids.
- When Acorus calamus changes from diploid to tetraploid, its volatile oil content goes from 2.1% to 6.8%.

Application Of Polyploidy

• Mutation breeding
• Seedless fruits production
• Bridge crossing
• Ornamental & forage breeding
• Disease resistance through aneuploidy
• Industrial application of polyploid

MUTATION:

A sudden change in the structure of a gene on a chromosome, or a change in the number of chromosomes.

Type of mutations:

1. Spontaneous and induced mutations.
2. Recessive and dominant mutations.
3. Somatic and germinal mutations.
4. Forward, back and suppressor mutation.
5. Chromosomal, genomic and point mutations.

Mutations can be artificially produced by certain agents called mutagens or mutagenic agent. They are two types:

a. Physical mutagens:

(i) Ionizing radiations: X-rays, gamma radiation and cosmic rays.

(ii) Non-ionizing radiation: U.V. radiation,

b. Chemical mutagens:

(i) Alkylating and hydroxylating agents: Nitrogen and sulpher mustard; methyl and ethylsulphonate, ethylethane sulphonates.

(ii) Nitrous acid:

Acridines: Acridines and proflavins.

Ionizing radiation breaks down chromosomes. After that, these cells split up in a strange way.
If these include gametes, they might not be normal and die too soon. Purines and pyrimidines can easily absorb non-ionizing radiation, like UV rays. Photoproducts are the bases that have changed. When U.V. rays hit pyrimidine, it changes into pyrimidine hydrate and pyrimidine dimmers. Thymine dimer is a big mutagenic effect of U.V. rays that changes the DNA double helix and makes it harder for DNA to copy itself.

Application Of Mutation:

- This is a cheap and quick way to create a new type.
- For example, induced mutagen can cause CMS (Congenital Myasthenic Syndrome). Ethidium bromide is used to start CMS in barley.
- It helps make oligogenic characters better.
- This is the quickest, easiest, and best way to get a new character to appear.
- It helps crop plants fight off disease better.
- It is used to improve certain traits in varieties that are well-suited to their environment and produce a lot of fruit.

HYBRIDIZATION:

This is the process of mating or crossing two plants that have the genes or genotypes you want but are genetically different. The end result is a new plant called a hybrid.
The process that makes hybrids is called hybridization.

Hybridization, especially between homozygous strains that have been inbred for a number of generations, creates some heterozygosis, which often shows up in the size and other traits of the plants.
A hybrid is a living thing that comes from two species or varieties that are different in at least one way.

Based on the nature & relationship of plants to be crossed, hybridization can be

1. **Inter-varietal** – Cross between plants of two diff. var. of samespecies- intra specific hybridization. Eg. Hybrid Maize.
2. **Intra-varietal** – Cross between two plants of diff. genotypes butsame variety.
3. **Inter-specific** – Cross between two species of genus - Eg. Wheat, Cotton, Tobacco.
4. **Inter-generic** – Cross between two diff. genera. Eg. Sugarcane X Bamboo, Wheat X Rye, Radish X Cabbage

The following steps are involved in hybridization of plant:

1. **Choice of parents:** At least one of the two parents should be a well-known and popular type in the area. The second type should have the qualities that the first one doesn't.
2. **Emasculation:** Emasculation is the process of removing the stamens or anthers or killing the pollen grains of a flower without hurting the female reproductive organs. Emasculation is very important for flowers that are bisexual. .
3. **Bagging:** After you take the male parts out, you put the flowers or inflorescences in bags that are the right size so they don't cross-pollinate with other plants.
4. **Pollination:** When mature, fertile, and viable pollen is put on a stigma that is ready to accept it, this is called pollination. The process involves getting pollen from newly opened anthers and putting it on the stigmas of flowers that have been cut off from their male parts.

Significance of Hybridization

- Hybridization can help plants grow more.
- You can improve a plant by combining plants of different types that are of higher quality.
- The biggest problem with crops that produce a lot of food is that they get sick easily. Hybridizing plants that are resistant to disease is one way to solve this problem.
- You can cross plants that can handle different amounts of stress to make plants that can handle a lot of stress. • Hybridization can give you any traits you want, like being able to handle pests, diseases, and stress.
- In some crops that are worth a lot of money, the senescence period can be made longer and the effects of aging can be lessened.

Conclusion:

Polyploidy, mutation breeding, and hybridization are all very helpful when it comes to growing medicinal plants. These scientific methods not only make plants' genes more diverse, but they also help make better varieties that are more useful for medicine, produce more, and are better able to fight off diseases and environmental stresses.

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