DISCOVERY AND STUDIES ON POLIMA CMS LINE

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I. Brief introduction on the discovery of Polima,CMS line.

Polima, a cultivar /B.napus/ may come from Poland, it was introduced to our country from Russia in the early of 1960s. We planted "Polima" as a resource in the genetic material plot, and used mass selection for keeping on seeds every year. Until the flowering stage in the spring of 1972, we found nineteen typical male sterile plants in the Polima plot /five row plot, about one hundred plants/. These plants grew normally, green stems and leaves, small petals, short filaments, seriously degenerative anthers which appeared as a white sharp triangle. At that time, we used different cultivars and the fertile plants of Polima testcrossing with CMS plants of Polima, all added up to 45 crosses. During 1972-73, we soved seeds of test crosses with 18 male sterile plants and seeds of their free pollination /one plant had disease and died/, totally 71 materials. In the spring of 1973, many male sterile and partially fertile plants had appeared in these materials.

In the summer of 1973 a rapeseed scientific meeting of China was held in Wuhan. We delivered the seeds of free pollination, which were harvested from "Polima" male sterile plants, to 10 units such as Jiangsu, Hunan, Guangdong etc. Provincial Agricultural /Scientific/ Academies in our country. In the spring of 1974, majorities of male sterile or partially sterile plants also appeared from the free pollination progeny in these units. After that, we adopted one year two generations method to speed selection. During the process of selection we found that the sterility of Polima CMS plants had close relationship with their main-

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Note: graduate students Mr.Yang Guangsheng and Ms.Yu Fengqun have joined in this research work.

tainers, e.g, in some crosses, the sterility sensitive to high temperature /at high temperature the plants showed a little of fertile pollens/; some sensitive to low temperature /at low temperature the plants showed a little of fertile pollens/; the other crosses are unstable in either high or low temperature conditions. In 1976, Hunan Agricultural Academy utilized "Polima" CMS as a basis to establish firstly cytoplasmic "three lines" in our country for the utilization of hybrid vigor. But the hybrid vigor was not so high to fit for one market requirement.

From the late 70s and early 80s, Huazhong Agricultural University and Hunan Agricultural Academy and other institutes began to select the single low or double low CMS lines by Polima CMS. Up to now, they have obtained a series of single low "three lines" combinations and also began to test cross combinating ability and hybrid yield capacity.

II. Studies on the inheritance of Polima CMS

Firstly, we had tested the fertility of the pollen of Polima hybrids F_1's, finding that no segregation appeared. And we also investigated the fertility of F_2 plants, the segregation of the fertility has occured so we may say that Polima CMS system may belong to sporophyte CMS.

Secondly, we investigated the fertility of F_2 plants which came from the crosses: three CMS lines with Polima cytoplasm /Xiang-ai A, Po-bo A, Po-xin A/ X two of their restorers /Kenc, Huaie/, and also B_1 and B_2. The main results may be summarised as follows: the segregation of most F_2's: Fertile plants sterile plants show as 3:1, B_1 and B_2 show as 1:1. These results suggested that Polima male sterility was controlled by S-cytoplasm and one pair of recessive genes /rfrf/. But the F_2 of Po-bo A x Ken-c gave the segregation of 8.8:1, and B_1 3:1, B_2 1:1 /Table 1.2/. These suggested that the sterility may be controlled by two pairs of recessive nuclear genes /rf_1 rf_1 rf_2 rf_2/. It is necessary to keep on further studies.

Thirdly, we deduced that the genetic combination of the primitive cultivar "Polima" may be s/Rf Rf/, or s/Rf Rf Rf Rf/, or s/Rf Rf rf rf/, or s/rf rf Rf Rf/. When genic Mutation form s/rfrf/ or s/rf rf rf rf/ may occur, the male sterility will appear.

Table 1. Segregation of the sterility in F_2 of Polima CMS X their restorers.

Crosses	S	F	S:F	x	P
PoaA X Huaie	52	161	1:3.09	0.01	.05
XiangaiA X Huaie	51	137	1:2.70	0.35	.05
XiangaiA X Kinc-2	28	168	1:6.0	11.43	.01
PoboA X Huaie	57	168	1:2.95	0.001	.05
PobcA X Kenc-2	26	176	1:8.8	15.21	.01
PoxinA X Huaie	42	152	1:3.62	0.99	.05
PoxinA X Kenc-2	41	132	1:3.22	0.1	.05

Note:

/1/ S——Sterile Plants; F——Fertile plants.

/2/ Expected ratio is 1:3.

Table 2. Segregation of backcross generations of Polima system CMS.

Year		Crosses	S	F	S/F	x	P
1984	B_1	/1/	85	91	1:1.07	0.14	.05
		/2/	62	72	1:1.16	0.604	.05
		/3/	80	68	1:0.76	0.890	.05
1986	B_1	/4/	54	79	1:1.45	4.330	.01
		/5/	54	58	1:1.23	0.063	.05
		/6/	70	74	1:1.10	0.096	.05
		/7/	64	56	1:0.88	0.410	.05
		/8/	57	62	1:1.09	0.134	.05
		/9/	80	68	1:0.90	0.820	.05
1986	B_2	/10/	70	81	1:1.17	0.660	.05
		/12/	77	81	1:1.04	0.57	.05

Note:

/1/ Poa A x /PoaA x Huaie/; /2/ Xiangai A x /XiangaiA x Huaie/;

/3/ Xiangai A x /XiangaiA x Kenc-2/;

/4/ Plbo A x /PlboA x Huaie/;

/5/ Pobo A x /PoboA x Kenc-2/;

/6/ Poxin A x /PoxinA x Huaie/;

/7/ Poxin A x /PoxinA x Kenc-2/;
/8/ /Xiangai A x Huaie/ x Xiangai B ;
/9/ /Xiangai A x Kenc-2/ x Xiangai B ;
/10/ /Pobo A x Huaie/ x Bronowski ;
/11/ Pobo A x Kenc-2/ x Bronowski ;
/12/ /Poxin A x Huaie/ x Xin-4 .

III. The cytological studies on anther and pollen ontogeny of several male-sterile lines in B.napus

The studies of Polima CMS lines /Po-boA and Xiang-ai A/ compared with Shan 2A, 75-3A, Ogu-napus A and Yi-3A /genic Ms line/ seem to have indicated that these 6 sterile materials could be divided into three types:

/1/ Po-boA, Xiang-ai A, Shan 2A and 75-3A CMS lines seem to have the same type of anther ontogeny. All of these CMS lines have no differentiation of microsporangium. The inhibition of anther ontogeny occurred before the formation of sporogenous cell.

/2/ Ogu-napus A is generally able to undergo meiosis and form tetrads. A number of abnormalities are exhibited in subsequent stages. Some microspores fail to be released from tetrads. After some microspores are released, their exine developments are not much better. The tapetal cells enlarge toward the locule centre, appearing the microspores. There are ovules and papillae outside the female reproductive organ.

/3/ Anther ontogeny in Yi-3A /genic Ms line/ was normal before microspore mother cell stage. After that, there are chromosomal stickings and chromosomal bridges at meiosis prophage I and anaphase I respectively. Additionally, there are lagging chromosomes at metaphase I, metaphase II, anaphase I and anaphase II. On account of abnormalities of meiosis, the number of uninucleate pollen decreases. Pollen grains fail to develop into bi-and tri-nucleate ones. The development of exine is also not much better.