RAPESEED HETEROSIS BREEDING IN CHINA

T. D. Fu, G. S. Yang

State Key Laboratory in Genetic Improvements of Crops, Institute of Crop Genetic and Breeding, Huazhong Agri. Univ., Wuhan, 430070, China.

ABSTRACT

From 1985 to 1994, 14 rapeseed hybrids among which most were CMS or GMS hybrids were registered and hybrid planting area in 1994 was up to 1.2 million hectares, about 20% of the total rapeseed area in China. It is estimated that the hybrid area in China will reach about 40—50% of the total rapeseed area in the year of 2000. There are several ways of heterosis breeding in China, but CMS is the most important and practical one at present.

INTRODUCTION

Studies on the rapeseed heterosis of F1 hybrids were begun in early 1940s' in China. Up to now, the history of 50 years could be divided into three periods. (1) The exploring period (1940-1970): The characteristics of this time were that the heterosis in rapeseed were recognized by many breeders in China. (2)The preparing period (1970-1985): During this period, cytoplasmic male sterility (CMS) and one genic male sterility (GMS) system were discovered (Fu,1981, Liu,1973). Besides male sterility, Fu et al(1975) established self-incompatibility (SI) system in *Brassica napus*. (3) The utilizing period (1985-now): During the period, 14 rapeseed hybrids of *Brassica napus*, including eight CMS hybrids ("Qinyou 2" 、 " Huaza 2" 、 "Youyan 4" 、 "Chuanyou 12" 、 "Wanyou 9" 、 "Xinza 1" 、 " Xinza 2" and "Huaza 3"), one SI hybrid ("Youyan 3"), four GMS hybrids ("Shuza 1" , "Youyan 5" "Chuanyou 13" 、 "Chuanyou 14") and two chemical induced male sterility hybrids ("Shuza 2" 、 "Fuyou 1"), were registered and used in the production in China. At present, the planting area of rapeseed hybrids *Brassica napus* in 1994 was about 1.2 million hectares, about 20 percent of total rapeseed planting area (about 6 million hectares) in China.

WAYS OF HETEROSIS BREEDING

Cytoplasmic male sterility

CMS is the most important way of rapeseed heterosis breeding in China. Since Liu, et al (1973) discovered CMS line "Shantian A" of *B. campestris* in 1965, a few cytoplasmic male sterility systems have been reported. Fu, et al (1981) found pol CMS of *B.napus* in 1972 and the Crop Institute of the Agricultural Science of Hunan Academy, utilizing pol CMS, developed the pol CMS sterile line " Xiangai A" , and established the "three lines" in 1976 (Cui,1979); Li (1986) found the Shaan 2A CMS of B.napus in 1976, and

set up the "three lines" in 1983. Besides the CMS mentioned above, Liu, et al (1984), Fu (1989) and Li, et al (1989) developed 110A CMS, MI CMS and N86 CMS of *Brassica napus* respectively. The classification of these CMS systems is going on.

Genic male sterility

Yibing Institute of Sichuan province discovered dominant GMS line Yi-3 A of *B.napus* L. in 1972. Li et al (1986) demonstrated that shanghai GMS was controlled by two pairs of dominant interaction genes, and suggested a new hypothesis of using genic male sterile " three lines" to produce hybrids. Hou, et al (1990), Li, et al (1993) reported the GMS lines 117A and S45A which were controlled by two pairs of recessive genes. Chen et al (1984) reported a recessive GMS system which is controlled by three pairs of recessive genes. GMS, especially recessive GMS, is still an important way of rapeseed heterosis breeding in China. This is due to that GMS have complete male sterility and the labour cost is cheap in China.

Self-incompatibility

Fu and Liu (1975,1977) developed SI lines 211, 271 and their hybrids of *B. napus*. And one SI hybrid, Youyan No.3 was registered in 1991, which was bred by the Oil Crop Institute of Guizhou Province. In order to overcome the SI, Fu(1981) developed the SI lines and their maintainers and restorers, and realized using these three lines to produce hybrids. It is also demonstrated that 5—10 percent salt(NaCl) solution spray during flower period is effective to overcome SI of *Brassica napus* (Hu et al, 1983, Fu et al., 1984).

Chemical induced male sterility

Guan, et al (1981, 1987) reported the results by using male gametocides to kill pollen grains and produce hybrid seeds. They selected out "Male Gametocide No. 1" , "MG_4" etc chemical substances, which can kill more than 80 percent pollen grains.

Spontaneous hybrids

The Agricultural Science of Menyuian Institute in Qinghai province planted the two high combility varieties of *Brassica campestris* row by row. After ripening, the seeds were harvested mixedly, and yield of this hybrid is 23.8-31.8 percent higher than that of two parents.

Besides the ways mentioned above, Yang and Fu (1994) proposed a way of rapeseed heterosis breeding of genic and cytoplasmic male sterility (GCMS). GCMS has the advantages of both CMS and GMS.

PROBLEM AND BRIGHT FUTURE

At present, Chinese rapeseed cultivars are facing the two reforms. The

first is that single or double low cultivars replace the double high. The second is that hybrids replace the conventional cultivars. Although many rapeseed breeding units in China adopted quality breeding programme from 1978 to 1980, and have bred quite a few single low or double low cultivars, but planting area of these cultivars is only about 25% of Chinese rapeseed, for their lower seed yield and weaker disease resistance. Therefore, heterosis breeding is the very important way to overcome the proldem of good quality cultivars with low yield at present in China. According to a preliminary statistics of 1994—1995, 74 hybrids (38 double low, 21 single low, 15 double high) are taking part in the regional trials. It is estimated the rapeseed planting area in China in the year 2000 will reach about 7 million heotares, and among them 40— 50% are of hybrids.

Up to now, there are still a few barriers affecting the spread of F_1 hybrids in China: (1) the heterosis of hybrid with good qualities is not high enough, and hybrids with about 20% heterosis are required. (2) the oil content and disease resistance ability are needed to be improved. (3) The glucosinolate content of hybrids are needed still to be decreased (from 30 μmol/g to 20μmol/g).

REFERENCES

Chen, F.X. Hu, B.C. and Li, Q.S. 1994. *J. Huazhong Agri. Univ. Sup. Sum* (17):21

Cui, D.X. Den, X.X. 1979. *Oil Crops of China*, (2):15-20

Fu, T.D. Liu, H.L. 1975. *Oil Crops of China*, (4):77—85

Fu, T.D. Liu, H.L. Yang, X.N and Wu, J.S. 1977. *Oil Crops of China*. (4): 48—58

Fu, T.D. 1981. *Eucarpia Cruciferae Newsletter*, (6):9—11

Fu, T. D. Liu, X.P. Hu, Z.J. 1984. *Agriculture Education and Research*, (2):24—29

Fu, T.D. Si, P. Yang, X.N and Yang, G.S. 1992. *Plant Breeding*, 109:255—258

Fu, S.Z. 1989. *Acta Agronomica Sinica*, 15(4):305—309

Guan, C.Y. Wan, G.H. Zhao, J.T and Li, H.Q. 1979. *J. Hunan Agricultural College*, (4):47—52

Guan, C.Y. Wang, G.H. 1987. *Proc. of 7th Int. Rapeseed Cong*. 1:243—251

Hou, G.Z. Wang, H. Zhang, R.M. 1990. *Oil Crops of China*, (2):7—11

Li, D.Y. 1986. *Scientia Agricultura Sinica*, 19(5):94

Li, S.L. Qian, Y.X. and Wu, Z.H. 1988. *J. Shanghai Agricultural Science*, 1(2) :1—12

Liu, S.L. Zhou, Z.J. and Zhou, X.Y. 1993. *J. Shanghai Agricultural Science*, 9(4):1—7

Li, Y.C. Cai, M. and Gong, Y.B. 1989. *Oil Crops of China*, (4):6—10

Liu, G.H. 1973. *Oil Crops of China* (3):48—51

Liu, Z.W. 1984. *J. Jiangxi Agicultural Science*, (8):6—7

Hu, D.C. An, C.T. Dong, H.Z. Bing, D.J. and Niu, J.Y. 1983. *Oil Crops of China*, (2):1—5

Pan, T. Zheng, F.Y. Wu, H.S. 1988. *Oil Crops of China*. (3):5—8

Yang, G.S. Fu, T.D. 1984. *Cruciferae Newsletter*, (16):87—88