Integration of Genetic Modification and Molecular Breeding in Crop Improvement

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Abstract

Crop improvement through conventional breeding relies on natural genetic variation. However, natural genetic variation in many crop species is limited. In these cases, artificial mutation has been induced by chemical mutagens, such as EMS and sodium azide, or T-DNA insertion through transformation. Mutants thus generated represent useful material for functional genomics study, and with desirable traits the mutants could be directly developed into cultivars or used as breeding stocks. Double haploid technology represents another important technology for production of truly homozygous plants with novel traits.
Modern marker-assisted molecular breeding largely improves the efficiency of breeding, facilitated by QTL, RAPD, or SNP. Transgenic approaches are also increasingly adopted for crop improvement with transgenes from different sources, breaking the genetic barrier. *Agrobacterium*-mediated plant transformation has been established in many crop species, but it requires a proper facility and lengthy tissue culture. Alternatively, pollen-mediated transformation via electroporation provides a simple and fast method to generate transgenic plants without the need for tissue culture. The modern CRISPR-Cas9 gene editing technology is gaining popularity in crop improvement, and the newest version bypasses the requirement of integrating foreign DNA into the host genome. These technologies will significantly impact agricultural production in the future.

Key words: Molecular breeding, chemical mutagenesis, double haploid technology, genetic transformation.

遗传修饰及分子育种的整合在作物改良中应用

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摘要

通过常规育种进行作物改良需要依靠自然遗传变异。然而，许多作物中自然遗传变异是非常有限的。在这样的情况下，就出现了人工诱变的方法比如 EMS、叠氮化钠、或通过转化的 T-DNA 插入的化学诱变。产生的突变体代表着功能基因组学研究的有用材料，有目标性状的突变体可以直接培育成栽培种或被用作育种材料。双单倍体技术代表了另一重要技术用于创造具体全新性状的纯合植株。

现代分子标记辅助育种技术借助 QTL, RAPD 和 SNP 等极大地提高了育种效率。转基因方法也越来越多地被用于不同来源的转基因作物改良，打破遗传障碍。农杆菌介导的植物转化已在许多作物种中建立，但需要适当的设施和耗时的组织培养。或者，通过电穿孔的花粉介导的转化提供了一种简单而快速产生转基因植物而不需要组织培养的方法。现代 CRISPR-CAS9 基因编辑技术在作物改良中越来越普遍，并且最新的方式不需要将外源 DNA 整合到宿主基因组中。这些技术将显著影响未来的农业生产。

关键词：分子育种、化学诱变、二倍体技术、遗传转化