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Mutation Breeding: An Overview

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Introduction

Mutation is a sudden genetic change that does not result from genetic segregation or genetic recombination and occurs in the DNA of a living cell. The deliberate use of mutations in plant breeding is known as mutation breeding. Mutation breeding, as opposed to hybridization and selection, provides the benefit of repairing a flaw in an otherwise superior cultivar without sacrificing its agronomic and qualitative traits. The only simple method for developing seedless crops is mutation breeding. These benefits have led to mutation breeding finding a role in plant breeding ever since the initial release of mutant cultivars from basic mutation research in Europe. Techniques for inducing mutations with physical and chemical mutagens in major crops have been improved, and methods for selecting mutant populations have been described. Ionizing radiation and alkylating chemicals are still widely used, nevertheless. Thanks to the advent of strong *in vitro* procedures which have increased the effectiveness of mutation breeding in several crop species. *In vitro* methods are extremely effective because they can handle sizable mutagenized populations in a small area, have rapid progeny turnover in species that are propagated vegetatively, and can screen for a variety of biotic and abiotic stress factors in the culture environment. In the last ten years, reverse genetic methods have revolutionised the field of mutant screening.

The creation of high yielding cultivars is a basic necessity in the modern society. Breeders use techniques including selection, hybridization, and mutation to create variants and features capable of producing higher yields.Cross breeding would have required a lot of work and complexity in order to alter the genetics of plants, but mutation breeding has made this process simpler. Therefore, the combination of mutation techniques with molecular methods is opening up fascinating possibilities for contemporary plant breeding.

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More than 210 plant species from 700 different nations had a part in the formation of the 3200+ mutant variants that the process of induced mutation has given humanity.

Types of Mutation

Mutations are classified into two groups depending upon the magnitude of phenotypic effect produced by them (Gaul 1964).

(i) Macro mutations: The mutations which produce a large detectable phenotype effect on individual plants. These are oligogenic in nature and can be easily selected in the M2 generation

(ii) Micro mutations: These produce a small phenotypic effect that can be identified only on the basis of a population. These are polygenic in nature and selection for such mutations can be delayed till M3 or later generations.

Mutagen: Physical or chemical agents which greatly enhance the frequency of mutation.

Types of Mutagens:

a. Physical mutagen:

1.Ionising radiation:

a)Particulate radiation: Alpha-rays, Beta–rays, Fast neutrons and Thermal neutrons.

b)Non–particulate radiation: X-rays and Gamma rays.

2. Non ionizing radiation: Ultraviolet radiation.

b. Chemical Mutagens

Alkylating agents: Ethyl methane sulphonate (EMS), Methyl methane sulphonate (MMS), Nitrogen mustard.

Acridine dyes: Proflavine, Acridine orange.

Base analogues: 5 Bromo uracil, 5-Chlorouracil.

Other mutagens: Nitrous acid, Azide.

Procedure of Mutation Breeding

A) Selection of material

To achieve clearly defined objectives through mutation breeding, the selection of parent material is essential. Programs for breeding mutations should be well-defined, well-planned, and large enough to select desirable mutations at low frequencies. Mutation breeding can be used to create new alleles or improve locally adapted varieties that aren't in germplasm collections. When the goal is to release a new variety through mutation breeding,

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a locally adapted variety must be chosen, whereas any of the plant introductions can be used to create new germplasm for use in cross breeding.

B) Dose of the Mutagen

The properties of the mutagenic agent, the solvent medium, and the biological system all influence the dose required for high mutagenic efficiency. Many workers believe that the best dose should be one that is close to LD_{50}. LD_{50} is that mutagen dose, which would kill half of the treated people. The crop species and the mutagen used both affect LD. Typically, the appropriate mutagen dose is determined through a preliminary experiment. In general, an excess is probably going to kill too many treated people, while a lesser dose would not produce too much of changes.

C) Handling of mutagen treated material

1. About 500-600 seeds are treated with an appropriate mutagen. The plants raised from the treated seeds constitute M1 generation. The M1 is densely planted and seeds from individual plants are harvested separately. The M1 plants should not be allowed to cross pollinate.M1 population should be planted 75-100 m apart from the parental or other genotypes of the same crop species.Mechanical isolation is maintained. The M1 plants should be observed critically to look for dominant mutations, if any.
2. The M2 generation is raised from seeds harvested from M1 single plants in plant to progeny rows. Single plants from progeny rows suspected to contain mutant alleles are harvested separately. The recessive mutations are expressed in M2. To achieve the desired target of mutation breeding programme, the size of M2 generation should be large enough.
3. The selected M2 plants are grown in progeny rows to raise M3 generation. In M3 generation the homogeneous mutant progenies are harvested as bulks, whereas the heterogeneous progenies are further subjected to selection of mutant plants, if any, which can be grown to raise M4 homogeneous progenies.
4. In M4 generation, the uniform mutant progenies are further evaluated preferably in replicated trial. The segregating progenies, if any, must be rejected.
5. In M5, the superior mutant progenies are evaluated in preliminary yield trial along with a suitable check. The promising stable mutant progenies/lines are further tested in multi-location trials for 2-3 years before their release as a new variety. The low yielding

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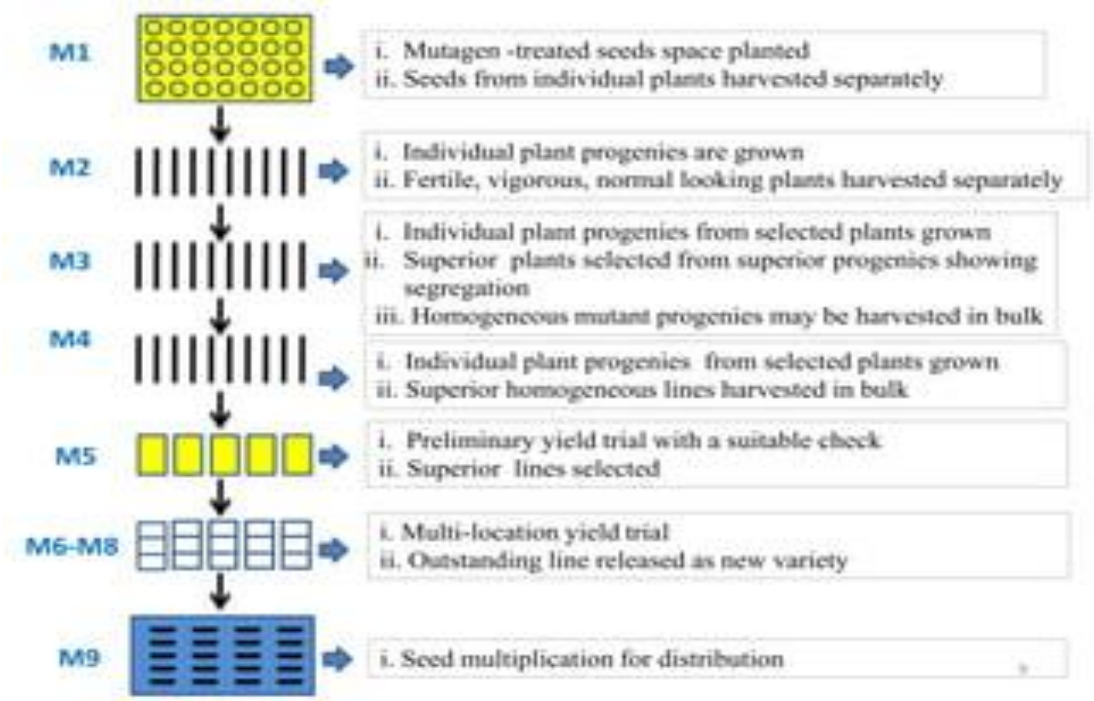
mutant lines can be retained for their use in hybridization programme to create variability.



Achievements of Mutation Breeding

- **Higher yield** Barley (DL 253), Pea (Hans), Groundnut (Co 2, TG 17).
- **Short stature** Barley (RDB 1),Rice (Prabhavati).
- **Earliness** Rice (IIT 48,IIT 60,Indira,Padmini)
- **Stress resistance** Salt tolerance in Rice (Mohan)
- **water logging tolerance** in jute (Padma)
- **Bold seed size** Groundnut (PB 1,PB 2,Vikram) andRice (Jagannath).

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