

The Utilization of Hybrid Rapeseed Based on Genetic Male Sterile (GMS) Line in China

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The area of hybrid rapeseeds (*Brassica napus*) in China was about two million hecta. It was up to 30 percent in the total rapeseed area. Seventy five-eighty percent of the hybrid was based on cytoplasmic male sterile (CMS) lines, twenty-twenty five percent based on GMS lines. There was very low ratio based on chemical induced male sterile (CIMS) lines. Among these systems, some advantages of GMS, such as any lines as its restorer, very easy to breed them, no limitation in restore-maintained relationship, no side effect as that of male sterile cytoplasm, were making it much more important in utilization of heterosis recently. There have been 30 cultivars registered since 1989. Seven cultivars of them were the hybrid based on GMS, up to 23.3 percent (Table 1). Here, we just reported three main kinds of genetic male sterile materials.

Table 1. The hybrid cultivars were registered in China (1989-99)

Year	CIMS		GMS		CMS		Total
	S. low	D. low	S. low	D. low	S. low	D. low	
89—94	1	1	2	0	4	2	10
95—98	2	0	0	5	8	5	20
Sub-total	3	1	2	5	12	7	30

Note: S, single; D, double

1. GMS with two pairs of recessive duplicate genes.

S45A (Pan, etal, 1988,1990), 117A (Hou, etal, 1990) and 90-2441A (Fu, 1990) belonged to one kind of GMS (Tu, 1997). Their male sterility was controlled by two pairs of recessive duplicate genes. Based on those materials, some hybrid cultivars were bred and extended widely, such as Shouza No 6 (Pan, 1995) and No 7 (1996), Youyan No 7 (Hou, 1995) and No 8 (1998). For this kind of GMS, the advantage was that any lines could be as its restorers, unfortunately, there were some disadvantages, such as 50 percent fertile plants had to be removed from the female parent lines when it was used for commercial productions. It might cause to increase cost because of much more labor inputs.

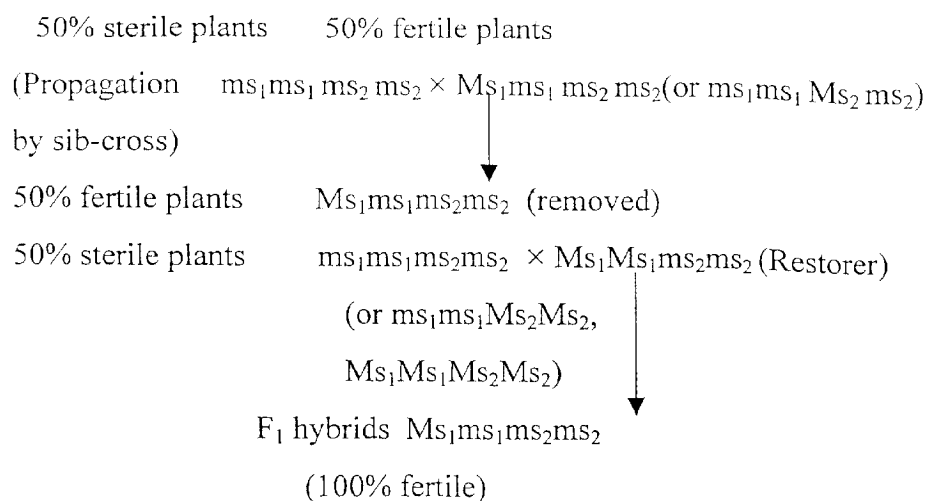


Fig 1. The propagation scheme of parent lines and their hybrids based on GMS (two pairs of recessive duplicate genes) two lines

2. GMS with two pairs of dominant interactive genes.

The typical materials of this kind of GMS were Yi3A (Yibin Agricultural Institute) and 23AB (Li et al, 1980). Li and his colleagues have identified that their male sterility was controlled by two pairs of dominant interactive genes, and designed the 'three-line' model to propagate the parents and produce the hybrid seeds (Fig. 2). The advantage was to get

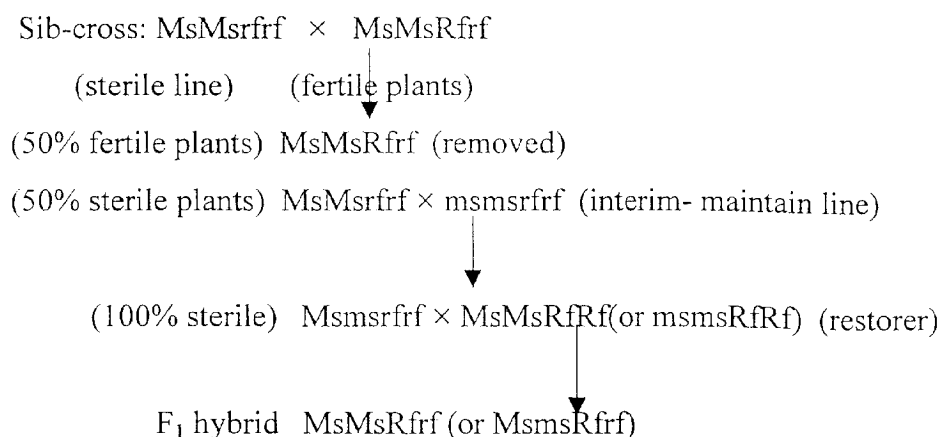


Fig 2. The propagation scheme of parent lines and their hybrid seed based GMS (two pairs of dominant interactive genes) three lines

a whole sterile population by using an interim-maintain line, and avoided removing 50 percent fertile plants from female parent line when it was used to produce F_1 hybrid seed. But it was not easy to find the restore gene.

3. GMS with an epistatically recessive gene and two recessive duplicate genes

This kind of material, 9012A was reported by Chen (1995, 1999), was controlled by an epistatically recessive gene and two recessive duplicate genes. When the epistatically recessive gene (rf) was identical, it can inhibit another two recessive genes (ms_1, ms_2) to express and the plant showed the male fertile phenotype, not male sterile. According to this genetic principle, Chen also designed a 'three-line' model to propagate and produce (Fig. 3). The advantage was that there were a lot of restorers, and the whole sterile population was gotten by using the interim-maintain line. Otherwise, it was difficult to breed the interim-maintain line.

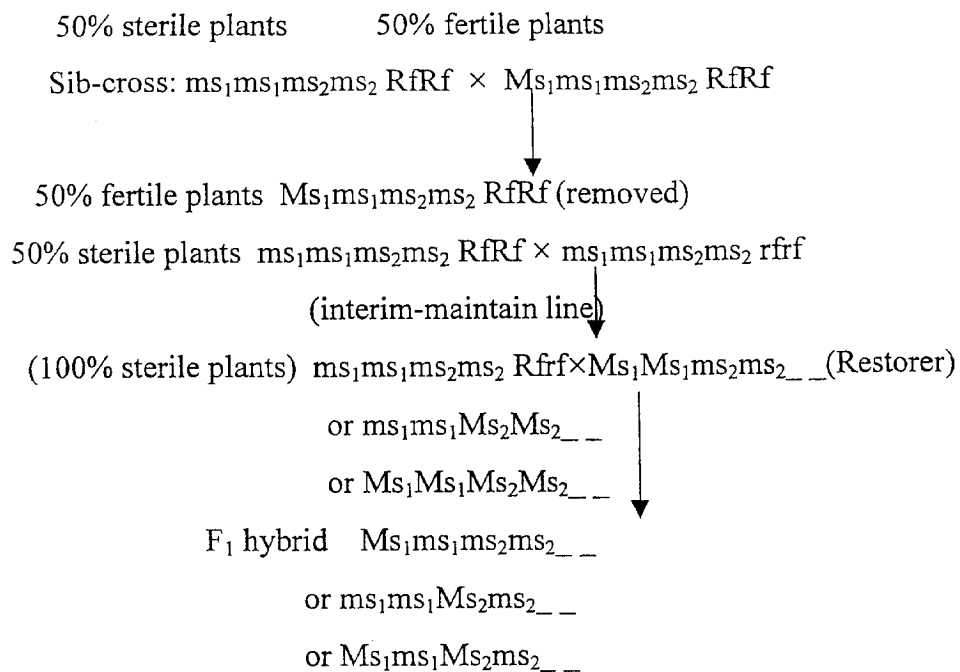


Fig. 3. The propagation scheme of parent lines and their hybrid seed based on GMS (two pairs of recessive duplicate genes with an epistatically inhibition recessive gene)

three lines

Note: Rf, a dominant gene, can't inhibit the function of the sterile gene (ms), while rf, a recessive gene, can do it.

4. Molecular markers to the GMS genes

In order to solve the problem that it was difficult to breed the interim-maintain line, Tu et al (1999) developed the molecular markers to assist selection. The BC₁F₁ population from S45A₁ × Zi-1968 was investigated by bulked segregant analysis (BSA), and it was found that two RAPD markers, UBC158.580 and UBC187.880, were linked to the purple stem gene and the male fertile gene (Ms1). The results showed that these four genes were located in the same linkage group. According to Chen's report (1998), the epistatically recessive gene (rf) of 9012A could also inhibit the male sterile genes of S45A. So the next work will be to find the markers of the epistatically recessive gene.

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