

研究论文

花粉不育基因互作的同源四倍体水稻杂种染色体行为和生殖特性

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收稿日期 2005-8-1 修回日期 网络版发布日期 2006-9-14 接受日期 2006-3-15

摘要 利用同源四倍体水稻台中65-4x及其携带花粉不育基因的四倍体近等基因系组配的花粉不育基因座位互作的四倍体杂种, 对其花粉母细胞减数分裂期间染色体行为及生殖特性进行研究。结果表明, 四倍体亲本及杂种多数细胞在终变期都是四价体与二价体共存, 台中65-4x染色体配对方式为 $9.20[IV+5.60]II$, 杂种平均为 $9.52[IV+4.90]II$, 亲本与杂种间四价体数目差异不显著; 随后的过程中均出现各种染色体行为的异常, 包括拖曳染色体、落后染色体、染色体断片、微核、染色体不同步分离和形成未减数的配子等。四倍体亲本和杂种的花粉育性、胚囊育性和结实率均比二倍体原种明显下降。杂种与四倍体亲本比较, S-b座位单互作和与S-a或S-c双互作杂种的花粉育性明显较四倍体亲本低, 其他座位互作降低幅度相对较小; 杂种的结实率普遍较四倍体亲本低, 其中S-b座位互作的下降最为明显。初步表明, 花粉不育基因互作可能与减数分裂期间染色体异常行为无关, 但其中S-b座位互作与四倍体杂种育性下降有关, 该基因座可能与染色体异常行为协同作用于同源四倍体水稻杂种的不育性。

关键词 [同源四倍体水稻](#) [花粉不育基因](#) [减数分裂](#) [染色体](#) [生殖特性](#)

分类号 [S511](#)

Chromosome Pairing Behavior and Reproduction in the Hybrid Developed by the Interaction of Different Pollen Sterile Genes in Autotetraploid Rice

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Abstract Autotetraploid rice is a special germplasm with four sets of genome that is derived from diploid rice treated by colchicine. Compared with its diploid progenitor, the chromosomes and genome of the autotetraploids are doubled, thus the phenotype or morphology of the autotetraploids, especially the reproductive traits, are obviously changed. When *indica* and *japonica* are respectively developed into autotetraploid by chromosome doubling and crossed with each other, the autotetraploid hybrid will have superior heterosis in growth and biological character compared with their parents and the diploid hybrid directly in rice breeding. Therefore, it is very important to study the mechanism of low seed setting rate in the autotetraploid hybrids. In the diploid hybrid between *indica* and *japonica*, it is known that the interaction of pollen sterility genes, such as S-a, S-b and S-c, causes the hybrids to be low fertility. However, it is little known how these pollen sterility genes work in the autotetraploid hybrid between *indica* and *japonica*. In this study, autotetraploid rice Taichung 65-4x and its near-isogenic lines with pollen sterile genes were used to develop the autotetraploid hybrids with interaction at different pollen sterility gene loci, i.e. S-a, S-b and S-c. The chromosome behaviors during the meiosis of PMC were studied by the technique of chromosome squash and showed that quadrivalents and bivalents coexisted in the diakinesis in the most of PMCs of autotetraploid parents and their hybrids. The chromosome association per PMC was $9.20[IV+5.60]II$ in Taichung65-4x, and $9.52[IV+4.90]II$ in the hybrids on an average, showing no significant difference in the number of quadrivalent between the parents and the hybrids. Abnormal behaviors were found in the following process of meiosis, which included lagging chromosomes, chromosome fragments, micronuclei, the loss of synchronization in segregation of chromosomes and the formation of unreduced gametes (Plate II). Pollen fertility, embryo sac fertility (Plate I), which were observed by WCLSM, and seed setting rate in both the tetraploid parents and their hybrids were significantly lower than those in Taichung 65. The average of pollen fertility was 30.57% in the hybrids with the single-gene interaction at the locus of S-b, and 37.56%, 26.53% in the hybrids with double-gene interactions of S-b and S-a, S-b and S-c, respectively. The pollen fertility in these hybrids was significantly lower than that in the autotetraploid parents, with 67.93% on an average. The hybrids with interactions at other loci were not significantly decreased in the pollen sterility compared with the autotetraploid parents, which were those with the single-gene interaction at the locus of S-a or S-c, and double-gene interactions of S-a and S-c etc. The seed setting rate was lower in all hybrids, which was from 0.90% to 22.75% on an average, than that in the autotetraploid parents (26.12%), and that in the hybrid with the interaction at the locus of S-b was the lowest, with 0.90% on an average. It concludes preliminarily that the interaction of pollen sterile genes at different loci has no obvious effect on the abnormal behaviors of chromosome in meiosis; however, the interaction by locus of S-b may decrease the fertility of hybrids, which may be caused together by abnormal behaviors of chromosome in meiosis because of four genomes in autotetraploid rice.

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Key words [Autotetraploid rice](#); [Pollen sterility gene](#) [Meiosis](#); [Chromosome](#) [Reproduction](#)

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