Research Highlight

Hybrid Rice: achievement, challenges and opportunity

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Hybrid Rice: achievement, challenges and opportunity

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In commemoration of the publication of Professor Yuan Longpig's article, "Rice Male Sterility", *Chinese Science Bulletin* produced a special issue on hybrid rice for its 50th anniversary [1]. This special issue reviewed and summarized all breakthroughs, achievements, and research progress made in the last 50 years for hybrid rice in China. From the simple concept of using male sterility to explore heterosis in rice, hybrid rice development has undergone significant advancement. After the discovery of wild abortive rice plants in 1970 [2], different sources of cytoplastic male sterility have been identified and exploited with the relationship between male sterility and its corresponding maintainer and restorer lines intensively studied at genetic, morphological, and cellular levels. As a result, the hybrid rice system of three-lines was completed in *indica* and *japonica* rice varieties and successfully applied to rice production.

Further studies revealed a completely different type of male sterility, photoperiod thermo-sensitive genic male sterility (P/TGMS), which was quickly integrated into hybrid rice production after fine tuning the stability of male sterility. The change from three-line to two-line hybrid rice systems not only simplified the process of hybrid rice breeding and seed selection, but also created and expanded the germplasm pool, allowing rice heterosis to increase from 15% to 30% over conventional rice varieties. There have also been scientific breakthroughs in the aspect of developing genetic materials and technologies essential to breeding high-yield and super high-yield hybrid rice varieties, mapping and cloning male sterility/fertility genes, and applying molecular breeding based on the knowledge of genetic and functional genes. Wide-compatibility genes are used to breed inter-subspecific hybrids (*indica*/*japonica*) combined with morphologic improvement. Genes favorable for high yield and heterosis were identified, mapped, and integrated into new hybrid rice varieties [3, 4]. The success of hybrid rice reversed the assumption of non-heterosis in self-pollinating crops and modernized theory and practice.

Hybrid rice formulated the concept of genetic profiles, male sterility mechanisms in cellular and molecular biology, and the application and regulation of high-yield rice breeding. Innovation in hybrid rice research and development has played a significant role in achieving China's food security within