

Implementation of National Education Policy -2020: Multidisciplinary Education

ISBN: 978-93-94819-23-8

Pub. Date: 12/02/2023

Volume: I

Review on Role of Physical Mutagen in Mutation Breeding

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Abstract

Radiation is a simple and quick way of breeding that has applications in agriculture and biology. The majority of the researchers concluded that increasing the production and nutritional value of this key crop using radiation would result in significant improvements in the quality and quantity of animals and their products. Scientists have found that when plants mature and reproduce, protein content is converted to carbs, resulting in a drop in protein %; nevertheless, early investigations have indicated an increase in protein and carbohydrate content in response to a specific dose of gamma radiation. The main topics of this review article are mutation, mutant selection, when to employ induced mutations, how much of them to utilise, and their applications in plant breeding. Mutation is brought on by a mutagen. Mutants are widely used in a variety of fields, including genetics, plant breeding, and plant physiology. Hugo de Vries first used the term "mutation" in 1901 to describe an abrupt change in personality that was thought to be heritable. Consequently, an agent that causes mutation is referred to as a mutagen, while transmissible to the progeny. Naturally occurring mutations can also be caused by other factors, including chemical mutagens, ultraviolet radiation, x-rays, gamma rays, and so on (induced mutation). Mutagenesis is the process through which an organism's genetic makeup changed in a stable way and led to mutation.

Keywords: Mutation, Physical Mutagen, Mutation Breeding

Introduction:

Mutation breeding refers to the method of using artificial mutagenesis to obtain new biological cultivars, mainly through chemical or radiation mutagenesis. Chemical mutagenesis refers to the biochemical reaction between chemical agents and genetic material, and the result is mostly point mutations in genes (Chandrashekaret.al, 2013). Although chemical mutagenesis is effective, its environmental optimization and biological safety need to be improved. Comparatively, radiation mutagenesis has the characteristics of more complex genetic mutations and more beneficial mutant phenotypes.

Since it has been employed for almost a century, radiation mutation breeding has successfully enhanced crops by boosting genetic diversity. Numerous issues, including rapid population increase, environmental pollution, and climate change, are posing problems for the world's food production. Breeders face huge hurdles in trying to feed the enormous human population on the planet. Enhancing germplasm diversity through mutation is still essential in modern and classical radiation breeding because it is more likely to produce random mutations in

the entire genome. This is true even though advanced technologies, such as gene editing, have made it possible to breed varieties by editing one or more specific target genes. This review also looks into the future development of radiation mutation breeding, hoping to deepen our understanding and provide new vitality for the further development of radiation mutation breeding.

Need For Genetic Improvement:

India is primarily an agricultural country with animals being an important element. It is India's economic strength in terms of income, employment and foreign exchange remunerations. The dairying industry is anticipated to contribute 15% of the country's gross national income. Nearly 65-70 percent of people in the country live in villages and 69 percent practice in agriculture or work in the dairy industry. Increased research efforts in the domain of feed processing using biological, biotechnological, chemical and physical technologies are needed to meet the nutritional requirements of high yielding milk animals by enhancing bioavailability of feeds and fodders. In plant breeding, mutation breeding is one of the most common strategies. It has applications in morphology,

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cytogenetics, biotechnology and molecular biology among other domains. In recent years, mutation breeding has gained popularity as a useful technique for crop development and as a means of complementing existing germplasm for cultivar improvement in breeding programmes.

Selection of Mutagen:

Plant products such as plant parts, flowers, anthers, pollen grains, single cell culture, seeds, complete plants and protoplast are all irradiated using gamma sources. For plant breeding, radiation has been successfully utilised to generate beneficial mutation (Desai and Rao, 2014). The use of a mutagenic therapy enhances biochemical components, which are employed to increase economic characteristics (Muthusamy *et.al*, 2003). Because gamma radiation can have both helpful and negative effects on crops, it is necessary to estimate the optimum favourable dose for improving specific crop plant characteristics (Jamil and Khan, 2002). Inducing mutations with ionising radiations can also increase genetic diversity. Mutant line genetic diversity can be investigated utilising morphological, agronomic and molecular characterizations (El-Sherif *et.al*, 2011). Furthermore, the effectiveness of gamma radiation in enhancing seed quality, cooking time, plant growth and physiological processes is inversely proportional to the dosages utilised. (Kionget *et.al*, 2008).

Gamma rays are the most energetic electromagnetic radiation with energies ranging from 10 to hundreds of kilo electron volts (Kev). As a result, they penetrate deeper than other types of radiation like alpha and beta rays (Rahimi and Bahrani, 2011). Nuclear techniques are used in agriculture in a variety of ways. Irradiation of seeds can cause genetic variability in plants, allowing plant breeders to select new genotypes with improved traits like grain yield, maturity, salinity tolerance and superiority (Ashraf, 2003). When trading agricultural products within the same country or from country to country ionising radiations are also utilised to disinfect them in order to extend their shelf life or prevent pathogen proliferation (Borzouei *et.al*, 2010). Grey units are used to measure the quantity of radiation energy

absorbed (or Kilograys, KGy). A joule per kilogramme or 100 Rads is equal to one Gray.

Ionizing radiation is a powerful mutagen altering the biochemistry of bases and generating double-strand breaks in DNA. Increased levels of radiation have caused harm to numerous processes, resulting in decreased photosynthesis, growth inhibition (Bond *et.al*, 1996) and plant productivity drop. Changes in compatible solute levels such as amino acids, polyamines, carbohydrates and others are thought to be an effective stress tolerance mechanism (Galiba, 1994). Because of their direct association with physiological activities including photosynthesis, translocation and respiration changes in carbohydrate content are particularly important (Farrant *et.al*, 1993). The main sugar components are sucrose, glucose and fructose. Sucrose can operate as a water replacement to keep membrane phospholipids in the liquid crystalline phase and to keep soluble proteins from changing structurally (Koster and Leopold, 1988). Mutagens, mutagenic effectiveness and efficiency as well as their dosages are required for mutation induction and usage (Sharma *et.al*, 2005).

Wavelengths of ionising radiation are fewer than 100 nanometers. High-energy particles such as photons and electrons are excited by these radiations. Gamma radiations and X-rays are two forms of ionising radiations (Kovacs and Keresztes, 2002). Gamma rays have a shorter wavelength and thus greater energy than other types of radiation. Cobalt-60 and Cesium-137 are the most common gamma ray sources utilised in mutation induction. When gamma rays interact with atoms or molecules in the cell they form free radicals, which are classified as ionising radiation. These free radicals cause cell harm but they can also change the cells and components (Shahbazi *et.al*, 2008). The amount of radiation that damages or alters cells and components is determined by the quantity of radiation. The anatomy, morphology, physiology and biochemistry of plants are all affected by these radiations (Mohajer *et.al*, 2014). The effect of these rays is dose dependant as they stimulate plant growth even at low doses. As a result, these radiations are critical for crop development

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by changing the plant DNA (Jan *et.al*, 2012; Rahimi and Bahrani, 2011). According to studies, there are approximately 2570 radiation-induced mutants, with gamma rays producing 1023 crop mutants (Hamideldin and Eliva, 2015). Electromagnetic radiations, ionising radiations and a photon of energy that resembles gamma rays are all referred to as X-rays. Although gamma and alpha radiation come from separate sections of the atom they share the same properties. Outside the nucleus, X-rays are emitted, whereas inside the nucleus gamma rays are released.

Future Prospects:

Mutation breeding is currently frequently employed for generating genetic alterations and creating new genetic resources, especially in crops that are difficult to improve via predictable procedures such as hybridization (Mohajer *et.al*, 2014). In recent years, scientists have begun to use mutant breeding in addition to standard plant breeding to develop novel crop varieties. Here is a review of the facts on the use of radiation on various crop species. Mutations are used in crop improvement through two sets of technologies, in vitro culture and molecular method. Induced mutations are not only limited to crop improvement but also used in exploring biology (Brunner, 1995). The physical mutagen gamma irradiation is frequently employed for mutation breeding, food sterilization, and therapeutic therapy. In plant breeding, gamma ray irradiation is a common strategy for producing mutants. Irradiation is a potentially valuable method for assuring the safety of food production and prolonging its shelf life around the world. Mutation breeding shortens the time taken for the development of cultivars via induced mutation compared to those via hybridizations and also creates variability in a crop species (Toker *et al.*, 2007).

Conclusion:

Among various method of breeding in crop plant mutation breeding i.e. induced mutation is one of the preeminent methods of creation of variation/genetic variation. Conventional method of breeding takes long time to improve a crop variety due to a very slow increase in genetic variation. To overcome this induced mutation play a crucial role which helps in creation of genetic

variation in a short period. Over last several year's mutation breeding is getting popular and is adopted by several countries. It improves several qualitative and quantitative characters of crop plant and is successfully applied in several cereal, grain legume, oil seed, vegetable, fruits, medicinal plant, ornamental plants and fodder crops. With the advancement of various plant breeding, genetics, and biotechnological tools mutation breeding contribute toward the increase in global food and agriculture production which ultimately overcome global hunger and improve the nutritional status of the globe.

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