Progress and Prospects of Rapeseed Breeding in Korea

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INTRODUCTION

Agriculture, which was the major industry in ancient times, remains important as a source of food and of national stability in Korea, although its contribution to the gross national product (GNP) decreased along with the rapid industrialization. Production expanded in fishing, higher valued fruits, vegetables and oil crops due to changes in dietary patterns from supplementary staple grains of barley and potatoes to a wider variety of higher value food in Korea (Choi *et al.*, 1977; Jang *et al.*, 2002 ; Kae *et al.*, 1971 ; Kwon *et al.*, 1971, 1981 ; Lee *et al.*, 1980a, 1980b, 1981c, 1981, 1982 ; Rho *et al.*, 1986).

The rapeseed of commerce is obtained from species of *Brassica*, members of the Cruciferae, and within the genus are some 160 species, mainly annual and biannual herbs. Many of the rapeseed are of economic importance and especially all plant parts such as contribute to their usefulness commercially in one species or another : roots, stems, leaves, inflorescence or seeds. The name rape is derived from the Latin *rapum* meaning turnip (Weiss, 1983).

The two most important species as commercial oilseed producers are *B. Compestris* L., which has a fairly wide world distribution and probably still exists as a truly wild species, and *B. napus* L., restricted basically to Europe and North Africa, but there is some doubt whether a truly wild species exists so far (Sharapov 1956 ; Harberd 1972).

Major advantages of rapeseed cultivation in Korea are 1) utilization of idle winter paddy field, 2) sufficient domestic supply of edible oil, 3) double low erucic acid and glucosinolate composition of oil and cake respectively, 4) increased supply of high protein feed, 5) widely adaptation and tolerance to various climates and soils, 6) ample return of absorbed nutrients, 7) less damage by disease and pests, 8) higher grain and oil yields per unit area than other oil crops and, 9) easiness to grow. Disadvantages of the crop production are 1) cheaper price of rapeseed, 2) lower income than other oil crops of sesame and peanut, and 3) lower income as compared with other winter crops in Korea. Thus, higher price of rapeseed should be provided subsidizing rapeseed-growing farmers to produce more rapeseed and to replace large quantity of edible oil imported from foreign countries (Kwon *et al.*, 1981)

The objective of this publication written in English is to introduce the highlights of the rapeseed research achievements. By our oil crop scientists in Korea, to plant scientists of foreign countries, to agricultural policy makers, and to research and extension workers in the future.

HistoryofBreedingofRapeseedinKorea

Several local varieties had been grown throughout Korea by 1966, and many of them had been replaced by Japanese varieties such as Miyuki and Asahi. The varieties of Miyuki and Asahi were introduced from Japan in 1962, and released in 1967 to southern area and Jeju island. In 1964 Chonnam local varieties were sown at the Mokpo Branch Station to select superior individual plants adaptable to the southern part of Korea. From them "Yudal" variety was selected and released as a new vareiety being widely adaptable to the southern part of Korea (Kae *et al.*, 1970).

Cross breeding program was initiated at the Mokpo Branch Station in 1968, and the acreage planted with newly developed varities "Mokpo 11" (1977), " Yongdang " (1977), "Nojeokchae"(1979), "Naehanyuchae"(1980), "Youngsanyuchae" (1980), " Cheongpungyuchae"(1983) and " Hallayuchae" (1985) has increased since the first crossbred varieties " Mokpo 11" and "Yongdang" were released in 1977 (Table 1). Particularly, " Yongdang" cultivar was the first variety with low erucic acid developed from a cross between "Oro" with low erucic acid and "Norin 16" with high productivity in Korea.

To improve oil quality and oil cake, "Naehanyuchae" was developed from the cross between "Erra" and "Tower" classified as non-eruic acid and non-glucosinolate varieties, respectively.

The double zero variety was tolerant to cold and well adapted to southern part of Korea.

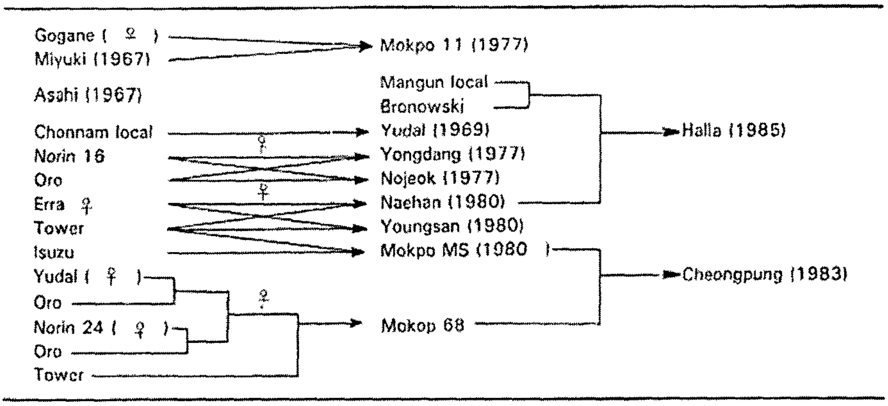
Erucic acid and glucosinolate had not been extracted from the variety.

"Youngsanyuchae" with better oil and cake quality had also been developed from the same cross. In Korea, breeding of F_1 hybrid varieties was made a great contribution the varietal improvement of rapeseed in recent years. A new single cross rapeseed hybrid "Cheongpungyuchae" was developed using "Mokop MS" which was perfect male sterile line developed at the Mokpo Branch Station.

The "Mokop MS" is a new cytoplasmic genetic male sterile line, and does not restore its fertility under any temperature regimes (Kwon, 1984).

The MS line is a double zero line containing no erucic acid and glucosinolate in oil and oil cake, respectively. The MS plant was selected in F_2 generation of a cross between "Tower" and "Isuzu" originated from Canada and Japan, respectively.

The MS line has been maintained pollinating with feriile sister line (Kwon *et al.*, 1984).



Flow chart of the rapeseed varieties developed in Korea was shown in Fig. 1.

Breeding for high yielding, improved fatty acid composition and glucosinolate.

Table 1. The agronomic characteristics of new varieties.

Variety	Released year	Maturing date	Plant height (cm)	Branches per plant	Pods per ear	Grain yield (kg/10a)
Miyuki	1967	June 2	89	43	26	221
Asahi	1967	June 5	120	39	47	264
Yudal	1969	June 8	145	37	34	323
Mokpo 11	1977	June 8	124	39	34	267
Yongdang	1977	June 4	156	46	48	213
Nojeok	1979	June 9	135	23	41	264
Youngsan	1980	June 5	143	40	49	289
Naehan	1980	May 30	146	40	50	275
Cheongpung(F_1)	1983	June 11	172	19	46	412
Halla	1985	June 7	157	24	37	255

Table 2. The chemical compoments of oil and oil cake of new varieties.

Variety	Oil content (%)	Protein content (%)	Erucic acid (%)	Glucosinolate (mg/g)			
				BI	PI	OZI	Total
Miyuki	39	23.1	48	3.45	0.46	7.42	11.33
Asahi	43	23.4	58	5.22	0.69	3.78	9.69
Yudal	45	23.5	59	2.91	0.63	8.69	12.23
Mokpo 11	46	23.4	47	3.44	0.47	7.42	11.33
Yongdang	43	24.9	0	4.15	0.37	6.16	10.68
Nojeok	42	24.2	0	3.75	0.27	6.68	10.70
Youngsan	44	24.5	0	0.06	0.03	0.34	0.43
Naehan	43	23.4	0	0.28	0.17	0.58	1.03
Cheongpung(F_1)	45	24.2	0	0.70	0.55	0.54	1.79
Halla	45	24.1	0	0.45	0.30	0.75	1.50

Development of maintainer and Mokpo MS

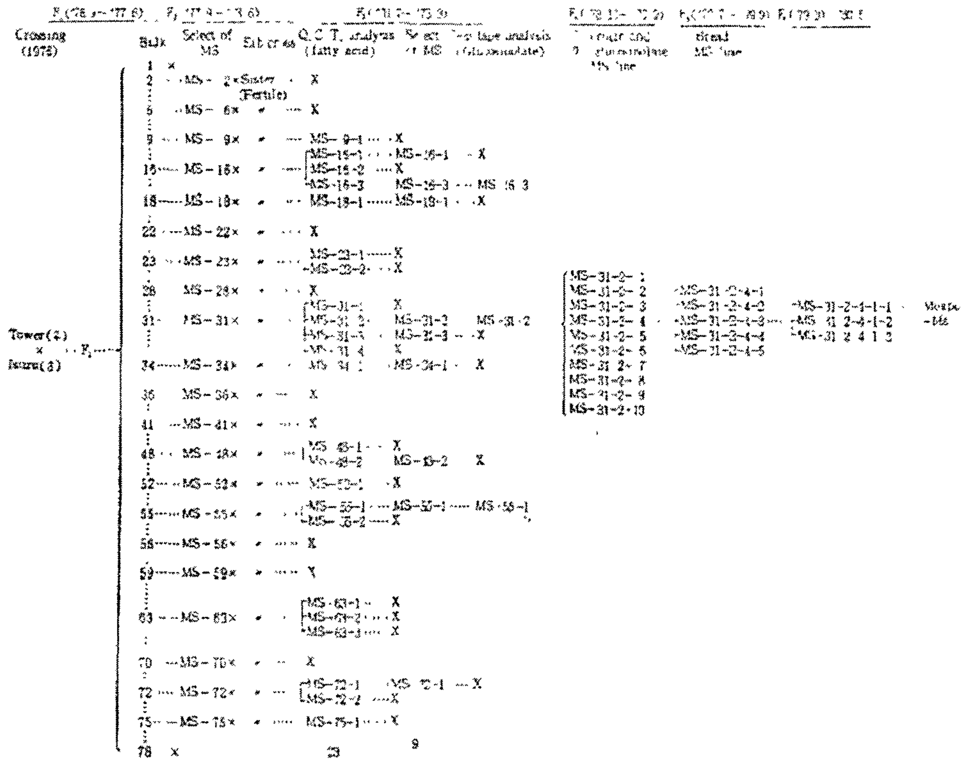


Fig 2. Pedigree of cytoplasmic -genetic male sterile line, Mokpo-MS.
Note : X mark shows discarded plant .

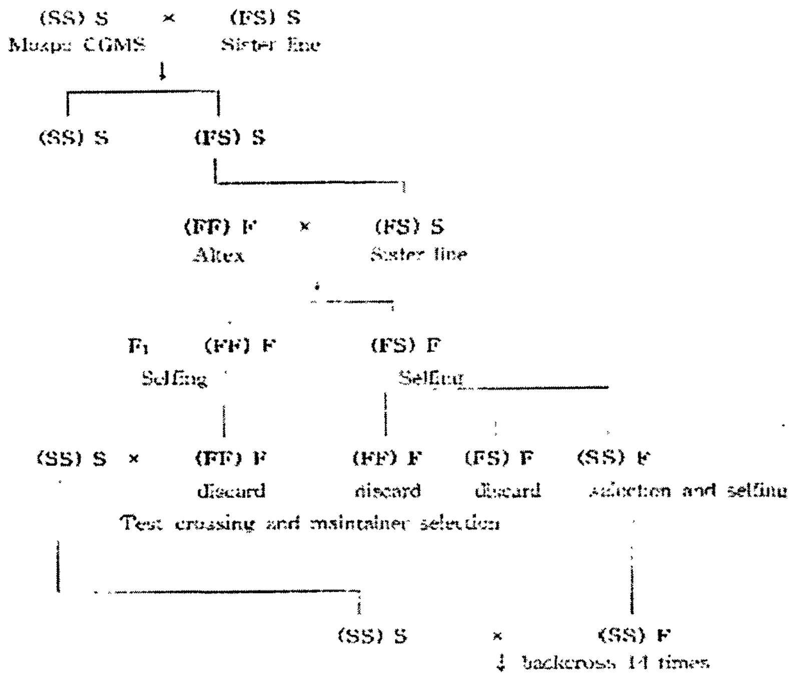


Fig 3. Breeding scheme of Mokpo-MS mantainer.

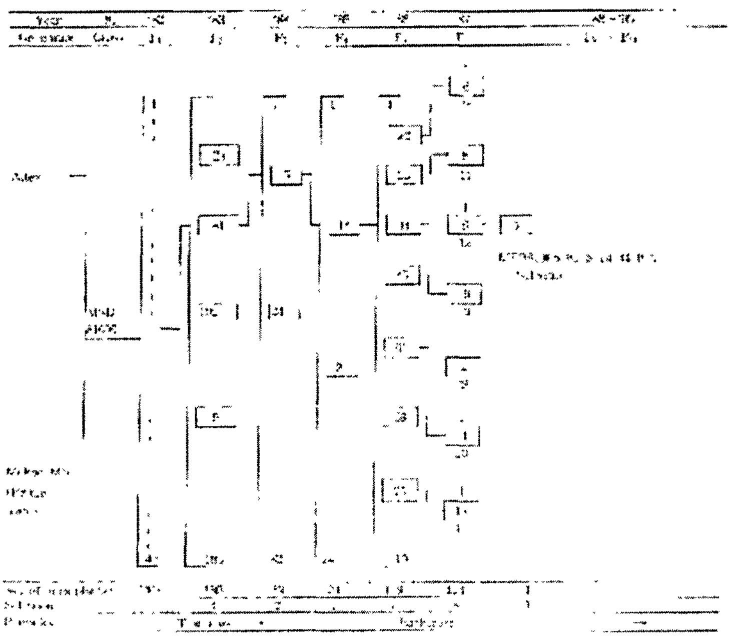


Fig 4. Pedigree diagram of male steaility-maintainer development.

Table 3. Comparison of the agrnomic characteristics between Mokpo MS and MS maintainer.

Line	Plant height	Flowering time	Mataring time
Mokpo MS	156±2.5	Feb. 10th±0.7	Apr. 5th±0.6
MS maintainer	152±2.8	Feb. 6th±0.8	Apr. 2th±0.5

Table 4. The effect of temperature on anther type of Mokpo MS, *pol*- MS and nap-MS limes in *Brassica napus* L.

MS lines	Temperature regimes (day/ night ℃)		
	22/16	26/20	30/24
Mokpo-MS	Sterile	Sterile	Sterile
pol - CMS	Sterile	Sterile	Partially sterile
nap - CMS	Sterile	Partially sterile	Fertile

As shown in Table 1 and 2, "Miyuki", "Asahi", "Yudal" and "Mokpo 11" varietiey shows a high yielding potential with ideal characteristics such as many branches and pods per ear and "Yongdang", "Nojeok", "Youngsan", "Naehan" and "Halla" varieties have a high yielding potential with an ideal plant type, lower erucic acid, and glucosinolate, and well adapted to Jeju island and southern parts of Korea. "Cheongpung" F_1 hybrid variety was characterized by a good oil and cake quality with lower erucic and glucosinolate variety along with extremely high productivity of 412kg/10a.

A cytoplasmic genetic male sterile line(MS) in rapeseed of which fertility is not restored under any temperature regimes and have the better quality of oil and oil cake was developed (Fig. 2) This MS line was found as a complete cytoplasmic-genetic male sterile having the quality of oil and oil cake were greatly improved by introducing zero-erucic acid and zero glucosinolate gene from Tower variety (Lee *et al.*, 1980).

Heterosis breeding system needs to develop male sterile(MS) line, MS -maintainer and restore line in order to increase commercial value of F_1 hybreed seeds. MS and restorer lines can be easily obtained in rapeseed, but MS- maintainer is difficult to breed artifically or to discover from germplasm. As shown in Fig. 3, 4. to develop perfect maintainer which can produce 100% male sterile plants, a cross between Altex (normal) cytoplasm and FF nuclear genotype) and fertile sister line of Mokpo MS (sterile cytoplasm and FS nuclear genotype) was made. It was difficult to select th line with normal cytoplasm and male sterile nuclear gene in F_2 plant to the Mokpo MS 14 times, a perfect maintainer generation because all phenotypes including heterozygous and homozygous types were expressed in the same plants and Mokpo MS line in order to select maintainer (Table 3 and 4). After back crossing the F_2 producing 100% male sterile plants was identified in progenies (Jang *et al.*, 2002).

To select maintainer plants of male sterility it was carried out to test cross between individual plants of F_2 population and MS line. Lines with perfect maintenance capability were abtained in progency generation. For the results of several times tested maintenance capability, it was identified as perfect maintainer with expressed 100% of male sterile plants.

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