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Popular Article

Roles of Molecular Marker in Varietal Identification

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Abstract

Molecular markers are vital tools in varietal identification within plant breeding. They enable genetic differentiation, distinguishing visually similar varieties, genetic fingerprinting, and unique barcode creation for each variety. Molecular markers also aid in parentage verification, clonal identification, purity testing, and marker-assisted selection. They contribute to germplasm conservation by ensuring integrity and establish varietal distinctness for intellectual property protection. These markers assist in identifying genes related to disease resistance and stress tolerance and enable comparative genomics studies for understanding genetic relationships.

Keywords: molecular markers, varietal identification, genetic differentiation, genetic fingerprinting.

Introduction

In the realm of modern agriculture and plant breeding, molecular markers have emerged as indispensable tools for unraveling the intricacies of genetic differentiation and identity in plant varieties. These markers, operating at the DNA level, provide a lens through which researchers and breeders can peer into the genetic code of plants, revealing subtle yet crucial distinctions that may elude visual inspection. This arsenal of genetic techniques empowers stakeholders in agriculture, from breeders striving to develop improved crop varieties to conservators safeguarding genetic diversity. In this context, we will delve into the multifaceted applications of molecular markers, spanning from genetic differentiation and fingerprinting to



parentage verification, clonal identification, and beyond.

Genetic Differentiation

Molecular markers allow researchers to assess genetic differences among plant varieties at the DNA level. This information can be used to distinguish one variety from another, even when they appear visually similar. This is particularly valuable when working with visually similar cultivars or when trying to distinguish landraces with subtle differences.

Example: Wheat is a crop with numerous varieties, some of which may look similar. Researchers have used molecular markers like SSRs (Simple Sequence Repeats) and SNPs (Single Nucleotide Polymorphisms) to distinguish wheat varieties with similar morphological characteristics.

Genetic Fingerprinting

Molecular markers generate unique genetic fingerprints for each plant variety. These fingerprints serve as a kind of genetic barcode that can be used to identify and differentiate varieties accurately. Each variety has a specific pattern of markers, making it distinct.

Example: DNA fingerprinting through techniques like RAPD (Random Amplified Polymorphic DNA) has been employed to create genetic fingerprints for different fruit varieties.

Parentage Verification

Molecular markers can be used to verify the parentage of a plant variety. This is especially important in plant breeding programs to confirm the lineage and parent-offspring relationships of new varieties. By comparing the genetic profiles of offspring with potential parents, breeders can confirm their genetic ancestry.

Example: In the case of grapevine breeding, parentage verification is crucial. Molecular markers have been used to confirm the parentage of various grape varieties.

Clonal Identification

In vegetatively propagated crops, where plants are reproduced through cuttings, grafting, or other vegetative means, molecular markers are crucial for identifying and confirming the genetic identity of individual plants within a clonal population. This helps maintain the integrity of the clone and ensures that it retains its desirable characteristics over time.

Example: Citrus trees, such as oranges and lemons, are often propagated clonally. To confirm the genetic identity of clonal plants, researchers have used molecular markers like SSRs.

Purity Testing

Molecular markers are used to assess the purity of seed lots and plant materials. They



can detect the presence of off-types or contaminants in a seed lot, ensuring that the variety being sold or used in breeding is true to type. This is especially important in commercial agriculture and seed production.

Example: In the case of maize (corn) seed production, maintaining the genetic purity of hybrid seed is critical. Molecular markers, such as SNPs, have been employed to verify the genetic purity of hybrid maize seeds.

Marker-Assisted Selection (MAS)

Molecular markers are employed in breeding programs to facilitate the selection of desired traits without the need for time-consuming and costly phenotypic evaluations. This accelerates the breeding process by enabling breeders to identify and select plants with the desired genetic characteristics more efficiently.

Example: Disease resistance is a trait often targeted in breeding programs. For instance, in wheat breeding, markers associated with resistance to wheat rust diseases have been used for MAS.

Conservation and Preservation

Molecular markers are valuable tools in germplasm conservation efforts. They help ensure the preservation of genetic diversity by confirming the identity of plant accessions in gene banks and by identifying duplicates or mislabeled specimens. This is crucial for maintaining the genetic diversity of plant species and safeguarding them against extinction or genetic erosion.

Intellectual Property Protection

In the context of intellectual property rights, such as plant variety protection (PVP) and patents, molecular markers can be used as evidence to establish the distinctness, uniformity, and stability (DUS) of a new plant variety. This helps plant breeders and companies protect their intellectual property and commercial interests.

Example: One well-known case is the use of molecular markers in the protection of new grapevine varieties. The European Union (EU) has a system for granting Plant Breeders' Rights (PBR) to new plant varieties. Molecular markers are often employed to provide evidence of distinctness, uniformity, and stability.

Disease Resistance and Stress Tolerance

Molecular markers can assist in identifying and tracking specific genes or markers associated with disease resistance or stress tolerance, allowing breeders to develop and select for varieties with enhanced resistance to pests, diseases, or adverse environmental conditions.

Example: In the context of disease resistance, researchers have used molecular markers to



identify and track genes associated with resistance to various pathogens.

Comparative Genomics

Molecular markers enable comparative genomics studies, helping researchers understand the genetic relationships and evolution of different plant varieties and species. By comparing the DNA sequences and genetic markers of different plants, researchers gain insights into their evolutionary history and genetic diversity.

Example: One classic example of comparative genomics in plant biology is the study of the Brassicaceae family, which includes the model plant *Arabidopsis thaliana* and important crops like broccoli and cabbage. Researchers have used molecular markers, including DNA sequence data, to study the relationships between different Brassicaceae species and understand their evolutionary history. These studies provide insights into the genetic basis of traits and can help in crop improvement.

Conclusion

In the ever-evolving landscape of agriculture, the significance of molecular markers cannot be overstated. These tools, with their ability to decode the genetic intricacies of plant varieties, have reshaped plant breeding, conservation, and intellectual property protection. From distinguishing visually similar varieties to confirming parentage and maintaining clonal integrity, molecular markers have revolutionized the way we perceive and interact with plant genetics. Moreover, they play a pivotal role in addressing contemporary agricultural challenges, such as disease resistance and stress tolerance, while also shedding light on the evolutionary tapestry of plant species. These tools not only serve as beacons of precision but as a testament to the fusion of genetics and agriculture in our quest for a brighter, more resilient agricultural future.

