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Mutation breeding for vegetable crop improvement

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Introduction

Sudden heritable change in DNA sequence is known as mutation. Mutation leads to change in characteristics of an organism. 'Mutation breeding' include operation related to the mutation induction & isolation of mutants. It may induce both qualitative and quantitative variation relatively in a short period of time.

Classification of mutation

On the basis of occurrence, mutation can be classified as

Spontaneous mutation- occurs naturally without any treatment. Frquency of spontaneous mutation is very low *i.e.* 10^{-6}.

Induced mutation- it may be induced artificially by treating with some physical or chemical mutagens. Agents used for producing them termed as mutagens. Induced mutation occurs at higher frequency then spontaneous mutation.

Based on the structural change-

Genomic mutation-Change in chromosome number (gain or loss in complete sets of chromosomes or parts of a set)

Structural mutation-Change in chromosome structure (duplications of segments, translocation of segments)

Gene mutation- nucleotide constitution of DNA is changed.

Based on the gene action

Dominant mutation- Change of a recessive allele to a dominant allele (aA).

Recessive mutation-Change of a dominant allele to a recessive allele (Aa).

Characteristics of mutations

- Mutations are generally recessive.
- Mutations are generally harmful to the organism.
- 0.1 percent of mutation is beneficial.
- Mutations are random.
- Mutations are recurrent.
- Induced mutation commonly shows pleiotropy.

Variations in chromosome structure caused by mutation

1. Deletions.
2. Duplications.
3. Inversions
4. Translocations (moving a DNA segment).

Effect of Mutation

1. **Lethal:** Kill all the individual
2. **Sublethal &Subvital** : Sublethal kill more than 50% of the individuals, while sub vital kill much less than 50%.
3. **Vital** : Do not reduce viability of the individual carrying them

Mutagens are any agents which induces mutations.

Types of mutagens

Physical mutagen

1. **Ionising radiation:** Non-particulate: Electromagnetic, X-ray, Gama ray Particulate

and radiation: Alpha ray, Beta ray, Fast & Thermal neutrons

2. **Non- ionising radiation:** U.V rays

Effect of physical mutagens in vegetable crops

Among the radiation based methods, gamma-ray and X-ray in most applications. In which gamma-ray is less destructive whereas fast neutron bombardment causes large deletions.

Table 1. Effect of gamma radiation on vegetable crops

Dose	Effect	Crop
20 kR	Mutants with different flower colour and altered size, shape and seed coat colou	Phaseolus vulgaris L. cv. Waghya
20 kR	germinated seeds, pod length and photosynthetic pigment content	faba bean
400 and 500 G	more changes in genomic DNA patter	Okra
450G	induce new genetic variability in some agronomic traits	canol

- Chemical mutagens

1. **Alkylating agents:** Sulphur mustard, nitrogen mustard, EMS, MMS
2. **Acridinedyes :** acriflavine, proflavine, acridine orange etc.
3. **Base analogues:** 5-bromouracil, 5 chlorouracil
4. **Others:** Nitrous acid, hydroxyl amine, sodium azide

Table 2. Additive effect of physical and chemical mutagens

Crop	Effect	Mutagens	Reference
Cowpea	Chromosome aberrations like unorientations, multivalent, laggards, bridges and precocious movements etc. were noticed in mutagen treated population.	gamma rays and sodium azid	Kumar and Verma (2011)
Okra seed	Deleterious effects on seed germination, plant survival, seedling height and pollen and ovule fertility.	Higher doses of EMS (10%) and gamma ray (60kR)	Solanki et al. (2011)

Commercial utilisation of morphological mutants in vegetable crops

- Dwarf mutants
- Leaf mutants
- Flower mutants
- Mutants for earliness
- High yielding mutants
- Male sterile mutants
- Mutants with changed quality traits
- Mutant with changed post-harvest life
- Mutants released as new varieties.

Table 3. Mutant varieties in Vegetables

Crop	Variety	Mutant type
Tomato	S-12, Maruthan (Co-3), PKM-1, Pusa Lal Meeruti	X-ray mutant of Sioux, mutant of Co-1, Mutant of Annagi, Gamma ray mutant of Meeruti
Chilli	MDU-1	Gamma ray of mutant of K-1
French bean	Pusa Parvati	X-ray mutant of Wax pod
Hyacinth bean	Co-1	Gamma ray mutant of Co-6

Bitter gourd	MDU-1	Gamma ray mutant of MC-103
Palak	Jobnee Green	A spontaneous mutant from local cv.

Limitation of mutation breeding

- The frequency of desirable mutation is very low about 0.1 % of total mutations.
- the breeders has to screen large population to select a desirable mutations
- Desirable mutations are commonly associated with undesirable side effect due to other mutation, chromosomal aberrations.
- Often mutation produces pleiotropic effects
- There may be problems in their registration of mutant variety.
- most of the mutations are recessive

Conclusions

Mutations have the ability to increase the rate of domestication of many vegetable crops that may be potentially useful as a source of food, forage and industrial raw materials. Mutations used in the field of plant molecular biology which are actually of imperative use in breeding studies.

References

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