

Breeding of winter and spring oilseed rape at Plant Breeding Company Strzelce Ltd.

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Abstract

Several decades of plant breeding activities, formerly in the Plant Breeding and Acclimatization Institute and currently in the Plant Breeding Company Strzelce Ltd. reflect both historical and modern trends and innovations of oilseed rape breeding. Oilseed rape breeding programs have been performed at two Breeding Divisions - Borowo and Malyszyn. The main objective of the programmes is to develop both open-pollinated varieties and hybrids. However, the further improvement of agricultural and market value of the offered varieties, which have to meet domestic and European Union seed market requirements, is associated with improvement and differentiation of quality characters, such as: oil, fiber and protein contents and fatty acid composition. Production of doubled haploids at our tissue culture laboratory allows to shorten breeding cycle and create genetically uniform lines, especially restorer lines needed for the ogura hybridization system. The paper aims at presentation of the recent breeding works.

Key words: Oilseed rape, *Brassica napus*, breeding programme, variety, breeding method, hybrids, genetic distance

Introduction

In Poland oilseed rape is recognized as the most important oil crop. Documented evidence of oilseed rape cultivation and breeding in Poland shows that *Brassica napus* L. was first introduced for cultivation in the 19th century. Before the Second World War total acreage of *B. napus* cultivation was only 56 000 ha. From 1945 to 1960's a small increase in rape production was observed, mainly as the result of total planted area increase – up to 100 000 hectares. In that period the average seed yield of oilseed rape was very low – ca. 1 t per hectare. By the mid-1960's, large-scale growing of rapeseed began, as its adoption into modern agricultural rotations resulted from the specialisation into intensive arable farming. Acreage of this crop increased five-fold by 1990's and has continued to rise, due to further improvements in genetics and breeding ("00" varieties), as well as crop agronomy (Table 1). Recently, Polish market needs for biofuel give the stimuli for cultivation of extra 2 000 000 hectares.

From 1951 to 2000 breeding of oilseed rape was performed at the Plant Breeding and Acclimatization Institute (PBAI). Since 2000 the breeding programmes for winter and spring oilseed rape have been continued at the Plant Breeding Company Strzelce PBAI Group (PBC Strzelce) at two Breeding Divisions – Borowo (since 1949) and Malyszyn (since 1978). The paper aims to present the results of the recent breeding works.

Table 1. Cultivation acreage, seed yield and production of oilseed rape in Poland.

Years	Cultivation acreage thousand ha	Average seed yield dt/ha	Production thousand tons
2000	436,8	21,9	958,1
2001	443,2	24,0	1063,6
2002	439,0	21,7	952,7
2003	426,3	18,6	793,0
2004	538,2	30,3	1632,9
2005	550,2	26,3	1450,0
2006	560,0	24,0	1500,0

Material and Methods

The winter and spring oilseed rape breeding material of both open pollinated forms and hybrids, as well as the breeding methods have been developed and elaborated in the PBC Strzelce Breeding Divisions at Borowo and Malyszyn. Double haploid lines (DH) have been produced in our laboratory and in cooperation with the Laboratory of Plant Tissue Culture at PBAI in Poznań (Cegielska-Taras et al., 2002, Cichy et al., 2005).

Results of yielding of winter and spring oilseed rape varieties and composite hybrids came from 40 and 8 locations, respectively, of Post-registration Trial Network (COBORU) from 2003-2005.

In 2006 a field trial with a set of restorer lines was conducted in two replications, on 10 m² plots in Borowo.

The investigation aimed at evaluation of genetic distance between 47 restorer and 31 CMS ogura winter oilseed rape lines was performed at PBAI in Poznań. Isolation of DNA from leaves of each line was made according to the modified

method by Doyle and Doyle (1990). The RAPD method with the use of 27 arbitrary 10-bp-long oligonucleotides as primers was used in analysis of the investigated lines (Williams et al. 1990).

Results & Discussion

New varieties

Winter open pollinated varieties bred at PBC Strzelce showed high yield potential during the period of testing in official trials (COBORU) (Table 2). The variety Bojan, registered in 2004, is characterized by high seed yielding and has good resistance to most important fungi diseases. Moreover, this variety has excellent winterhardiness, the trait which is very important in Polish and European climatic conditions.

Table 2. Seed yield of open pollinated varieties of winter oilseed rape in post-registration trials in Poland (COBORU). Years 2005, 2004, 2003.

Variety	Yield (% check)			
	2005 - 2003	2005	2004	2003
<i>Mean check, dt/ha</i>	<i>47.1</i>	<i>48.6</i>	<i>54.3</i>	<i>38.3</i>
Bojan	104	102	103	107
Bosman	95	96	99	90
Kana	101	-	94	107

Our research (Woś et al., 1998) showed that the average effect of heterosis with respect to the seed yield was 16% in comparison with the tester variety Lirajet. The authors stated that the best hybrids yielded about 40% higher than the tester. Four composite hybrids have been created as temporary forms offered to farmers before development of restored varieties. Due to high yielding and good adaptation to environmental conditions of the country they are popular and still grown in Poland (Table 3).

Table 3. Seed yield of winter composite hybrids of oilseed rape in post-registration trials in Poland (COBORU). Years 2005, 2004.

Variety	Yield (% of check)		
	2004 - 2005	2005	2004
<i>Mean check, dt/ha</i>	<i>47.1</i>	<i>48.6</i>	<i>54.3</i>
Kaszub F ₁	106	105	106
Lubusz F ₁	108	107	109
Mazur F ₁	107	107	106
Pomorzanin F ₁	108	109	106

Three open pollinated varieties of spring type bred at PBC Strzelce have recently been registered and successfully introduced into practical farming (Table 4).

Tab. 4. Seed yield of spring varieties of oilseed rape in post-registration trials in Poland (COBORU). Years 2004-2005.

Variety	Pedigree	Yield (% of mean check=100%)		
		2004	2005	2004 - 2005
Huzar	Maluka×Cyclone	98	105	102
Markiz	J0445-13×Global	104	106	105
Bios	J0448-16×Star	105	107	106

Breeding of ogura restorers

Breeding programme for the development of hybrids started in 1995. From the beginning the most important task of the programme was selection of double low restorer lines because the content of glucosinolates in the initial breeding material was 60 µM/g. As the result of special cross-combination and using both traditional pedigree method and production of double haploids it was possible to find desired genotypes. During several years of single plant isolation we have improved effectiveness of restorer selection (Table 5). Recent advances in the restorer selection have allowed the further breeding progress resulted in seed yield improvement (Table 6).

Genetic distance of CMS and restorer lines

To remain internationally competitive, breeders of the PBC Strzelce initiate appropriate research and breeding cooperation with public and private organizations. One of the most promising projects aiming at enhancement of the development of hybrid components is currently underway in cooperation with Oilseed Crop Division of PBAI in Poznan. The main task of this project is to find components (CMS and restorer lines) for the best hybrids basing on the genetic distance analysis. The strategy is expected to reduce cost of production of new hybrids.

Tab. 5. Effectiveness of selection of winter oilseed rape restorer lines with the pedigree and double haploid method. Borowo 2002 – 2006.

Selection year	Method of selection	Number of single plants	
		sown with gene restorer	fertile, homogeneous
2002	pedigree	1260	24 (1,9 %)
2003	pedigree	1076	23 (2,1 %)
2004	pedigree	2323	95 (4,1 %)
2005	pedigree	930	92 (9,9 %)
	double haploid	30	30 (100%)
2006	pedigree	998	91 (9,1%)
	double haploid	60	60 (100%)

Tab.6. Yielding of restorer lines in comparison to the check open-pollinated variety Californium. Borowo 2006.

Restorer line	Yield dt/ha	% of check (Californium)
359RJ DH-10	42,30	100,7
<i>Californium - check</i>	42,00	100,0
359RJ DH-14	35,24	83,9
MR 10-3-2-5-3	34,93	83,2
301RJ-12	32,70	77,9
300RJ-6	32,32	77,0
358RJ-8-6	32,09	76,4
277R-1-4-1	30,99	73,8
89RJ-5-13-7	30,93	73,6

Figure 1 shows the dendrogram of genetic distance among 47 restorer and 31 CMS ogura winter oilseed rape lines. The clustering differentiated three groups of CMS lines. Group A consists of the most different genotypes. The lines of this group: MS 83, MS 65, MS 171, MS 108 are very good components of hybrids. Group B and group C are less or more genetically similar. Moreover, the clustering separated three groups of restorers: two groups of lines bred at PBAI in Poznan with using of a winter restorer genotype. The third group of restorers has been bred in the PBC Strzelce Breeding Divisions at Borowo on the basis of spring genotype as the source of restorer gene. Hasan et al., (2006) found similar genetic diversity between winter and spring forms in the *Brassica napus*.

Our research results on genetic diversity of ogura components are used in practical breeding work.

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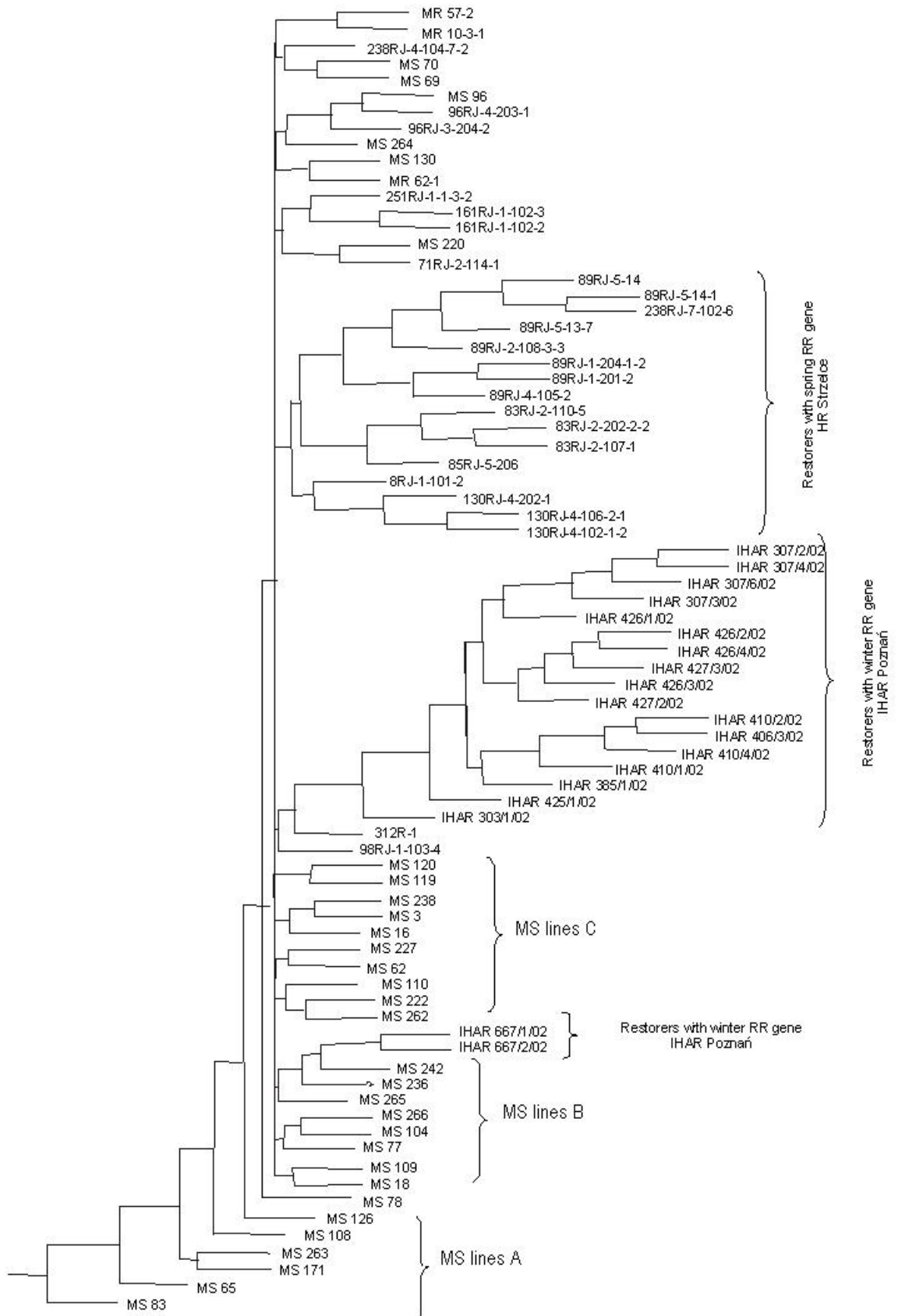


Fig. 1. Cluster dendrogram of genetic distance of 47 restorer and 31 CMS ogura lines of winter oilseed rape.