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A brief chronology and current status of plant mutation breeding

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Abstract

Most crops evolve over three phases: (1) gathering from the wild; (2) domestication and agronomy, and (3) improvement through plant breeding. Mutation has been a key factor in both domestication and crop improvement. The first reference to spontaneous mutants can be found in the ancient book of Lulan, China, 300 BC. From 1590 onwards there has been continual documentation of naturally occurring mutants in crop plants in the Western world. 1927 is a significant year as: (1) induced plant mutation was first described (in *Datura stramonium*), (2) Muller provided proof of mutation induction, (3) von Sengbusch developed the first mass screen for a desired mutant trait, and (4) Stadler published the first induced mutants in crop plants. In the 1930s deliberate plant mutation breeding programmes were set up, notably in seed propagated crops in Sweden, USA and Germany. The first mutant crop cultivar was in tobacco cv. 'Vorstenland' released in 1934 in Indonesia (induced by X-rays). 1942 saw the first induced disease resistant mutant (mildew resistance in barley) and in 1944 the term mutation breeding (*Mutationszüchtung*), was coined. The first reported chemical induced mutation was in 1944 and the first report of mutation induction by gamma rays was in 1949. In 1954 the first mutant cultivar in a vegetatively propagated crop 'Faraday' tulip was produced. In 1964 the Joint FAO/IAEA Division was established with a mission to use nuclear technologies to safeguard food security, this included mutation induction and mutation screening for plant breeding. In 1966 the first chemical induced mutant cultivar: barley cv. 'Luther' was released. The Joint FAO/IAEA established a data base of mutant cultivars (http://mvgs.iaea.org) in 1993, this currently lists over 3000 mutant cultivars in over 200 crop species; over 80% of these have been produced by physical mutagenesis, mainly gamma irradiation.

The PBGL of the Joint FAO/IAEA Division provides an irradiation service for Member States (MSs). In the past 50 years the PBGL has received over 1300 requests from 77% MSs with the USA making the most requests (15%) followed by Germany (7%), UK (7%), Pakistan (6%), Kenya (4%), Poland (4%), Nigeria (3%) and the rest 2% or less. In 2013 the PBGL received a record number of plant samples for mutation induction in a wide range of crop species. Resurgence in plant mutagenesis is driven by urgent demands for increased biodiversity in contemporary breeding material, mutant screening is now aided by high-throughput methods in plant (phenotypic) and DNA (genotypic) samples. Increased interest in plant mutation breeding is also being fueled by the current revolution in sequencing and functional genomics which exploit mutations in mapping and gene function studies. Plant mutation breeding is also quick compared to conventional breeding: mutation breeding typically takes a leading, favoured cultivar that is deficient for a trait (e.g. has become susceptible to a disease) and induces a mutation to overcome the deficiency. A recent example is the development of black stem rust (*Ug99*) resistant wheat cultivars in Kenya after just four years from the initial mutation induction.

Keywords

Biodiversity, crop improvement, database, irradiation, mutagenesis

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