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Perspective

New Developments and Innovations in Hybrid Seed Production Technology

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DESCRIPTION

The effective manufacture of sortable hybrid seeds from Genic Male Sterile (GMS) lines and maintainers is made possible by next-generation hybrid seed technology, although it necessitates a number of time-consuming and challenging stages. A hybrid's increased performance in comparison to its parental lines is referred to as hybrid vigour occurs frequently in both plants and mammals. The first and most successful crop in which hybrid vigour was utilised to boost production was maize. To meet the enormous demand for food, feed, and raw materials, hybrid variety cultivation is currently the only method used for global maize production.

A beneficial characteristic for the effective development of high-quality crop seeds is Male Sterility (MS). MS has therefore always been a crucial area of study in plant science. Depending on the source of the fertility gene, crop MS can be divided into Cytoplasmic Male Sterility (CMS) and Genic Male Sterility (GMS). The core elements of the first generation of hybrid technologies are MS, fertility preservation, and fertility restoration. It takes time and effort to set up all three lines for a given hybrid: the CMS line, its maintainer, and the related restoration line. Additionally, because to cytoplasmic-nuclear interactions, commercial agricultural CMS technologies frequently restrict the parental line options available, limiting access to genetic variety. As a result, the restoration of CMS lines may be inconsistent.

The commercial maize seed industry's usage of CMS technology has been constrained by these disadvantages. When compared to CMS technologies, which rely on cytoplasmic genes, nuclear genes, and their particular interactions, GMS technologies are far more genetically stable and trustworthy because sterility and fertility restoration are decided by the same nuclear gene. Typically, the maintainer line that produces both the GMS line and the maintainer line itself is the recessive/Wild-Type (WT) heterozygote.

It is challenging to sort the GMS line and its maintainer line during hybrid and parental line seed production due to this heterozygous pattern's restricting bottleneck. A successful two-line system with sterile and maintenance lines built on the careful use of environmentally sensitive GMS is necessary for second-generation GMS hybrid technology. Under various environmental conditions, the same line functions as both the maintenance line and the MS line in photoperiod and/or thermosensitive GMS. Despite the extensive use of PTGMS in rice, the systems are susceptible to uncontrollable environmental changes, which presents inherent challenges for the development of hybrid seeds as well as sterile line and maintenance line seed propagation.

By utilizing the Seed Production Technology (SPT) procedure, next-generation GMS hybrid biotechnology offers an efficient method for sorting GMS and maintenance seeds. The WT Complete Coding Sequence (CDS) of a male fertility gene for fertility restoration, a pollen-inactivating gene to prevent the formation of transgenic pollen, and a seed colour marker gene for seed sorting make up the transgenic method used to establish the SPT maintainer line. Therefore, in order to produce a GMS line and an SPT transforming in the GMS genetic background as a maintainer line, SPT requires knockout (KO) of endogenous fertility gene alleles. There is a lot of potential for SPT to be used in 2019). Several techniques comparable to SPT have been developed for rice and maize to date.

While this approach includes genetic manipulation, it can also be applied to non-transgenic hybrid cultivars. These GMS breeding plans frequently begin with naturally occurring KO mutants of the reproductive genes. The GMS line is then converted into a controlled GMS maintainer by two lengthy, independent stages of difficult and involved backcross breeding. As we have previously shown with maize, there is currently a quick and effective approach to create precise mutations in most crops. Due to the requirement of simultaneously providing an exogenous element of the same nuclear fertility gene in order to restore male fertility, the routine design of KO mutations in target genes using CRISPR/Cas9 cannot be employed for such purposes.

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