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If you are a fan of Marvel comics, you have almost certainly seen the movie X-Men. Humans with superpower abilities called mutants, appear in this film. While human mutants with superpowers are only seen in movies, in real life mutation in humans results in mere abnormalities. For instance, having six fingers in one hand, or, having three legs. But in the case of plant mutants, abnormalities are not the only outcome. Although plant mutants show abnormal traits like human mutants, we can create our desired traits by inducing mutation artificially. And if their traits turn out to be beneficial enough for human health, we may even consume them. Mutation breeding is the method that allows us to develop plant mutants. Mutation breeding is one of four strategies of crop improvement, depending on the types of reproduction and pollination mechanisms of plants.What is mutationHugo de Vries. Source: WikipediaHugo de Vries coined the term mutation in 1900. It originated from the Latin word mutare, which means to change. Mutation refers to the sudden heritable change in an organism other than those caused by Mendelian segregation and recombination.The mutation may change a gene, chromosome, or plasma gene(genetic material inside mitochondria and chloroplasts).Point mutation: A point mutation is a gene mutation caused by a change in the nucleotide sequence of a gene. In this mutation, a single nucleotide base is modified, added, or deleted from a DNA or RNA sequence of an organisms genome. Gene mutations include transition, transversion, deletion, duplication, and inversion.Chromosomal mutation: A chromosomal mutation is any change or error that occurs within the chromosome.Chromosomal aberration: Chromosomal aberration refers to abnormalities in the structure or number of chromosomes.What is mutation breeding/mutagenesisMutation breeding or mutagenesis is the deliberate development of mutations and their use to create new crop kinds. It is also called variation breeding. In other words, mutation breeding is the process of exposing the seeds to chemicals or radiation to generate mutants with desirable traits to breed with different cultivars.We can change the structure of a plant for our benefit through this approach, resulting in a higher-quality plant. Usually, the improvement of crop variety takes place by changing the genotype/ genetic structure. Plants or seeds developed using mutation breeding or mutagenesis are known as mutagenic plants or seeds.AKE Gustafsson is the father of mutation breeding. History of Mutation BreedingMutation breeding dates back to 300BC. The ancient Chinese book lulan provides the first documentation of mutant selection in plant breeding.In the year 1590, the first verifiable plant mutant was described. It was a mutant of greater celandine(Chelidonium majus).Hermann J Muller demonstrated the first artificial mutation in 1927. He treated jimson weed (Datura stramonium) with radium.In 1928, Lewis Stadler published the first result of mutation induction in crop plants, such as barley, maize, wheat, and oat. However, he was skeptical about the use of induced mutation for crop improvement. The researches of Muller and Stadler gave birth to Mutation breeding, which represents a new departure from the conventional breeding procedures in agriculture.In 1936, the first induced mutant variety was released. It was a tobacco variation that was created by the induction of X-rays in Indonesia.In 1942, induced disease resistance of a crop plant(barley) was first reported.In 1944, the chemical-induced mutation was first introduced.Hermann J Muller. Source: Nobel PrizeLewis Stadler. Source: Alchetron.comIn this way, a whole new process entered traditional agriculture. Before 1927, plant mutations occurred naturally, not artificially. Only after Muller and Stadler, scientists started inducing mutation with radiation. After 1944, people learned that they could even use chemicals alongside radiations to cause artificial mutation in plants and seeds. Types of Mutation BreedingThere are two forms of mutation breeding based on how the mutation is induced. The types are:Spontaneous mutationInduced/ artificial mutationSpontaneous MutationThe mutation which arises automatically in nature due to subjection of the living organism to treatments of naturally occurring agents, such as electric currents, atomic rays, and particles, injuries, disease & insect attacks, chemicals, etc., is called spontaneous mutation. These mutations remain arising constantly and continuously. This type of mutation provides the base of crop improvement by conventional breeding methods.Naturally occurring plant color mutations. Source: Michigan State UniversityAbnormal flowers due to spontaneous mutation. Source: imagur.comInduced/ Artificial MutationInduced or artificial mutations are mutations at will by artificial means. The artificially induced mutations are similar to those produced spontaneously in nature. Since the changes made are similar to those created by spontaneous mutation.Induced mutation in Arabidopsis. Source: ResearchgateInduced mutation can be of two types:Macro mutation: Mutation with distinct morphological changes in the phenotype. This involves significant changes in the traits. Even one can detect the changes without instrumental help. Thus, the traits can be measured at the level of the individual plants.Micro Mutation: Mutations with invisible phenotypic changes. These are quantifiable differences that one can measure at the level of population. Micro mutations produce genetic variability in the quantitative characteristics of the crops. Hence, the plant breeder gives full attention to micro mutations.Difference inSpontaneous MutationInduced MutationOriginThey originate spontaneously in nature.They do not arise in nature spontaneously. As a result, artificial induction is necessary for them to arise.OccurrenceThey are under the control of nature and therefore remain continuously arising in nature automatically.They are artificial and therefore occur when man induces them. Otherwise, never found.SourceNaturally occurring mutagenic agents such as electric currents, atomic particles, rays, temperature, variations, etc. create spontaneous mutation.Subjecting the plants or other organisms artificially to mutagens such as gamma rays, x-rays, neutrons, ultraviolet rays, etc. induce artificial mutation.FrequencyTheir frequency of occurrence is rare and sluggish.They arise more frequently than spontaneous mutation because they are the intentional creation of a human being.UseThey are the basis of crop improvement by the conventional method.They are the basis of mutation breeding, especially when further improvement in crops is not possible by spontaneous mutation. Related articles ReferencesPrinciples of plant genetics and breeding by George Acquaah 4.9 7 votes Article Rating Share copy and redistribute the material in any medium or format for any purpose, even commercially. Adapt remix, transform, and build upon the material for any purpose, even commercially. The licensor cannot revoke these freedoms as long as you follow the license terms. Attribution You must give appropriate credit , provide a link to the license, and indicate if changes were made . You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use. ShareAlike If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original. No additional restrictions You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits. You do not have to comply with the license for elements of the material in the public domain or where your use is permitted by an applicable exception or limitation . No warranties are given. The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. Mutation breeding is a type of plant breeding technique that involves exposing plants to radiation or chemicals in order to induce mutations in their genetic material. This process can create new genetic variations that can potentially result in desirable traits such as improved yield, disease resistance, and enhanced nutritional value. The present post discusses the process of mutation breeding in crop improvement and look into the disadvantages and advantages of mutation breeding.Learning objectives: What is Mutation Breeding? History of Mutation Breeding, Steps in Mutation Breeding, Mutation Breeding for Oligogenic and Polygenic Traits, Advantages and Limitations of Mutation Breeding, Achievements of Mutation Breeding, Mutation Breeding in India, Induced Mutations for Crop Improvement.Learn more: Mutagens- Physical, Chemical & Biological Mutagenic AgentsWhat is Mutation Breeding? Definition: The utilization of induced mutations in crop improvement is called mutation breeding The term mutation breeding was first coined by Freisleben and Lein in 1944 to refer to the deliberate induction and development of mutant lines for crop improvement.History of Mutation Breeding The term mutation was for the first time introduced by Hugo de Vries. The mutagenic activities of X-rays were first described by Muller on Drosophila melanogaster (Nobel Prize). Stadler and Baoley described the mutagenic activity of - rays.Learn more: Comparison of Alpha, Beta and Gamma Rays Auerbach and Rohion proposed the mutagenic ability of mustard gas (Sulfur mustard). Nilsson Ehle initiated the mutation breeding programme in USSR for the first time.Learn more: What is Gamma Garden?Mutation Breeding The utilization of induced mutation in crop improvement is called mutation breeding. In mutation breeding, desirable mutations are induced in crop plants with the use of physical or chemical mutagens. The variability generated through induced mutations are either released as new variety or used as the parent for subsequent hybridization programmes. Treating of biological materials with mutagens to induce mutation is called mutagenesis. If any class of radiations are used as a mutagen to induce mutation in crop plants, the exposure of biological organism to the radiation is called irradiation. Mutation breeding programme should be clearly planned and should be large enough with sufficient facilities to screen large population.Steps in Mutation Breeding(1). Objectives of the programme Mutation breeding should have well defined and clear-cut objectives.Learn more: Objectives of Plant Breeding(2). Selection of the varieties for mutagen treatment The variety selected should be the best variety available.(3). Part of the plant to be treated Seeds, pollen, vegetative propagules, sometimes complete plant as treated with mutagen The selection of plant part varies with crop plant. Seeds are best part in sexually reproducing plants. Seed treatment is the treatment of embryo. (4). Dose of mutagen The mutagen treatment reduces germination, growth rate, vigour and fertility of organism. The mutation also increases frequency of chromosomal changes, mitotic and meiotic irregularities in the organism All these damages increase with increase in the dose mutagen and duration of exposure. Thus, the dose should be optimized for a maximum success rate The dose and treatment duration of mutagens varies with crop and plant parts and also with the type of mutagen used. The optimum dose is the dose at which maximum frequency of mutation will occurs with minimum killing of the organism. The optimum dose of mutagen is expressed as LD50. LD50: Dose of mutagen which will kill 50% of treated individuals. LD50 varies with crop plants and type of mutagen used.(5). Giving mutagen treatment M1: generation produced directly from mutagen treated plant parts. M2, M3 & M4 are subsequent generation derived from M1, M2 and M3. M2, M3 & M4 are produced by selfing or clonal propagation.(6). Handling mutagen treated population Mutation treatment in seeds and vegetative propagules produce chimeras. Mutation usually occurs in small section of plant parts such as seeds or meristem. One or more clonal or sexual generations with selection are necessary for stable mutant phenotype. Mutant alleles are generally recessive. Dominant mutation do occurs, however, the chance of dominant mutation is very less. In sexually reproducing plants dominant and recessive mutations are useful. However, in clonal propagated plants, the dominant mutations are beneficial.Mutation Breeding for Oligogenic Traits Mutation breeding is most used to improve the qualities of a crop plant which are controlled by oligogenic traits.Mutation breeding for Polygenic Traits Mutagenesis also produces genetic variations in polygenic traits. This variation is however 50% less than that generated in F2 generationAdvantages of Induced Mutations in Crop Improvement Mutation breeding can be used for both oligogenic and polygenic traits in plants. It improves morphological and physiological characters of cultivated crops. Mutation breeding can improve the disease resistance of crop plants.Learn more: Vertical Resistance vs Horizontal Resistance Induced mutations can induce desirable mutant alleles in crop plants. Mutation breeding can be used to improve the specific characters of a well-adapted high yielding variety. Quantitative characters characteristics of crop plants including yield can be improved by induced mutations. The F1 hybrids obtained from inter varietal cross are treated with mutagen to increase variability.Learn more: Terminologies in Genetics and Plant Breeding Mutation breeding can effective to disseminate an undesirable character from a crop variety.Limitations / Disadvantages of Mutation Breeding The frequency of desirable mutation will be very low (0.1 % of total mutations). The breeder must screen a large population to select a desirable mutation. Desirable mutations are commonly associated with undesirable side effects. Mutations often produce pleiotropic effects. Mutation in quantitative traits is usually in a direction away from the selection history of the parent variety. There may be problems in registration of mutant variety in many parts. Most of the mutations are recessive and their effects are not expressed due to the dominance of its allelic counterpart.Achievements of Mutation Breeding Many crop varieties have been produced by mutation breeding all over the world.Mutation breeding in India Till 1990, 219 mutant varieties of crop plants have been produced in India. Among which 116 are seed propagated and 103 vegetative propagated plants.Crop varieties produced in India by Mutation Breeding Jagannath is a gamma semi dwarf mutant from tall cultivar T-141. Jagannath has improved resistance to lodging, high yield, more responsive to fertilizers than its parent. In wheat, NP-836 is an awned mutant from the awn-less seed variety NP-799. Sugarcane CO-8152 is a gamma induced mutant from CO-527. CO-8152 has 40% more yield than the parent.