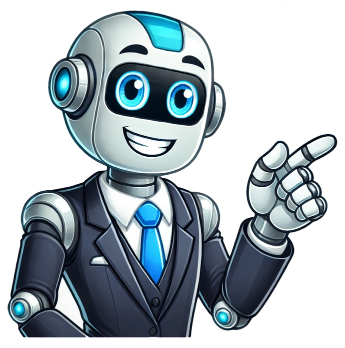

Significance of Mutation in Plant breeding and its role in Evolution Authors: Prof. Jiitendra E. Wayde, Assistance Professor (Genetics and Plant Breeding), H.H.S.S. Muralidhara Swamiji College of Agriculture, Malegaon, Nasik, Maharashtra, India.Prof. Shilpa K. Udamale, Assistance Professor, (Dept. of Botany), H.H.S.S. Muralidhara Swamiji College of Agriculture, Malegaon, Nasik, Maharashtra India.Dr. Manoj kumar Bahel, Assistance Profesor (Genetic and Plant breeding) Lovely Professional University, Jalandhar, Punjab, India. Introduction:Hugo de Vries is the first scientist presented a term of mutation in 1886. He first recognized the sudden changes in Oenothera Lamarkiana and studied the hereditary and came to this condition in 1901. De Vries's theory was one of the chief contenders for the explanation of how evolution worked, leading, for example, Thomas Hunt Morgan to study mutations in the fruit fly, until the modern evolutionary synthesis became the dominant model in the 1930s. Somewhat ironically, the large-scale primrose variations turned out to be the result of chromosomal duplications (polyploidy), while the term mutation now generally is restricted to discrete changes in the DNA sequence.Mutation play important role in plant breeding and also evolution in species Role of Mutation in Plant Breeding: Mutation in plant breeding improving the crop quality but improving the heredity through the cross hybridization technique. Plant mutation can be artificially affected by mutagenic agents and its utilization for production of traditional to new superior variety is called plant mutation breeding. In India mutation breeding started in 1935 at Bose institute, Calcutta and established at IARI, New Delhi in 19591) Mutation breeding in Rice (Oryzae sativa) 2n=24: Rice is common in Asia. Some chemical mutagens used in Rice to produce polyploidy varieties and diploids produce high yield and resistance varieties through hybridization. P-500.28 these mutated variety obtained from T-1145 at Boses institute, Calcutta. Jagannath variety produced from T.141.2) Mutation breeding in Wheat (Triticum aestivum) 2n= 42: Chemical mutagen and Eradication being used to produce resistance wheat varieties NP836 from NP799 at IARI New Delhi. Using gamma ray on NP799 variety and produce NP836 mutant variety.3) Mutation breeding in Cotton (Gossypium) 2n=52: Cotton variety produced by X-ray treatment. Indore-2 was produced from Malwa Upland 4. Indore-2 L.SS Burry-0394, 320-F and H-14 improved cotton varieties from mutation breeding.4) Mutation breeding in Potato (Solanum tuberosum) 2n=48: Production of early harvesting varieties and high yielding varieties introduced from mutation breeding. Chemical mutagen and Eradication used through cross breeding.5) Mutation in breeding in Sugarcane (Saccharum officinarum) 2n=80: Chemical mutagen and Eradication used to the mutation in sugarcane. Nodal buds of sugarcane are exposed to the radiation in mutant buds and tillers selected to f1 and f2 generation through artificial crosses and field. Co-213, Co-602, Co-612, H.M-661 varieties is higher quality produced of sugarcane through mutation breeding.Role in Evolution: Mutation key role of evolution and origin of new species. According to the mutation theory was proposed by Hugo de vries in 1901 he explained process of mutation in Oenothera Lamarkiana they marks sudden heritable changes in plants. He forwarded that:1. Mutation carries the chance of selection 2. Mutation arises through new species 3. Mutation takes place virtually dictate and may involve anyone characters. Oenothera chromosome number is 14 but Hugo de Varies was observed in some generation the chromosome numbers tend to vary and some it was found in 15, 16, 22, 24, 27, 28, 29 and 30. In this result variation shows the plant. In this plant flower size, shape, arrangement of buds and seed size. According To Stages of Mutation Breeding: 1. Gene level: alteration of structure and position of gene 2. Alteration of phenotypic and genotypic of an organism 3. Change the basic number of chromosome either loss or addition of set of chromosome 4. Mutation in chromosomal level is established in population they subjected to natural selection. A. Mutation breeding in Self Pollinating SpeciesMutant characters is fairly direct in crops that are capable of self-pollinating. Because several mutations are recessive, after mutagenic treatment, the material should be self-pollinized and innovative to at least the M2 before phenotypic screening. Positive mutant identifications should be kept for future selection. This allows the breeder to have a series of lines from which to select for performance in addition to the presence of the mutant trait. B. Mutation breeding in Cross Pollinating SpeciesCross pollinating species increase some difficulties. Because species which are mostly cross pollinating typically exhibit significant inbreeding depression, the necessary self-pollinations to identify mutants in the population result in reduced plant vigor due to the genetic background and not necessarily the mutations. C. Mutation breeding in Vegetatively propagated speciesWhen trying to effect mutation in vegetatively propagated species such as banana or sugarcane, it is important to note the chimeric nature of mutagenic treatment. All cells exposed to the mutagen will not necessarily sustain mutations, but those that do sustain mutations, will give rise to cells exhibiting the mutation. D. Mutation breeding in Seed propagated speciesSeeds treated with mutagenic agents give rise to chimeric plants. Chimeric plants produce both mutant and non-mutant seed. This can be problematic However, one just needs to plant more seeds to find the desired mutants. As long as an efficient screening method is in place, this should produce no significant consequences. Mutagenic treatment of seed is by far the most popular method in mutation breeding programs. References De Vries H. (1909). The mutation theory, Open Court Pub. Co., Chicago. Bibikova M., Beumer K., Trautman J.K., Carroll D. (2003) Enhancing gene targeting with designed zinc finger nucleases. Science 300:764. Brunner H., Keppl H. (1991) Radiation induced apple mutants of improved commercial value, Proc Plant Mutation Breeding for Crop Improvement, Internl Symp, IAEA and Food Agric Org of the UN, Vienna. pp. 547552. Chakrabarti S. (1995) Mutation breeding in India with particular reference to PNR rice varieties. Journal of Nuclear Agriculture and Biology 24:7382. About Author / Additional Info: I have completed M.Sc. in Agriculture (Genetic and Plant Breeding) from Lovely Professional University, Punjab 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.