



Mutation Breeding

What is mutation breeding?

The genetic improvement of crop plants for various economic characters through the use of induced mutations is called mutation breeding. Mutation breeding is used when desired variability is not found in the germplasm of cultivated species.

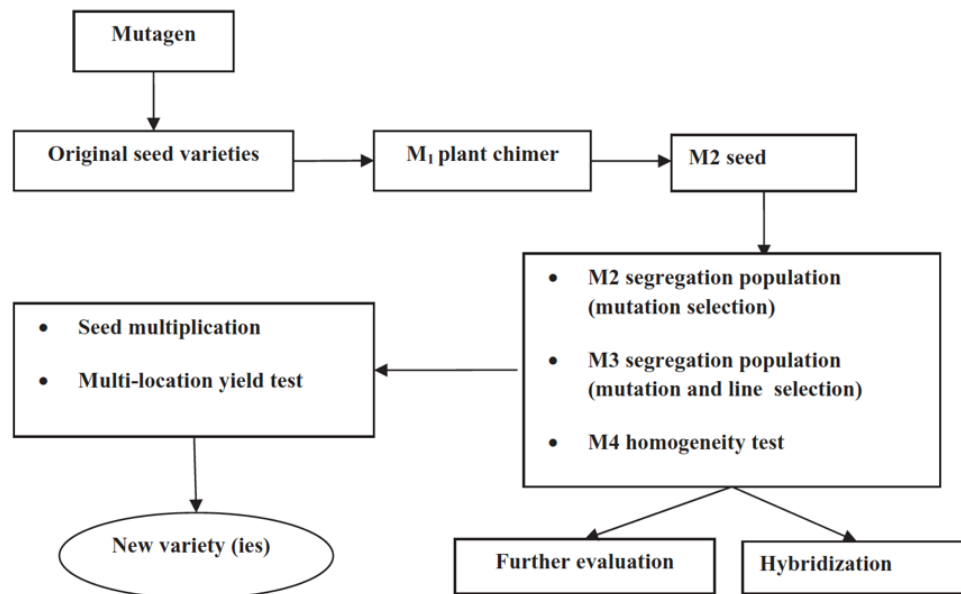
Natural selection operates to bring about evolution of new races and species through the variability created by natural mutations and amplified by subsequent recombination of genes during sexual reproduction. Besides natural mutations that occur spontaneously due to various kinds of radiations and cosmic rays received from the sun and also emitted by several radioactive elements, mutation can also be artificially induced by a number of physical agents like gamma rays and X-rays and several types of chemical agents belonging to few specified groups known as chemical mutagens. The standard technique of creating variability by means of altering genes through induction of mutations by physical or chemical mutagens and using the same effectively through elaborate methods of selection techniques in various generations for improvement of a particular crop species for desired objectives is called mutation breeding. This is frequently practiced by plant breeders all over the world for crop improvement. Inducing desirable mutations and exploiting them for crop improvement. It is commonly used in self-pollinated crops and used to produce traits in crops such as larger seeds, new colour.

Steps involved in mutation breeding

- Choice of plant material
- Choice of mutagen
- Mutagen treatment

- Handling of treated material
- Identification of desired mutant
- Evaluation of mutant.
- Dose of the mutagen, Mutagens generally induce a high frequency of chromosomal changes and meiotic and mitotic irregularities, Optimum mutagen dose is one, which produces maximum frequency of mutations and causes the minimum killing.

Method of mutation breeding



Merits:

1. De Novo (New) Creation of Genetic Variability:

When the desired character does not exist, mutations are used to get the new character.

2. Breaking Undesirable Linkage:

When two undesirable characters are linked together, mutagen treatment may be used to break the linkage.



3. Production of Haploids:

Haploids may be produced using X-rayed pollen for pollination; un-fertilised egg develops into haploid which are variously used.

4. Increase or Decrease of Chiasma Frequency:

Mutation may change the chiasma frequency which is directly related with recombination and segregation of characters.

5. Production of Transitory Sexuality in Apomicts:

Apomictic plants breed like asexually propagated plants and breeding is difficult. Transitory sexuality can be induced so the better apomictic type can be selected after crossing with various sexual types.

6. Reduction of Incompatibility in Wide Crosses:

Though actual mechanism is not known but irradiation induces better pollen tube growth in few genera which enables inter-specific crosses with the irradiated pollen.

7. Variation in F₁ Hybrids:

F₁ hybrids from inter-varietal crosses may be treated with mutagens in order to increase genetic variability by inducing mutation and to facilitate recombination of linked genes.

8. Production of Distant Hybrid with Translocation:

Irradiation of inter-specific (distant) hybrid causes chromosomal segment translocation carrying some desirable genes which may help in transfer of character from one species to another.

Demerits:

1. Unpredictability:



The frequency of desirable mutants is very low, 0.1% of total mutations. So it is required to grow a large population of M_2 generation and it is laborious to screen out a few economically wanted mutated progenies.

2. Difficulty in Detection:

Mutation breeding is difficult if the detection procedure is elaborate. The disease resistance or quality characters cannot be detected easily which needs elaborate tests. Thus, mutation breeding is not easily applicable to improve this type of character in crop. Moreover, most of the mutations are recessive in nature; it is very difficult to detect it in polyploid species.

3. Undesirable Expression:

Desirable mutations are sometimes associated with undesirable side effects or chromosomal aberrations. To remove these kinds of deleterious effects, back-crossing is done which requires more time and expenses.

4. Unrepeatability:

Since the process of mutation is not well understood, so there is no control on the outcome or result of mutagen treatment. Unless directed mutagenesis is applied, it is difficult to obtain the same or desired mutants every time

Micro-mutations: Mutations with invisible phenotypic changes are called micro-mutations. Such mutations are observed in quantitative characters and, hence are also known as polygenic mutations. Identification of such mutations is very difficult. Micro-mutations are of economic value in plant breeding.



Macro-mutations: Induced mutations are of two types, viz. macro-mutations and micro-mutations. Mutations with distinct morphological changes in the phenotype are called macro-mutations. Such mutations are found in qualitative character and, therefore, are also called oligogenic mutations. Identification of such mutations is easy.

Physical mutagens

- X-rays
- Gamma rays
- Alpha rays
- Beta particles
- Fast neutrons
- Thermal (slow) neutrons
- Ultraviolet rays.

Chemical mutagens

- Alkylating agents
- Base analogues
- Acridine dyes
- Others.

List of mutant varieties of rice released in India

In rice several mutant varieties have been developed through X-rays, gamma rays and Ethyl methane sulphonate (EMS) as given below:

(i) X-rays – Biraj, CNM 20, LNM 25, CNM 31, CNM 6 and Jagannath.



(ii) Gamma rays – AU1, AU4, K84, Mohan, Padmini, Rasmi, Sattari, Hybrid mutant

(iii) EMS – PL 56, IIT 60, Indira and Prabhavati.

References

- www.biologydiscussion.com
- Yusuff Oladosu, Mohd Y. Rafii, Norhani Abdullah, Ghazali Hussin, Asfaliza Ramli, Harun A. Rahim, Gous Miah & Magaji Usman (2016) Principle and application of plant mutagenesis in crop improvement: a review, *Biotechnology & Biotechnological Equipment*, 30:1, 1-16, DOI: 10.1080/13102818.2015.1087333

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