

DNA Fingerprinting

A Revolutionary Tool in Crop Breeding and Improvement

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Introduction

DNA fingerprinting, also known as DNA profiling, is a powerful molecular technique that involves the identification of unique genetic patterns in the DNA of organisms. First introduced in forensic science, this method has found extensive applications in plant science, particularly in crop improvement. With increasing global food demand and the necessity for sustainable agriculture, DNA fingerprinting plays a crucial role in identifying, conserving and improving plant genetic resources.

Applications in Crop Improvement

1. Germplasm Characterization and Conservation: DNA fingerprinting helps assess the genetic diversity within and among plant species, enabling efficient management of germplasm collections. This is essential for conservation strategies and identifying duplicates or mislabeling in gene banks. Accurate characterization ensures the availability of genetically diverse material for breeding programs.

2. Cultivar Identification and Protection: It is often necessary to distinguish between plant varieties for intellectual property protection and seed certification. DNA fingerprinting provides a precise and reliable method to confirm the identity of cultivars, ensuring that farmers receive the correct seeds. This is vital for maintaining varietal purity and avoiding disputes in plant variety rights (PVRs).

DNA fingerprinting relies on the analysis of DNA sequences that show high polymorphism among individuals. These include microsatellites or simple sequence repeats (SSRs), single nucleotide polymorphisms (SNPs) and amplified fragment length polymorphisms (AFLPs). DNA samples are extracted, amplified using PCR and analyzed through gel electrophoresis or sequencing. The resulting profiles help differentiate genotypes based on their unique DNA banding patterns or sequence variations.

3. Marker-Assisted Selection (MAS): One of the most transformative applications of DNA fingerprinting is in marker-assisted selection. DNA markers linked to desirable traits such as disease resistance, drought tolerance or high yield are used to select superior genotypes at the seedling stage, accelerating the breeding process. This approach increases precision and reduces the time and cost involved in developing improved varieties.

4. Hybrid Purity Testing: In hybrid seed production, maintaining purity is essential to ensure uniform performance. DNA fingerprinting helps confirm the genetic identity of parent lines and assess the purity of hybrid seeds. This prevents economic losses due to admixtures and ensures consistent quality in hybrid crops.

5. Genetic Mapping and QTL Analysis: DNA fingerprinting provides the foundation for constructing genetic linkage maps and identifying quantitative trait loci (QTLs). These maps help locate genes or genomic regions associated with complex traits, guiding breeders in introgressing beneficial alleles through backcrossing or genomic selection.

Conclusion

DNA fingerprinting has become an indispensable tool in modern plant breeding. Its applications in germplasm characterization, cultivar identification, MAS and hybrid purity testing significantly enhance the efficiency and accuracy of crop improvement programs. As molecular

6. Identification of Genomic Regions under Selection: Using DNA fingerprinting, researchers can detect regions of the genome that have been subjected to natural or artificial selection. This information helps in understanding domestication processes and improving traits under specific environmental conditions.

technologies evolve, DNA fingerprinting will continue to play a pivotal role in developing resilient, high-yielding and sustainable crop varieties, thereby contributing to global food and nutritional security.