Molecular marker application in breeding of self- and cross- compatible sweet cherry (P. avium L.) varieties

Gunārs Lācis,
Silvija Ruisa, Irita Kota
Introduction

- Sweet cherry (Prunus avium L.) collection at the Latvia State Institute of Fruit-Growing (135 accessions):
  - advanced cultivars,
  - semi-wild samples,
  - landraces,
  - diverse germplasm from the northern temperate zone.
Introduction

- **Need for self-compatibility information:**
  - All commercial cultivars of sweet cherries grown in Latvia are known to be self-incompatible. Commercial sweet cherry orchards need suitable pollinators to ensure fertilization and subsequent fruit development.

- **Developing of self-fertile cultivars:**
  - Winterhardy enough at our country
  - Breeding programme - crossing cultivars - Sf gene donors with winterhardy local or introduced cultivars.
**Gametophytic incompatibility system**

- mono-factorial, multiallelic (16 alleles (Tobutt et al 2004))
- governed by a single S locus
- if a pollen S-allele matches the S-alleles of the pistil, the growth of the pollen tube is arrested in the style inhibiting fertilization.
Molecular markers vs. traditional approaches

- **Traditional approaches**
  - Crossing experiments with following cytoembryological assessments of the pollen tube growth within the style
  - **Drawbacks:**
    - necessity of flowering plants
    - time consuming
    - depending on weather during blooming

- **Molecular markers**
  - Allele specific markers:
    - Detection during juvenile period
    - Independence from weather conditions
S (self-incompatibility) gene marker

Marker system 1

Degenerate PCR primer pairs developed by Wiersma et al. (2001)

Marker system 2

Determination of alleles 1 to 6

S-RNase allele specific PCR primer pairs developed for each allele (S1 to S6) by Sonneveld et al. (2001)
Marker system 3

Determination of allele $S4'$ (self- compatibility)

S-RNase allele specific PCR primer pairs developed for allele ($S4'$) by Zhu et al. 2004
Applications

- Screening of genetic resources collection:
  - Detection of compatibility groups
  - Detection of self-compatibility donors

- Introduction of markers in breeding:
  - Testing and selection of potential parents
  - Testing of hybrids
Results:

- **56 varieties screened**
  
  *(Lacis et al. 2008)*

### Table 1: S-alleles identified in accessions of the Dobele HPBES sweet cherry collection

<table>
<thead>
<tr>
<th>No</th>
<th>Accession name</th>
<th>Origin</th>
<th>S-allele</th>
<th>Incompatibility group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Agris</td>
<td>LC</td>
<td>S₃S₂</td>
<td>I</td>
</tr>
<tr>
<td>2</td>
<td>AM-10-12-6</td>
<td>LC</td>
<td>S₃S₅</td>
<td>V</td>
</tr>
<tr>
<td>3</td>
<td>AM-10-6-12</td>
<td>LC</td>
<td>S₄S₃</td>
<td>II</td>
</tr>
<tr>
<td>4</td>
<td>AM-24-10-22</td>
<td>LC</td>
<td>S₄S₄</td>
<td>IX</td>
</tr>
<tr>
<td>5</td>
<td>AM-28-6-7</td>
<td>LC</td>
<td>S₅S₅</td>
<td>V</td>
</tr>
<tr>
<td>6</td>
<td>Balzams</td>
<td>LC</td>
<td>S₅S₅</td>
<td>VIII</td>
</tr>
<tr>
<td>7</td>
<td>Brjanskaja Rozovaja</td>
<td>RC</td>
<td>S₅S₆</td>
<td>VI</td>
</tr>
<tr>
<td>8</td>
<td>Drogon’s Gelbe</td>
<td>EO</td>
<td>S₃S₅</td>
<td>XIV</td>
</tr>
<tr>
<td>9</td>
<td>Elfrida</td>
<td>LC</td>
<td>S₅S₆</td>
<td>XV</td>
</tr>
<tr>
<td>10</td>
<td>Kati</td>
<td>EC</td>
<td>S₄S₅</td>
<td>VII</td>
</tr>
<tr>
<td>11</td>
<td>Meelika</td>
<td>EC</td>
<td>S₄S₆</td>
<td>XVII</td>
</tr>
<tr>
<td>12</td>
<td>PU-13629</td>
<td>PU</td>
<td>S₅S₆</td>
<td>XX</td>
</tr>
<tr>
<td>13</td>
<td>PU-13802</td>
<td>PU</td>
<td>S₅S₆</td>
<td>XXV</td>
</tr>
<tr>
<td>14</td>
<td>PU-14419</td>
<td>PU</td>
<td>S₅S₆</td>
<td>XV</td>
</tr>
<tr>
<td>15</td>
<td>PU-14421</td>
<td>PU</td>
<td>S₃S₅</td>
<td>V</td>
</tr>
</tbody>
</table>
Screening of genetic resources collection

Results:

* Allele frequencies calculated from S-allele identification data published by Tobutt et al. (2004)

The S-allele frequencies published for over 250 sweet cherry cultivars from Western and Southern Europe.
Screening of genetic resources collection

Results:

* Allele frequencies calculated from S-allele identification data published by Tobutt et al. (2004)
The S-allele frequencies published for over 250 sweet cherry cultivars from Western and Southern Europe.
Screening of genetic resources collection

- Further applications:
  - as accession descriptor
  - planning of crosses
  - for conservation of alleles
  - population genetics studies
  - practical fruit growing
Introduction of markers in breeding

Parents:
‘Lapins’ (self-fertile)
‘Iputj’ (winterhardy)

Progeny:
IxL (I) (S4’)
IxL (II) (S4’)
IxL (III)
IxL (IV) (S4’)
IxL (V)
Thank you for your attention!