ACCEPTANCE LECTURE

GCIRC SUPERIOR SCIENTIST AWARD

by

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I am very pleasant to be here and to have the opportunity to meet so many old and new friends and exchanged so much scientific informations and points of views on rapeseed science and production. I think that the 8th International Rapeseed Congress will deeply affect the development of rapeseed science and production world wide.

It is a great honour to have an opportunity here to introduce rapeseed production and research works in China.

The rapeseed growing in China has been developing very rapidly during recent 10 years. The sowing area and yield were 2 to 2.7 million hectares and 600-650 kilogram per hectare, respectively, before 1978. By 1990, the rapeseed sowing area was about 5.5 million hectares with a yield of 1,260 kilogram per hectare. That means we have in China one third of world rapeseed sowing area and total production. By 1995 it might be expected that the sowing areas would be 6.5-7.0 million hectares and the total production 10 millions ton in China.

Canola breeding began around 1980 in China. Forty single or double low varieties or lines have been bred, among them about 10 cultivars which have covered 0.6 million hectares, 9 percent of total rapeseed sowing area in 1990. Up to 1995, we may predicate that the planting area of single or double low cultivars would be 1.4-1.7 million hectares, which is about 20-25 percent of the total.

The research on rapeseed hybrid breeding has been developing fast during the last two decades in China. In 1976, the Chinese Ministry of Agriculture founded the project. In 1985 the cooperation network for hybrid rapeseed in China was set up. More than twenty agricultural research units and universities and more than 100 scientists have taken part in the research for heterosis in rapeseeds. Already 31 hybrid cultivars have been put on official trials in several provinces from which 4 have been produced commercially including one single low hybrid. In 1991 the sowing area for hybrid rapeseeds was 0.73 million hectares about 12 per cent of the total rapeseed planting area in China. But the area of double high CM hybrid, Qinyou No. 2 (Li, D.R. 1986), is about 85% and commencing in 1986 was the first rapeseed hybrid to be produced commercially.

My university, Huazhong Agricultural University, is located at the central portion of China along Yangtze River, where there is located the largest area of rapeseed production in China. Our Institute of Rapeseed Genetics and Breeding, headed by Professor Dr. Liu Hou-li, is divided into quality breeding, yellow-seeded breeding, hybrid rapeseed breeding, disease resistance breeding, interspecific hybridization, and tissue culture research groups. I am in charge of the rapeseed hybrid breeding group.

I finished my graduate research works and defended my thesis in 1965, which was conducted under the direction and guidance of Prof. Dr. Liu Hou-li from 196-65. I started research on heterosis utilization in rapeseed in 1971. My main research spheres are self-incompatible and cytoplasmic sterility. During the first decade my research emphasis was on the self-incompatibilit and, for the last ten years, I have devoted myself to the study of cytoplasmic sterility.

Now, I would like to talk about some scientific views on the research works for the utilization of rapeseed heterosis according to my personal experience for last 20 years.

A. Ways to utilize heterosis

The main ways of utilizing rapeseed heterosis in China are:

A. Spontaneous hybridization
B. Self-incompatible (SI) hybridization
c. Chemically induced male sterile hybridization
D. Genic male sterile (GMS) hybridization
E. Cytoplasmic male sterile (CMS) hybridization

A good strategy would be to put one's emphasis on CMS hybrid breeding, or, to breed SI, GMS, chemical and natural hybrids as supplementaries at the same time in China. For the SI hybrids, it may be easier to carry out since the maintainers and restorers of SI lines can be bred (T.D. Fu, 1981, 1987) (Table 1), and also the multiplication of SI lines can be carried out by spraying 5%-10% table salt solution during the flowering period every three-five days (D.Z. Hu, C.T. An et al 1983; T.D. Fu et al, 1984) (Table 2). As for GMS hybrids, there is also good potential. For instance, Mr. Li in Shanghai, China, has found a temporary maintainer to keep one hundred per cent male sterility in his GMS line which is controlled by two dominant interacting genes.

B. Problem of trace of viable pollen in CMS systems

It was shown by our research that whether the Polima CMS is sensitive to temperature or not is depend on the nucleus.

It is possible to breed stable sterile lines with very little pollen by screening for better maintainers. Furthermore, it is easier to breed stable sterile lines in spring rapeseed than in winter rapeseed. There are high temperature sterile, low temperature sterile, and stable sterile types in polima CMS lines. Of course, every breeder wants to get stable sterile types of CMS. However, if we can not get the stable type for the time being, from a practical point of view, the high temperature sterile type is better than the low temperature type. We also found that the complete sterile material is often accompanied by weakness in plant vigor. How to handle and solve the contradictory troubles between the complete sterility and better agronomic characters? I prefer to choose the sterile line strong in growth vigor with trace pollen on the parts of flowers rather than complete sterile lines with weakness in vigor, because the former would have potentiality to produce a hybrid with strong heterosis no matter whether there is trace pollen (Table 3). There is a good tendency, in fact, that trace pollen produced on the sterile lines is lower in competitive ability than pollen from restorer lines when placed on stigmas. So, the quality of F_1 seeds would get little effect by trace pollens. Furthermore, the trace pollen of high temperature winter *Brassica napus* sterile lines can be effectively reduced to a very low level by delayed planting.

C. The use of recurrent selection to develop CMS restorers using dominant genic male sterility

There is one pair of main restorer genes and some modified genes for polima CMS. The main restorer gene exists mainly in European varieties of *B. napus*. It could be also found among native cultivars of *B. campestris*, especially those from northern parts of China, and also among native cultivars of *B. juncea*. The restorer genes might be located in the A genome (P.X. Cui et al, 1979; T.D. Fu et al, 1987). For enhancing the restorer genes of polima CMS, we are going to combine the restorer genes with canola quality, good agronomic characters and high oil content genes through recurrent selection by use of dominant GMS materials in addition to screening new restorer resources. We are going to pursue this approach for several years and have already established some basic populations for further breeding.

D. Restoration of pollen production in commercial crop can vary restorer rate

How high the restoring rate of F_1 hybrid is required? I think it is depended upon different conditions in different regions. Generally speaking, the restoring rate should be kept on a high level. Restoration can be above 90 per cent especially under moist humid conditions which ensures full seed set during the flowering period such as in the Yangtze River area in China. On the other hand, one could allow the restoring rate remain at a relatively lower level at less rainfall and dry areas. According to my experience, the restoring rate for field production could be reached to about 95 percent if the parental lines were pure, the isolating condition was good, and the row ratio between male and female lines was reasonable which ensured enough pollen provided from restore lines. At the Yangtze River area with the condition of trace pollen from CMS lines, the better row ratio would be one male to two female leading to 750 kilogram F_1 seeds per hectare produced.

E. The relationship between the origin and evolution of rapeseed and the development of "three line" CMS system

Upon reflecting on breeding for polima three lines, and analyzing the information about the breeding of three lines of rapeseed from different countries, I think that it is easier to find sterile cytoplasm and restorer genes among varieties which are of primitive evolution and located at the origin centre, or nearby. In contrast, it is also easier to get maintainers among cultivars which are advance in evolution and located far away from the origin centre. This tendency may help us to breed new three lines and enlarge the resources of CMS.

China has a long history of rapeseed production and has plenty of genetic resources of *B. campestris* and *B. juncea*. To combine quality breeding and hybrid breeding together is one of our main objects today. We are ready to cooperate on rapeseed research with scientists from different countries. I welcome everybody here to visit China to exchange scientific information and points of views about their rapeseed research work, and partake in cooperative scientific endeavours.

Table 1: The index of compatibility (IC) of different test crossing combinations

Year	SI Lines	Total No. of Combinations	Incompatible (IC<1.0)	Low compatiblibilty (IC=1.1-CK)	High compatiblibilty (IC>CK)
1980	211,271 (Double high)	334	81(24.3%)	186(55.7%)	67(20.1%)
1986	180,184 (Single low)	55	4(7.3%)	40(72.7%)	11(20.0%)

According to above table, about 7.3-24.3% were maintainers, and about 20% were restorers, so it is easy to breed SI maintaining and restoring.

Source: T.D. Fu, et al, 1981, 1987

Table 2: Suitable concentration of salt water for overcoming the self-incompatiblity in *B. napus* L.

Province	SI Line.	Suitable Concentration of Table Salt Water	Reporter
Gansu	271	10%	Hu, D.C. *et al*. (1983)
Hubei	271	5%	Fu, T.D. *et al*. (1984) Si, P. (1984, 1985)
Xingjiang	271	8%	Yin, J.Z. *et al*. (1990)

According to my research, 3-10% table salt water is effective to overcoming self-incompatibility.

Table 3: Studies on the mutual competition between pol CMS pollens and restorer pollens

Treat.	Eruic acid			Leaf types			Fertility		
	Total No. of F_1 seeds	No. of F_1 seeds with eruic acid	Hybrid (%)	Total No. of F_1 plants	No. of F_1 plant with curved leaves	Hybrid (%)	Total No. of F_1 plants	No. of F_1 plant with male fertility	Hybrid (%)
0	86	82	95.35	297	270	90.91	282	253	89.72
1	90	88	97.78	174	163	93.68	166	153	92.16
2	85	75	88.23	183	149	81.42	171	137	80.12
3	90	78	86.67	209	155	74.16	189	138	73.00
4	88	68	77.27	392	265	67.60	376	262	69.68
5	90	69	76.67	208	131	62.98	192	120	62.50

* The restorer line is high eruic, has leaves with curved edges and the restorer gene. The CMS line does not exhibit these characteristics. Hybrids were identified by the presence of these three characteristics.

0= Pollinating with pollen of the CMS and the restorer simultaneously.
1,2,3,4,5= Pollinating with pollen of restorer 1,2,3,4 and 5 hours after pollinating with pollen of CMS line, respectively.

According to the above table, hybrid production by simultaneously pollinating with the pollen of CMS and restorer was more than ninety percent, when there were still seventy percent hybrid production even when the CMS line was pollinated with restorer pollen 4 or 5 hours later.