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# HYBRID STERILITY AND ROLE OF WIDE COMPATIBILITY VARIETY IN DIFFERENT GENETIC BACKGROUNDS OF RICE (*Oryza sativa* L.) UNDER TEMPERATE CONDITIONS OF KASHMIR

S. Najeeb, M.A. Zargar, A.G. Rather, Badrul Hassan*, F.A. Sheikh, M.A. Ahanger, S.M. Razvi**, Z.A. Dar** and G.S. Sanghera

*Rice Research and Regional Station, SK University of Agricultural Sciences & Technology of Kashmir (SKUAST-K), Khudwani, Anantnag, Kashmir 192 102 (J&K)*
**Directorate of Resident Instructions, **Division of Plant Breeding and Genetics, SKUAST-K, Shalimar, Srinagar 191 121 (J&K);* e-mail: *najeeb_sofi2006@yahoomail.com*

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The exploitation of pronounced heterosis in crosses between *indica* and *japonica* sub species of the Asian cultivated rice (*Oryza sativa* L.) has been limited by hybrid sterility, which has been recognized as one of the basis for speciation and genetic differentiation (Ouyang, 2009). Identification and use of WC genes (wide compatibility varieties) have been found effective in overcoming the hybrid sterility problem (Liu *et al.*, 1996; Zhang *et al.*, 1997). Inter-subspecific hybrids of rice have been developed since an early attempt in China (Yuan, 1994). Similar kind of attempt was made under temperate Kashmir conditions to get generate preliminary information about the genetic relatedness among different genotypes available at the germplasm base of RRRS, Khudwani. Moreover, the study was aimed to determine the role of genetic background of different genotypes for hybrid sterility and possible overcome using one WCV genotype.

Five *indica* varieties as lines viz., Jhelum ($L_1$), SKAU-382 ($L_2$), Shalimar rice-1 ($L_3$), China-1039 ($L_4$) and Chenab ($L_5$) were crossed in kharif 2008 with 3 typical *japonica* varieties as testers [Koshihikari ($T_1$), K-332 ($T_2$) and Kohsar ($T_3$)] to generate 15 *indica*/*japonica* (inter-subspecific) crosses as per line x tester mating design proposed by Kempthorne (1957). Similarly five single crosses of *indica* lines including Dular (WCV) as one of the parent were mated to three typical *japonica* genotypes viz., Koshikikari, K-332 and Kohsar in the same season to generate 15 three-way crosses. All the 30 crosses were evaluated for pollen and spikelet sterilities during kharif 2009 under two agro-ecologies of Kashmir viz., RRRS, Khudwani and High Altitude Rice Research Sub-station, Larnoo situated at 1650 and 2250 m amsl, respectively. Pollen fertility was observed under a light microscope using iodine potassium iodide (0.1%) staining method. Similarly, main panicles of five randomly selected plants were bagged before heading stage. The harvested panicles were observed for filled and empty spikelets and mean spikelet sterility was calculated. The pooled data over the locations (mean) for pollen and spikelet sterility were subjected to statistical analysis for interpretation of results.

The variety $L_1$ (Jhelum) followed by $L_4$ (China 1039) realized the maximum mean pollen sterility in their respective single crosses, however, $L_3$ (Shalimar Rice-1) demonstrated highest mean spikelet sterility (85.3%) followed by $L_4$ (China 1039) and $L_2$ (SKAU-382) [Table 1]. The effect of WCV through three-way crosses on mean pollen and spikelet sterilities was prominent in $L_1$ (Jhelum) background (61.5 and 16.9%) with percentage overcome of 78.9% and 73.8%, respectively. This was followed by $L_3$ (Shalimar Rice-1) with estimated mean pollen sterility of 24.4% and $L_5$ (Chenab) for spikelet sterility of mean estimate of 22.1% with a reduction level of 53.3 and 74.1%, respectively. High estimates of pollen and spikelet sterilities of 64.2 and 82.5%, respectively was observed on $T_3$ (Kohsar) among *japonica* testers involved in single crosses as one of the parents, whileas the magnitude relatively of low intensity was noticed on $T_2$ (K-332) (47.9%) and $T_1$ (Koshihikari) (69.7%) for pollen and spikelet sterility, respectively. The remarkable expression in the percentage overcome for pollen and spikelet sterilities was obvious for three-way crosses in $T_3$ (Kohsar) background with an estimate of 71.9 and 80.0%, respectively. This was followed by three-way crosses with $T_1$ (Jhelum) background (65.8 and 66.5%). However, the overcome was in negative direction (-10.69%) i.e., WCV in $T_2$ (K-332) background could not play any role in overcoming pollen sterility.

**Table 1: Hybrid sterility [mean over locations] in inter-subspecific crosses and behaviour of WCV genotype (Dular) with five *indica* and three *japonica* backgrounds in overcoming pollen and spikelet sterilities through three-way crosses in rice**

| Single crosses (*Indica x japonica*) | Mean pollen/ spikelet sterility (%)** | Three-way crosses | Mean pollen/ spikelet sterility (%)** | %age overcome in pollen/ spikelet sterility** |
|---|---|---|---|---|
| **a) WCV (Dular) with five *indica* background** | | | | |
| Jhelum x Koshihikari [$L_1$ x $T_1$] | 78.3 (64.5) | (Jhelum x Dular) x Koshihikari [($L_1$ x D) x $T_1$] | 16.5 (16.9) | 78.9 (73.8) |
| Jhelum x K-332 [$L_1$ x $T_2$] | | (Jhelum x Dular) x K-332 [($L_1$ x D) x $T_2$] | | |
| Jhelum x Kohsar [$L_1$ x $T_3$] | | (Jhelum x Dular) x Kohsar [($L_1$ x D) x $T_3$] | | |
| SK-382 x Koshihikari [$L_2$ x $T_1$] | 38.8 (74.7) | (SK-382 x Dular) x Koshihikari [($L_2$ x D) x $T_1$] | 31.8 (39.0) | 18.7 (47.8) |
| SK-382 x K-332 [$L_2$ x $T_2$] | | (SK-382 x Dular) x K-332 [($L_2$ x D) x $T_2$] | | |
| SK-382 x Kohsar [$L_2$ x $T_3$] | | (SK-382 x Dular) x Kohsar [($L_2$ x D) x $T_3$] | | |
| SR-1 x Koshihikari [$L_3$ x $T_1$] | 52.3 (79.8) | (SR-1 x Dular) x Koshihikari [($L_3$ x D) x $T_1$] | 24.4 (25.1) | 53.3 (68.4) |
| SR-1 x K-332 [$L_3$ x $T_2$] | | (SR-1 x Dular) x K-332 [($L_3$ x D) x $T_2$] | | |
| SR-1 x Kohsar [$L_3$ x $T_3$] | | (SR-1 x Dular) x Kohsar [($L_3$ x D) x $T_3$] | | |
| China-1039 x Koshihikar [$L_4$ x $T_1$] | 71.1 (78.1) | (China-1039 x Dular) x Koshihikari [($L_4$ xD) x$T_1$] | 44.2 (25.6) | 37.8 (67.2) |
| China-1039 x K-332 [$L_4$ x $T_2$] | | (China-1039 x Dular) x 332 [($L_4$ x D) x $T_2$] | | |
| China-1039 x Kohsar [$L_4$ x $T_3$] | | (China-1039 x Dular) x Kohsar [($L_4$ x D) x $T_3$] | | |
| Chenab x Koshihikar [$L_5$ x $T_1$] | 50.6 (85.3) | (Chenab x Dular) x Koshihikari [($L_5$ x D) x $T_1$] | 37.2 (22.1) | 26.4 (74.1) |
| Chenab x K-332 [$L_5$ x $T_2$] | | (Chenab x Dular) x 332 [($L_5$ x D) x $T_2$] | | |
| Chenab x Kohsar [$L_5$ x $T_3$] | | (Chenab x Dular) x Kohsar [($L_5$ x D) x $T_3$] | | |
| **b) WCV (Dular) with *japonica* testers (as third parent)** | | | | |
| Jhelum x Koshihikari [$L_1$ x $T_1$] | 62.6 (69.7) | (Jhelum x Dular) x Koshihikari [($L_1$ x D) x $T_1$] | 21.4 (23.3) | 65.8 (66.5) |
| SK-382 x Koshihikari [$L_2$ x $T_1$] | | (SK-382 x Dular) x Koshihikari [($L_2$ x D) x $T_1$] | | |
| SR-1 x Koshihikar [$L_3$ x $T_1$] | | (SR-1 x Dular) x Koshihikari [($L_3$ x D) x $T_1$] | | |
| Ch-1039 x Koshihikar [$L_4$ x $T_1$] | | (China-1039 x Dular) x Koshihikari [$L_4$ xD) x $T_1$] | | |
| Chenab x Koshihikar [$L_5$ x $T_1$] | | (Chenab x Dular) x Koshihikari [($L_5$ x D) x $T_1$] | | |
| Jhelum x K-332 [$L_1$ x $T_2$] | 47.9 (77.2) | (Jhelum x Dular) x K-332 [($L_1$ x D) x $T_2$] | 53.0 (37.5) | -10.7 (51.4) |
| SK-382 x K-332 [$L_2$ x $T_2$] | | (SK-382 x Dular) x K-332 [($L_2$ x D) x $T_2$] | | |
| SR-1 x K-332 [$L_3$ x $T_2$] | | (SR-1 x Dular) x K-332 [($L_3$ x D) x $T_2$] | | |
| China-1039 x K-332 [$L_4$ x $T_2$] | | (China-1039 x Dular) x K-332 [($L_4$ x D) x $T_2$] | | |
| Chenab x K-332 [$L_5$ x $T_2$] | | (Chenab x Dular) x K-332 [($L_5$ x D) x $T_2$] | | |
| Jhelum x Kohsar [$L_1$ x $T_3$] | 64.2 (82.5) | (Jhelum x Dular) x Kohsar [($L_1$ x D) x $T_3$] | 18.0 (16.4) | 71.9 (80.0) |
| SK-382 x Kohsar [$L_2$ x $T_3$] | | (SK-382 x Dular) x Kohsar [($L_2$ x D) x $T_3$] | | |
| SR-1 x Kohsar [$L_3$ x $T_3$] | | (SR-1 x Dular) x Kohsar [($L_3$ x D) x $T_3$] | | |
| China-1039 x Kohsar [$L_4$ x $T_3$] | | (China-1039 x Dular) x Kohsar [($L_4$ x D) x $T_3$] | | |
| Chenab x Kohsar [$L_5$ x $T_3$] | | (Chenab x Dular) x Kohsar [($L_5$ x D) x $T_3$] | | |

**The figures in brackets spikelet sterility; $L_1$ - $L_5$ *Indica* lines; $T_1$ - $T_3$ *Japonica* testers; D = Dular (WCV)

The fertility/ sterility analysis showed a considerable variation in hybrids with different genetic *(indica* and *japonica)* background with the same WCV source (Dular). Differential expression may be due to inadequate nature of wide compatibility gene (WCG) from Dular source to neutralize hybrid sterility loci in all genotypes. The other possible reason for this variable fertility/sterility is that additional genes may be involved that modify hybrid fertility in the presence of WCV. Kumar and Chakrabarty (2000) also observed differential degrees of expression of WCG. Kubo and Yoshimura (2005) and Kubo *et al.* (2008) suggested the role of epistatic interactions for differential expression of hybrid sterility. Ikehashi and Wan (1996) proposed other loci with minor effects for this differential expression. The results provide basic information about this complex phenomenon, and the behaviour of WCV with the cultivated gene pool existing in under temperate conditions of Kashmir has not so far been reported. The lines displaying more hybrid sterility are suggested as genetically more distinct and provide us the opportunity of combining the traits of interest across two typically differentiated sub-species. Besides, WC genes from other backgrounds will be deployed to develop broad spectrum compatibility between our two distinct sub-species so as to combine the desirable traits from both subspecies for deriving more improved lines/super rice for different agro-ecologies of Kashmir. This will also develop the opportunity to exploit the inter-subspecific heterosis only after developing standardized CMS system for hybrid seed production.

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