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Molecular Cytogenetics in Agriculture: A Perspective on Rice Improvements

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Abstract

Cytogenetic studies in plant science are extremely old strategy and widely used in the crop improvements. Moreover, the onset of molecular cytogenetics and the advances thereby has tremendously improved the potential of cytogenetic studies in realizing the crop improvements. In this chapter, we discuss the concepts of plant cytogenetics and its applications in the eras of molecular biology and genomics. Widely explored techniques, including fluorescence in-situ hybridization (FISH) and genomic in-situ hybridization (GISH) have facilitated the advancements in chromosome preparation and have increased the axial resolution limits. Several advanced and combinational techniques of the traditional FISH or GISH have broadened the ability of plant cytogenetics to shed light on genome structure and organization. Furthermore, using the molecular cytogenetic tools various advancement s have been achieved in some major crops, including rice and wheat. Here, we have presented an elaborate discussion of classical and molecular cytogenetics and the crop improvements via molecular cytogenetics.

Keywords: Cytogenetics, Molecular cytogenetics, FISH, GISH, Crop improvements

Among the significant progressions accomplished in the recent times in plant science, cytogenetics is one key field and has been investigated broadly in the region of plant research. The cytogenetic study of the chromosomes of several crops gave a superior comprehension of their development, hereditary qualities, hereditary recombination and karyotypic solidness. Besides, it improved the understanding of the chromosomal inheritance with the rediscovery of the associated Mendelian laws (Lavania, 2017). Consequently, the cytogenetic technique turned into a fantastic instrument for contemplating the chromosome landmarks, for example, heterochromatin, rRNA genes (Mukai *et al.*, 1990; Jiang and Gill., 1994), the centromere, the telomere and sub-telomere areas (Zhang *et al.*, 2004), their roles during cell division and proliferation (mitosis), and germ cell division (meiosis), as well as their influence on phenotype. It additionally incorporates the study of chromosomal variations and their casual mechanisms (Kannan and Alwi 2009), which has become a significant part of genome analysis (Zhang *et al.*, 2007). To realize cytogenetics in additional profundity, one should understand what a chromosome is, as the cytogenetic studies are usually carried out at the chromosomal levels. The chromosomal behaviour in plant propagation

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