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Progress and Prospectives of Distant Heterosis in Rice

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Distant Heterosis:

Hybridization crossing between two genetically dissimilar parents is called hybridization.

Distant hybridization between individuals from different species belonging to the same genus (interspecific hybridization) or two different genera of same family (intergeneric hybridization) is termed as distant hybridization and such crosses are known as distant crosses or wide crosses. This because individuals used for hybridization in such cases are taxonomically more distantly related than different variety from the same species.

Promises and Constraints of Distant Heterosis in Rice

- **Intra subspecific heterosis** is resulted from the interaction of different genes from two parental varieties belonging to the same subspecies, either indica or japonica rice.
- **Inter subspecific heterosis** is resulted from the interaction of different genes between the two subspecies, indica and japonica rice, respectively.
- **Interspecific heterosis** is resulted from the interaction of different genes from two species respectively, such as Asian rice vs. African rice, or Asian rice vs. a wild rice species.
- Since the heterosis of hybrids is generally positively correlated to the genetic diversity of the parents, the heterosis of distant crosses including inter subspecific and interspecific crosses is theoretically higher thant hat of the intra subspecific crosses.
- But the actual grain yield of distant crosses, however, is discouraging due to the

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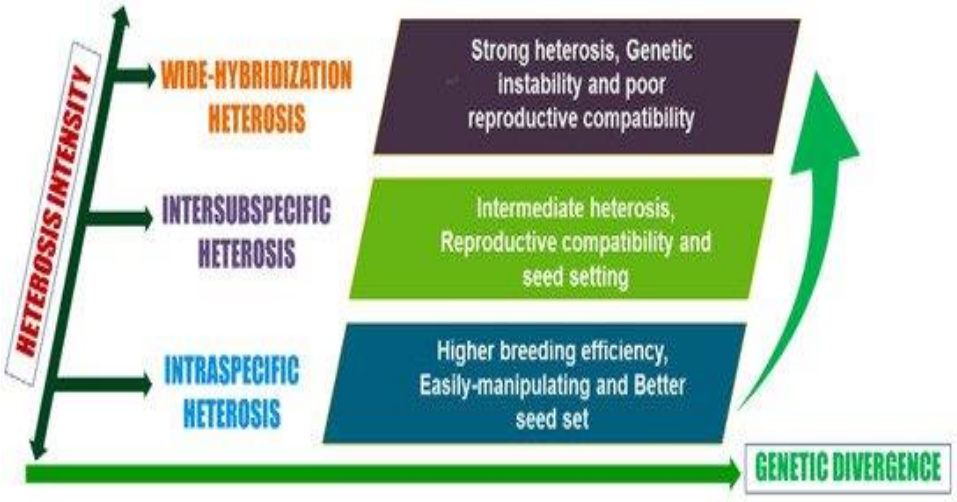
low seed set rate of the inter subspecific hybrids between indica and japonica rice and almost no seed setting in the interspecific hybrids between two cultivated species. Apparently, hybrid sterility is a major obstacle for exploiting the distant heterosis inrice.



Barriers in Distant Heterosis

- Reproductive isolation mechanisms restrict gene exchange between diverging species or populations include pre-zygotic barriers that limit the potential for mating or zygote formation.
- Post-zygotic barriers that reduce the fertility of hybrid offspring, which plays a vital role during speciation in evolution. The hybrid sterility of distant crosses is a typical form of post-zygotic barrier.
- The Dobzhansky-Muller model explains that hybrid sterility can be caused by incompatible gene interactions between two diverging species or populations.
- Ikehashi studied hybrid sterility between indica and japonica rice and screened for compatibility varieties to overcome the inter subspecific reproductive barrier and proposed a model which is essentially consistent with the Dobzhansky-Muller model to explain the inter subspecific hybrid incompatibility.
- The two incompatibility alleles designated as S5i and S5j for indica and japonica, respectively, and deleterious interactions between S5i and S5jresulted in reduced spikelet fertility of the inter subspecific hybrid.

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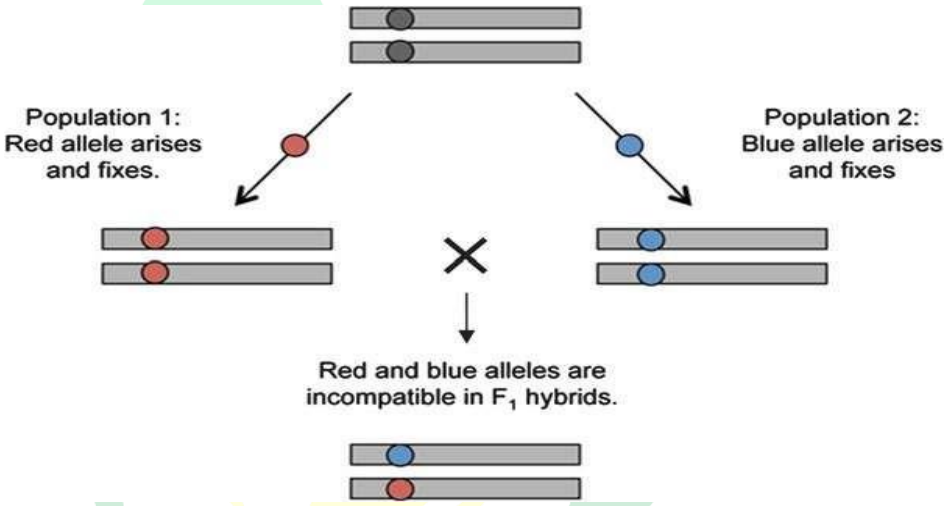
- TheDobzhansky-Muller model for a single locus hybrid incompatibility: an ancestral population splits into two geographically isolated populations that diverge genetically and eventually fix different alleles (red or blue) at the same locus. In the F_1 hybrid, these two derived alleles are incompatible.
- Several major genes responsible for the inter-specific hybrid sterility between the two species have been detected from *O. glaberrima*.
- The interspecific hybrid sterility was mainly caused by an arrest of pollen development at the microspore stage.



Strategies For More Effective Approach To Distant Heterosis

Doubled Haploid (DH) Methodology

Conventional breeding procedures commonly take eight or nine generations to achieve approximately complete homozygosity inbred lines; more generations are needed to obtain genetically stable inbred lines derived from distant crosses, whereas DH lines achieve it in just one generation. Doubled haploid (DH) lines can be produced androgenesis or invitro anther culture and parthenogenesis or in vivo induction of maternal haploids.

Molecular Genetics

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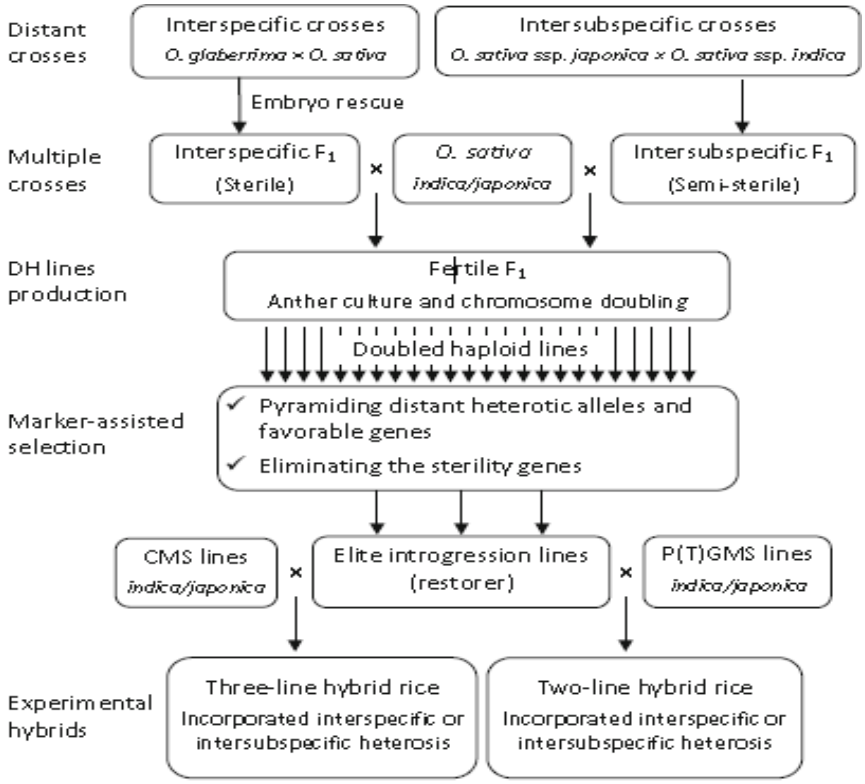
It made monitoring the transmission of foreign genes into introgression lines possible. It facilitates the investigation and the understanding of heterotic alleles involved in distant crosses. Technologies such as embryo rescue, anther culture and molecular markers can be employed for more effective approach to the interspecific heterosis between the two cultivated rice.



Technical route proposed for effective distant heterosis breeding