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A NEW SOURCE OF MALE STERILITY IN RYE (*SECALE CEREALE* L.)

ABSTRACT

Pampa cytoplasm has served as the main source of male sterility in hybrid rye breeding programs in Europe for 30 years and there is a need of introducing new *CMS* sources to prevent cytoplasm uniformity. Several *CMS* sources were discovered and studied in the former Soviet Union. The *CMS* sources in rye can be classified into two major groups, the P (Pampa) type and the V (Vavilov) type. The main goal of this study was to widen the "sterile" cytoplasm as a tool for rye hybrid development.

'*Koerntner*' represent the same or similar source of male sterility like *CMS 'CM'* and *CMS* 'V type'. This source is genetically different from the sources of male sterility 'Pampa' and 'D. Zlote'–1. In F_2 progenies develop by self–pollination F_1 plants, of P.6.2–1 × line 113, segregation according to the ratio three male fertile plants to one male sterile, was observed. The segregation ratio in F_2 indicate that one or two recessive gene(s) are being involved in the interaction with mutated (S) cytoplasm to cause male sterility

Key words: male strility, new sources, rye, type P, type V

INTRODUCTION

Since 1970 Pampa (Geiger and Schnell,1970) cytoplasm has served as the main source of male sterility in hybrid rye breeding programs in Europe and there is a need of introducing new *CMS* sources to prevent cytoplasm uniformity. Several *CMS* sources were discovered and studied in the former Soviet Union in late 1960's and in 1970's: Chekhovskaya (1965), Zdril'ko (1966), Kobylyanskij (1969), Kluchko and Belousov (1970), Gulyajeva (1972). All of these sources were spontaneous male sterile plants found in various rye populations. The spontaneous *CMS* sources in rye also were found by Geiger (1971) in Germany, by Grabow (1977) in former DDR and Madej (1976) in Poland. Lapinski in Poland (1972,1975) induced the sterility in rye by crossing *Secale cereale* with *Secale montanum* and also *S.cereale* with *S.kuprjanovii*.

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The comparison of *CMS* sources was done by several rye researchers. According to Geiger (1982) the *CMS* sources in rye can be classified into two major groups, the P (Pampa) type and the V (Vavilov) type. The V type was also named the R (Russian) type (Kobylyanskij *et al.* 1980). The P type of *CMS* can be easily distinguished from V type. Most pollinator genotypes act as maintainer to the P type and as partial or complete re–storer to the V type.

The comparative studies on *CMS* sources were conducted by Madej (1975a 1975b), Adamchuk *et all.*(1979), Kobylyanskij *et all.* (1980), Adolf and Winkel (1982), Geiger and Morgenstern (1975) and Morgenstern and Geiger (1982). The above mentioned authors compared their own *CMS* sources to the *CMS* 'Pampa'. They found that the most common were pollen parent genotypes which maintained male sterility in the *CMS* 'Pampa' and restored pollen fertility in the other *CMS* sources. The genotypes which restored pollen fertility in the *CMS* 'Pampa' (only about 3% of tested pollen parents) acted as restores in the compared *CMS* sources. The genotypes which maintained male sterility in the *CMS* sources of V type, which occurred very rare, generally restored pollen fertility in the *CMS* 'Pampa'. However, Morgenstern and Geiger (1975) found the genotypes which were common maintainers to two *CMS* genetically different sources: 'Pampa' and '235b'.

In our studies accomplished in 1990 (Warzecha and Salak–Warzecha, 1996), we differentiated four sources of rye male sterility into two groups according to their interaction with selected inbreds of divergent genotypes. *CMS* 'Pampa' and *CMS* 'D. Zlote–1' belonged to one group, while *CMS 'CM'* and *CMS* 'V–type' to the second group. We proposed genotypes of certain *CMS* sources and interacting maintaining male sterility and pollen restoring inbreds. We found that the most common group constituted inbreds which served as maintainers to CMS 'Pampa' and *CMS* 'D.Zlote–1'. The same inbreds restored pollen fertility in *CMS* *'CM'* and *CMS* 'V–type'. We selected rare inbreds which acted as uni–versal maintainers or universal restores to the all four *CMS* sources.

In this study we applied of the obtained results and selected inbreds of specific genotypes for rapid determination of the genetic nature of a new discovered source of male sterility in rye. The main goal was to widen the "sterile" cytoplasm as a tool for rye hybrid development.

MATERIALS AND METHODS

Material for the study consisted:

Male sterile plant, coded under name P.6–2–1, found as a spontane–ous source of male sterility in the open–pollinated progeny of Austrian variety '*Koerntner*'.

Three selected inbreds of specific genotypes: L100, L113 and L 106.

Three ears of the spontaneous male sterile plant were crossed to the selected inbreds, showing different type of interaction with elaborated

sources of male sterility. Line 100 acted as the universal maintainer to certain rye male sterility gene–cytoplasmic sources, namely: Pampa', 'D. Zlote–1', *CMS* 'CM' and *CMS* 'V type'. Line 113 acted as the universal restorer to these sources. Line 106 showed different interaction: maintained male sterility in *CMS* 'Pampa' and *CMS* 'D. Zlote–1', and restored pollen fertility in *CMS 'CM'* and *CMS* 'V–type'.

The pollen fertility of F_1 was evaluated visually at anthesis. Also the ears were put under bags before flowering to determine of seed seting. Occasionally microscopic investigation of anthers samples was performed. The plants were grouped to three classes according to their fertility: MS –male sterile, PMF – partially male fertile and MF– male fertile.

MS plants formed reduced size, undehiscend anthers which did not shed pollen and their ears bagged before flowering did not set any kernels. The anthers of MS plants contained pollen grain usually enviable in 90–100%, empty, unstained in acetocarmine. Only a few viable pollen grains could be observed in some squashed anthers of MS plants. MF plants produced normal size, dehiscent anthers which shed pollen and set seeds in bagged ears like pollen parent inbred lines. The fertility of PMF plants was reduced and they shed much less pollen and usually set no kernels or set a few of them.

RESULTS AND CONCLUSIONS

F_1 progeny resulted from the cross of P.6.2–1 plant ear and line 100 was completely male sterile. It was back–crossed to line 100. BC_1 progeny also showed complete male sterility.

Both F_1 progenies resulted from the crosses of P.6.2–1plant ears with lines 113 and 106 were restored (Table 1).

Table 1

Segregation in the progenies of the male sterile plant selected from rye cultivar 'Koerntner' and the three diverse pollen parent inbreds (L 100, L106 and L113).

Progeny pedigree	Generation	Number of plants				Ratio MF : MS
		Total	MF	PMF	MS	
MS × L100	F_1	15	0	0	15	0:1
MS × L100	BC_1	20	0	0	20	0:1
MS × L106	F_1	16	16	0	0	1:0
MS × L113	F_1	16	16	0	0	1:0

The obtained data indicate that the source '*Koerntner*' represent the gene–cytoplasmic (gc–mst) type of male sterility. *CMS* '*Koerntner*' represent the same or similar source of male sterility like *CMS 'CM'* and *CMS* 'V type'. This source is genetically different from the sources of male sterility 'Pampa' and 'D. Zlote'–1.

In F_2 progenies develop by self–pollination F_1 plants, of P.6.2–1 × line 113, segregation according to the ratio three male fertile plants to one male sterile, was observed (Table 2).

Table 2

Segregation in F_2 progenies derived out of the cross of the male sterile plant selected from rye cultivar 'Koerntner' and the inbred L113

Progeny pedigree	Number of plants			Ratio MF:MS	Ch^2	P
	Total	MF	MS			
MS × L113–1	14	9	5	3:1	0.86	0.50 – 0.30
MS × L113–2	25	19	6	3:1	0.02	0.90 – 0.70
MS × L113–3	19	15	4	3:1	0.45	0.50
MS × L113–4	23	18	5	3:1	0.11	0.90 – 0.70
MS × L113–5	24	18	6	3:1	0.00	1.00

The segregation ratio in F_2 indicate that one or two recessive gene(s) are being involved in the interaction with mutated (S) cytoplasm to cause male sterility

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