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Perspective

Strategies to Mutagenesis and Its Influence on Crop Improvement

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DESCRIPTION

Mutagenesis is the phenomenon by which chemical, physical, or biological factors generate rapid heritable changes in an organism's genetic information that are not caused through genetic segregation or genetic recombination. Three types of mutagenesis are used in mutation breeding. Mutations are caused by irradiation (gamma rays, X-rays, ion beams, etc.) or chemical mutagens; site-directed mutagenesis, which seems to be the act of establishing a mutation at a defined site in a DNA molecule; and insertion mutagenesis, which is caused by DNA insertions, either through genetic transformation and insertion of T-DNA or transposable element activation. Regarding crop enhancement, plant breeding necessitates a genetic variety of valuable features.

Multiple mutant alleles, on the other hand, represent a source of genetic variety for crop breeding and, in many cases, functional investigation of the targeted gene. The method of discovering individuals having a target mutation, which involves two primary steps: mutant screening and mutant confirmation, is the most important part of mutation breeding. When compared to the parent, mutant screening is a method that involves selecting individuals from a large mutated population who meet specified selection criteria, such as early blooming and disease resistance. These selections, however, are frequently classified as putative mutants or false mutants. Mutant confirmation, on the other hand, is the process of re-evaluating putative mutants using large samples in a controlled and duplicated context. Many ostensibly mutants are discovered to be phony mutants as a result of this technique. In general, major crop improvement mutations are single-base changes that may or may not alter protein synthesis.

Induced mutagenesis is among the most productive strategies for creating genetic variation and identifying critical regulatory genes for economically relevant features in crop development. Physical, chemical, and insertional mutagen therapies can all generate mutations; however, these approaches are not recommended due to their high cost and time-consuming nature. Nonetheless, with advances in Next-generation Sequencing (NGS) technology, millions of mutations can be found in a relatively short amount of time, making it convenient and cost-effective. Furthermore, the combination of induced mutagenesis with whole-genome sequencing has established a solid foundation for forward and reverse genetic applications.

Furthermore, the accessibility of whole-genome sequence data for a wide variety of crops has made target-specific genome editing techniques the preferred way for engineering desirable changes. ZFNs (Zinc Finger Nucleases), transcription activator-like effector nucleases (TALENS), and the clustered regularly interspaced short palindromic repeats (CRISPR)/CRISPR-associated Cas9 endonuclease have all been used to perform site-specific alterations in a variety of plant species. Because of its simplicity and resilience, CRISPR/Cas9 has revolutionized genome editing and has thus been used to improve biotic and abiotic stress resistance. The scientific community's efforts to identify novel genes for crop improvement using mutagenesis techniques are highlighted in a special issue of Plants.

Chemically induced mutagenesis has resurrected in the last decade, due to the discovery of TILLING (Targeting Induced Local Lesions in Genomes) technology. TILLING ads to mutagenesis by isolating chromosomal DNA from each mutant line and screening the population at the DNA level with contemporary molecular methods. TILLING seeds are exposed to a potent mutagenic chemical, compared with conventional mutagenesis, which induces random mutations across the entire genome. However, great effort is taken to ensure that the target genome is saturated with mutations. Most researchers begin by establishing a "decapitate slope" with their mutagen of choice, where concentration is plotted versus seed survivability before forming the TILLING population.

CONCLUSION

Mutation breeding has always become a useful tool in the toolbox of both plant breeders and basic geneticists. Induced mutagenesis gives one avenue of possibilities in crops where trait diversity is low or non-existent. Mutagenesis can be very useful for crop plant development if it has a clear goal, an effective mutagenic technique, and high throughput and efficient phenotypic screening method.

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