5. Fine mapping of S-31 for hybrid sterility gene in rice (*Oryza sativa* L.)

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Hybrid sterility is the main barrier in utilizing the heterosis of subspecies in rice. Wide compatibility varieties (WCVs) are a special class of rice germplasm that produces hybrids with normal spikelet fertility when crossed with both *indica* and *japonica* subspecies. In this research, a set of 66 F₁ hybrids is gained by combination between Asominori and IR24 chromosome segment substitution lines (CSSLs) with the genetic background of Asominori, a *japonica* variety (Kubo, et al. 1999, 2002), as well as, a set 66 F₁ hybrids is also constructed between ‘02428’ and CSSLs. From the spikelet fertility in F₁ hybrids of “CSSLs × Asominori” in 2003 and 2004, we found most F₁ hybrids had a normal spikelet fertility except a few of hybrids (Fig. 1A). The sterile hybrids were derived from CSSL4, CSSL34, CSSL37, CSSL43 and CSSL44, of which CSSL4, CSSL34 and CSSL37 owned IR24 chromosome substitution segments on the short arm of chromosome 5, while CSSL43 and CSSL44 owned segments on chromosome 6. The spikelet fertilities of F₁ hybrids of CSSL4/Asominori, CSSL34/Asominori, and CSSL37/Asominori were ranged from 50 to 60%, while those of CSSL43/Asominori and CSSL44/Asominori were ranged from 30 to 40%. The results indicated that an allelic interaction between IR24 chromosome substitution segments and Asominori caused hybrid sterility. Furthermore, the reduction of fertility was more severe at S5 locus than at S31 locus, which suggested hybrid sterility between IR24 and Asominori were controlled by these two major loci. Spikelet fertility in F₁ hybrids population “CSSLs×02428” was normal (Fig. 1B), which might be due to the fact that ‘02428’ is a *japonica* variety with high wide compatibility (Zhang et al. 1997).

Interestingly, a segment substitution, CSSL34, harbors the same locus for S31(t) identified previously(Zhao et al. 2006). To fine map the locus, one population of 1230 F₁ plants derived from the three-way cross CSSL34/02428//Asominori showed a continuous distribution for spikelet fertility percentage, which range from 1 to 100. Even though overall, the distribution was continuous, there was an indication of bi-modality with a distinct valley
at around 70% level (Fig. 2). Considering 70% as the cut-off point between semi-sterility and fertility, the population segregated for semi-sterility: fertility at the ratio of 1:1 ($X^2=0.41, P > 0.5$). These results demonstrate that locus could be treated as a single Mendelian factor.

The $S31(t)$ locus was previously mapped in the interval between two SSR markers, RM5579 and RM13, on the short arm of chromosome 5 (Zhao et al. 2006). A number of SSR markers located around this genomic region were selected to screen polymorphism between CSSL34 and 02428. Finally the $S31(t)$ locus was mapped to the interval between RM1024 and RM17811, with 0.1cM from RM1024 on one side and 0.7cM from RM17811 on the other side.

In this study, wide compatibility variety 02428 was detected to have the neutral alleles at loci $S31(t)$ and can overcome the sterilities in the $F_1$ between IR24 and Asominori. The fine mapping of sterile loci and the detection of wide compatibility genes were useful for inter-subspicific hybrid rice breeding.

**Fig. 1.** Frequency distribution of spikelet fertility in the two set of 66 $F_1$ crosses. Fig. 1A Frequency distribution of spikelet fertility in the set of 66 $F_1$ crosses (“CSSLs×Asominori”) in 2003 and 2004, respectively. Fig. 1B Frequency distribution of spikelet fertility in the set of 66 $F_1$ crosses (“CSSLs×02428”) in 2003.
Fig. 2. Distributions of spikelet fertility of 1230 plants in the three-way cross AIS34/02428//Asominori in 2005.

Fig. 3. Location of the S-3f locus on the molecular linkage map of chromosome 5.
References


