Indian J. Genet., **63**(1): 30-32 (2003)

Vytilla 3 — A new cytoplasmic male sterile source of tropical rice (*Oryza sativa* L.)

Vanaja T.[1], Luckins C. Babu[2] and V.V. Radhakrishnan

Department of Plant Breeding and Genetics, College of Horticulture, KAU, Vellanikkara, Thrissur 680 651

(Received: February 2002; Revised: January 2003; Accepted: January 2003)

Abstract

Cytoplasm of Vytilla 3, an improved saline tolerant variety of Kerala was identified as a new source for cytoplasmic male sterility in rice (*Oryza sativa* L.), suitable to warm humid tropical climatic conditions experienced in the rice growing tracts of the world. This is a break through in hybrid rice production in this country. The varieties IR36 and Hraswa (an extra short duration variety of Kerala) are the proposed maintainer lines and the variety Mattatriveni is the proposed restorer line.

Key words : Rice, male sterile cytoplasm, maintainer line, restorer line

Introduction

Heterosis breeding has immense scope in breeding programmes for increasing the productivity of rice. Cytoplasmic male sterility (CMS) is one of the most effective genetic tools for developing F_1 rice hybrids. Wild abortive (WA) cytoplasm identified in China is the major source of male sterility that has been widely used in hybrid rice development. This has led to genetic vulnerabilities of the crop to pests and diseases. Besides, when WA system is made use of in the tropical climate, it very often breaks down. Certain rice hybrids that has already been released were found to be not suitable to Kerala climatic conditions. The people of Kerala mostly prefer red kernel type. All the rice hybrids released so far are white kernel type. Hence to overcome these hurdles, identification and use of additional source of cytosterility suitable to tropical conditions are to be considered as paramount importance. The present study was under taken with the objective of identification of alternative source for cytoplasmic male sterility in rice suitable to tropical climatic conditions.

Materials and methods

Twelve genetically diverse photoinsensitive rice genotypes, selected based on cluster analysis, were subjected to diallele crossing (including reciprocals) with an objective of searching new source of cytoplasm that would induce male sterility in rice. The crosses which showed high reciprocal differences for pollen and spikelet sterility (Vytilla 3 × IR36 and Vytilla 3 × Hraswa) were selected. Sterile F_1 hybrids were further back crossed with respective recurrent parents, to transfer the nuclear genes, as well as carried to F_2 generations.

Results and discussion

Two hybrids, out of 132 F_1 hybrids obtained through distant hybridization namely Vytilla 3/R36 (Figs. 1&2) and Vytilla 3/Hraswa (Figs. 4&5) were found to be highly sterile. The F_1 hybrids of their reciprocal crosses namely IR36/Vytilla 3 (Fig. 3) and Hraswa/Vytilla 3 (Fig. 6) showed high fertility. This suggests that Vytilla 3 (Fig. 9), an improved saline tolerant rice variety bred for Kerala conditions does possess sterility inducing cytoplasm. Singh [1] suggested that in certain wide crosses, fertility of the hybrid depends upon which of the two species was used as female. That is, the hybrid is fertile when one race is used as female, but it is sterile when the other race is used as female, in such cases sterility is produced by the cytoplasm. Similarly four indica cultivars namely Kalinga-1, Ptb 10, IR 27280-13-3-3-3, and CO-41 were found to possess male sterile cytoplasm with fertility restoring genes (Pradhan *et al.*) [2]. The details of spikelet sterility percentage and yield plant^{-1} of hybrids exhibiting male sterility in F_1 generations are given in Table 1. Percentage of pollen sterility was estimated using iodine potassium iodide solution. Seventy percentage pollen sterility was found in both crosses where Vytilla 3 was used as the female parent. The varieties Vytilla 3, IR36, and Hraswa belong to the clusters of maximum genetic distance.

Among the 100 BC_1 F_1 progenies from the cross Vytilla 3/IR36 [(Vytilla 3/IR36)/IR36], 50% pollen sterility in 52 % of the plants and 80-82% pollen sterility among

Present address: [1]Pepper Research Station, Panniyur, Kerala Agricultural University, P.B. No. 113, Taliparamba, Kannur 670 141; [2]College of Forestry, Kerala Agricultural University, Vellanikkara, Thrissur 680 651

Fig. 1 Fig. 2 Fig. 3 Fig. 4

Fig. 5 Fig. 6 Fig. 7 (above) Fig. 8 (below) Fig. 9

Fig. 10 Fig. 11 Fig. 12 Fig. 13

Fig. 1. Sterile direct cross of Vytilla 3 x IR 36; Fig 2. Panicle of Vytilla 3 x IR36 showing spikelet sterility; Fig. 3. Fertile cross of IR 36 x Vytilla 3 (reverse cross); Fig. 4. Sterile direct cross Vytilla 3 x Hraswa; Fig. 5. Panicle of Vytilla 3 x Hraswa showing spikelet sterility; Fig. 6. Fertile cross of Hraswa x Vytilla 3 (reverse cross); Fig. 7. Significant spikelet sterility variability in the direct cross (Vytilla 3 x IR 36) and reverse cross (IR 36 x Vytilla 3); Fig. 8. Significant spikelet sterility variability in the direct cross (Vytilla 3 x Hraswa) and reverse cross (Hraswa x Vytilla 3); Fig. 9. Vytilla 3; Fig. 10. 100% pollen sterility in one of the F_2 plants of Vytilla 3 x IR 36; Fig. 11. Cross showing capability of Mattatriveni with Vytilla 3; Fig. 12. Cross showing compatibility of Mattatriveni with IR 36; Fig. 13. Cross showing compatibility of Mattatriveni with Hraswa.

Table 1. Spikelet sterility percentage and yield plant^{-1} of crosses exhibiting male sterility in F_1 generation

Crosses	Pollen sterility	Spikelet sterility percentage			Yield plant^{-1}		
		Mean	Standard heterosis (%)	*sca* effect	Mean (g)	Standard heterosis (%)	*sca* effect
Direct Crosses							
Vytilla 3 × IR 36	70.3	76.3	3533.39**	47.23**	25.9	79.99**	14.48**
Vytilla 3 × Hraswa	70.4	79.15	3669.05**	50.47**	6.51	-54.76**	-4.54**
Reciprocal Crosses							
IR 36 × Vytilla 3	2.5	7.10	2.38	--	6.49	-54.90**	--
Hraswa × Vytilla 3	3.2	11.5	6.86	0.62	11.22	-22.03	1.68

*Significant at 5% level; **Significant at 1% level

the rest was observed. The segregation pattern of F_2 plants of the hybrid Vytilla 3/IR36 was also analyzed for pollen sterility. Out of 78 F_2 progenies, four plants showed 100% sterility (Fig. 10) and 74 plants showed sterility ranging from 3% to 92%. F_2 plants of the hybrid Vytilla 3/Hraswa also exhibited a high range of pollen sterility (5% to 80%). Vytilla 3 is a rice variety with high saline tolerance and adaptable to pokkali tracts of Kerala. Development of Cytoplasmic male sterile line suitable to tropical regions, from this newly identified source, can be achieved by repeated back crossing with IR36 or Hraswa. IR36 (International variety) and Hraswa (extra short duration variety bred in Kerala) are the proposed maintainer lines. Virmani *et al.* [3] had attained highly sterile BC_4 F_1 progeny from the back cross ARC13829-26/IR1079-2-3-1.

The array mean performance for the character, spikelet sterility percentage of the crosses, when Vytilla 3 was taken as common female and male parents were worked out (Table 2). It was found that spikelet sterility was consistently higher when Vytilla 3 was taken as female parent. This again confirmed the

Table 2. Array mean performance for spikelet sterility percentage showing influence of Vytilla 3 cytoplasm on increased spikelet sterility

Other parents	Array mean performance when Vytilla 3 was taken as common	
	Male parent	Female parent
IR 36	7.1	76.3
Kachsiung Sen Yu 338	10.5	12.2
Karthika	6.3	27.9
Mahsuri	10.1	16.5
Hraswa	16.5	79.2
Mattatriveni	0.9	10.7
Mean	8.6	37.1

cytoplasmic effect of Vytilla 3 on increased spikelet sterility. This was further proved by the high *sca* effect and high heterosis of the crosses Vytilla3/IR36 and Vytilla3/Hraswa for increased spikelet sterility (Table 1).

Among the F_1 hybrids, Vytilla 3/Mattatriveni (Fig. 11), IR36/Mattatriveni (Fig. 12) and Hraswa/Mattatriveni (Fig. 13) were found to be high yielding with promising grain characteristics (Table 3). Thus it was confirmed that Mattatriveni is highly compatible with the varieties Vytilla 3, IR36 and Hraswa for higher yield. This is again confirmed by the high *sca* effect of the variety Mattatriveni with Vytilla 3, IR36 and Hraswa (Table 3). Hence the variety Mattatriveni will be highly compatible as a good restorer with genotype having nucleoplasm of IR36 or Hraswa and cytoplasm of Vytilla 3, the proposed 'A' lines of IR36 and Hraswa.

Table 3. Yield performance and *sca* effect of selected crosses

Crosses	Yield plant^{-1} (g)	*sca* effect
Vytilla 3 × Mattatriveni	17.26	5.74**
IR 36 × Mattatriveni	12.18	5.31**
Hraswa × Mattatriveni	10.25	4.90**

The people of Kerala prefer red kernel type of rice. The entire rice hybrids released so far are white kernel type. The newly identified source of cytoplasmic male sterility is highly indigenous and adaptable to Kerala, with red kernel characteristic.

Conclusion

The cytoplasm of Vytilla 3 (an improved saline tolerant variety of Kerala, India) was identified as a new source for cytoplasmic male sterility in rice, suitable to warm humid tropical climatic conditions. The varieties IR36 (International variety) and Hraswa (extra short duration high yielding variety of Kerala) are the proposed maintainer lines and the variety Mattatriveni as the proposed restorer line for the newly identified male sterility source. The newly identified source of cytoplasmic male sterility is highly indigenous and adaptable to Kerala. Hence the use of this source for developing hybrid rice can make tremendous increase in the yield potential and can thus revolutionize the productivity of rice in Kerala.

References

1. **Singh B.D.** 1983. Plant Breeding - Principles and Methods. Kalyani publishers, New Delhi. pp. 492.
2. **Pradhan S.B., Ratho S.N. and Jachuck P.J.** 1990. New sources of cytoplasmic male sterility in cultivated indica rices. Euphytica. **48**: 215-218
3. **Virmani S.S., Raj K.G., Casal C., Dalmacio R. D. and Aurin P.A.** 1985. Rice genetics. IRRI. Manila, Philippines. pp. 635.