Development of resynthesised rapeseed forms with low erucic acid character and their use in hybrid breeding

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Abstract

Resynthesised (RS) forms of rapeseed (*Brassica napus* L.; genome AACC, 2n = 38) generated from interspecific crosses between its diploid progenitors *Brassica rapa* L. (syn. *campestris*; genome AA, 2n = 20) and *Brassica oleracea* L. (CC, 2n = 18) are getting interest in the development of rapeseed hybrids. Intensive breeding work during the last hundred years led to the narrow genetic base in this crop species. At the beginning the traditional quality of present rapeseed cultivars limited the use of rapeseed as plant oil. But the discovery of low erucic acid mutants in the cultivars Liho and Oro and the low glucosinolate character was found in the gene pool of rapeseed and transferred to other cultivars via crossing and backcrossing. During the screening of *Brassica* species *B. oleracea* genotypes with low erucic acid character were selected. The aim of this work is to develop 0-quality rapeseed forms over interspecific crosses with 00- *B. rapa* forms. We know that the low yield capacity of RS lines limits their use in yield breeding. On the other hand, the *B. oleracea* and *B. rapa* genotypes used in this study are winter forms. Rapeseed hybrids using RS-lines were developed before, but they were RS-lines with spring character and traditional fatty acid composition. At the end of this study 0-quality RS-lines will be developed via interspecific crosses and it will be the first time that rapeseed hybrids based on RS-lines will be developed using 0-ality RS-lines. These developed hybrids will further be tested for their yield capacity at field conditions.

Key words: *Brassica napus* – resynthesised rapeseed – hybrid breeding

Introduction

The gene pool of oilseed rape breeding material has been considerably narrowed by the emphasis on specific quality traits, genetic variability is restricted with regard to many valuable characters. On the other hand the development of synthetic *Brassica napus* forms provides important basic germplasm for further improvements of seed yield, disease and pest resistance as well as relevant seed quality traits (Chen & Heneen 1989a, Lühs et al. 2002).

Regarding seed quality traits some examples of introgression breeding are documented, such as the resynthesis approach to create new genetic variation for low glucosinolate content (Giland 1982, Raney & Rakow 1995), the approaches developing of yellow-seeded rapeseed *via* interspecific crosses (Chen et al. 1988, Chen & Heneen 1992, Rashid et al. 1994, Meng et al. 1998, Rahman 2001) and the development of quality RS lines (Seyis et al., 2005; Lühs et al., 2003).

Experiments were conducted by Chen & Heneen (1989b), Heath & Earle (1995, 1997), Rahman et al. (1996), Lu et al. (2001) and Rahman (2002) using interspecific *Brassica* hybridization in order to modify the fatty acid composition of oilseed rape. We know, that current double-low breeding material seems to be closely related and intensive quality breeding - using ‘Liho’/‘Oro’ and ‘Browinski’ spring rapeseed as unique donors for quality improvement - has also contributed to narrow the genetic base of oilseed rape. Using zero-erucic *B. oleracea* mutants (Lühs et al. 2000) resynthesised *B. napus* were developed to provide novel genetic resource for both quality and yield improvement of oilseed rape (Seyis et al., 2005).

Furthermore, the potential for hybrid rapeseed cultivars is well documented (Schuster and Michael, 1976; Semyk & Stefansson, 1983; Grant & Beversdorf, 1985; Lefort-Buson, 1987; Brandle & Mc Vetty, 1989). For this aim different pollination systems were developed (Buzza, 1995). CMS-systems (cytoplasmatic male sterility systems) like the Ogu/INRA CMS-System (Renard et al., 1997), and the MSL-System (male sterility system) (Paulmann & Frauen, 1998).

As oilseed rape breeders today are seeking for genetic diversity in their hybrid breeding programmes resynthesised *B. napus* (RS lines) forms are gaining interest (Lühs et al., 2002; Girke, 2002; Seyis, 2003). However, because of the low yield potential of RS lines their use is more directed to develope semi-synthetic rapeseed forms (cf. Kräling, 1987; Friedt et al., 2003) or backcross breeding procedures to introgress the novel genetic diversity.

The present work deals with the development of quality resynthesised rapeseed forms using 00-*B. rapa* forms and low erucic *B. oleracea* mutants and their use in developing rapeseed hybrids. This project is an ongoing project at it’s beginning and therefore we will present some results and the main object of this project.

Materials and Methods

Individual zero-erucic *B. oleracea* plants belonging to the three accessions ‘Kashirka 202’ and ‘Ladozhskaya’ (Lühs et al. 2003, 2000; Seyis, 2004) and Eisenkopf were crossed with different *B. rapa* quality types, namely ‘15080’ and ‘15591’, kindly provided from the Institute of Crop Science and Plant Breeding I, Justus-Liebig-University. The fatty acid composition of this material is shown in Table 1.
The efficiency of interspecific crosses (Fig. 1) will be aided by embryo rescue protocols as described earlier (Lühs & Friedt, 1994; Seyis et al. 2005). Cuttings from obtained hybrids will be treated with colchicine in order to obtain amphidiploid B. napus plants (C₀) and will be then artificially vernalised for 8 to 10 weeks at 5 °C.

![Fig. 1: In ovulum method in producing resynthesised B. napus (Seyis et. al, 2005)](image)

**Results**

As described earlier the fatty acid composition of used material can be seen in Table 1. These values were determined in seed samples of these genotypes.

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Oleic</th>
<th>Linoleic</th>
<th>Linolenic</th>
<th>Erusic</th>
</tr>
</thead>
<tbody>
<tr>
<td>PI 263058 Kashirka</td>
<td>61,6</td>
<td>19,2</td>
<td>11,4</td>
<td>0,5</td>
</tr>
<tr>
<td>PI 263072 Ladozshkaya</td>
<td>62,6</td>
<td>18,6</td>
<td>9,7</td>
<td>0,2</td>
</tr>
<tr>
<td>PI 246111 Eisenkopf</td>
<td>46,5</td>
<td>32,1</td>
<td>11,5</td>
<td>0,1</td>
</tr>
<tr>
<td>00-15991 B. rapa</td>
<td>56,89</td>
<td>22,03</td>
<td>16,34</td>
<td>0,00</td>
</tr>
<tr>
<td>00-15080 B. rapa</td>
<td>55,43</td>
<td>28,33</td>
<td>16,23</td>
<td>0,00</td>
</tr>
</tbody>
</table>

Therefore seeds of these genotypes were directly sown in pods and were vernalised as described before. Unfortunately, the B. oleracea genotypes Kashirka and Ladozshkaya did not flower and all plants from the B. rapa genotype 00-15591 died during vernalization. Therefore, only crosses could be made with Eisenkopf and 00-15080 (Table 2). In this table only obtained immature pods and transferred ovules are given in numbers. Only one plant were obtained from the crosses 00-15080 x PI 246111. This plant were multiplicated using cuttings and will be now vernalized under defined conditions.

**Discussion**

Resynthesised rapeseed forms were developed earlier (Lühs et al., 2003; Seyis et al., 2005). But because of the high glucosinolate content of the B. oleracea parents the developed hybrids showed mainly 0+-quality.

The B. rapa genotypes used in this work display both glucosinolate contents of 2-3 μmol. Of course, the developed RS-lines will have high amounts of glucosinolates, but if they were used in developing rapeseed hybrids, we hope to reduce this character for a further extent.

<table>
<thead>
<tr>
<th>Crossing combination</th>
<th>Immature pod</th>
<th>Obtained ovules</th>
</tr>
</thead>
<tbody>
<tr>
<td>PI 246111-4 x 15080-16</td>
<td>17</td>
<td>406</td>
</tr>
<tr>
<td>PI 246111-6 x 15080-16</td>
<td>25</td>
<td>498</td>
</tr>
<tr>
<td>15080-3 x PI 246111-9</td>
<td>7</td>
<td>36</td>
</tr>
<tr>
<td>15080-4 x PI 246111-9</td>
<td>18</td>
<td>139</td>
</tr>
<tr>
<td>15080-5 x PI 246111-9</td>
<td>22</td>
<td>165</td>
</tr>
<tr>
<td>15080-7 x PI 246111-9</td>
<td>15</td>
<td>133</td>
</tr>
<tr>
<td>15080-10 x PI 246111-9</td>
<td>21</td>
<td>139</td>
</tr>
<tr>
<td>15080-11 x PI 246111-9</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td><strong>Totally</strong></td>
<td><strong>128</strong></td>
<td><strong>1522</strong></td>
</tr>
</tbody>
</table>

**Conclusions**

RS-lines were used before in the development of rapeseed hybrids (Seyis et al., 2003; Girke, 2002). But the used RS-lines were either spring forms or have traditional quality characters. In our case, we hope to develop RS-lines with both winter character and low erucic acid content to use them in the development of rapeseed hybrids.

The traditional seed quality of resynthesised B. napus is limits often the broad use of this novel gene pool in modern double-low rapeseed (canola) breeding programmes. With the development of above described genotypes we hope to
overcome this problem.

Acknowledgements

TUBITAK (Türkiye Bilimsel ve Teknolojik Araştırma Kurumu = The Scientific & Technological research Council of Turkey) is funding this work. The authors thank Institute of Crop Science and Plant Breeding I, Justus-Liebig-University for providing seed material.

References


