TRANSFER OF DISEASE RESISTANCE FROM 
BRASSICA CAMPESTRIS L. TO RAPE (B. NAPUS L.)

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SUMMARY

Resistance to clubroot race 3 was successfully transferred from the Flemish turnip variety Waaslander to rape variety Nevin by the production of the fertile species B. napocampestris followed by back-crossing to Nevin. The recovery of the recurrent parent type appears to be very rapid, necessitating possibly only two generations of backcrossing.

INTRODUCTION

Clubroot disease caused by the fungal pathogen Plasmodiophora brassicae Wor. is widespread and can cause serious losses in brassica crops. Rape and swede (both forms of B. napus) are often severely attacked. The rape variety Nevin, bred at the Welsh Plant Breeding Station, carries resistance to races 1, 2 and 4 (JOHNSTON, 1968 and 1970). However, there are isolates of the disease which can attack Nevin severely. These are classed as race 3 by JOHNSTON, but may in fact be divisible into more than one pathotype by use of an extended list of differential genotypes.

Certain turnip genotypes show resistance to all four races, but complete resistance has not been found in B. napus by the author. The two species intercross freely and the transfer of genetic information from B. campestris is a practical possibility. The alternative procedure, to synthesize B. napus (2n = 38, AACC) from B. campestris (2n = 20, AA) crossed with B. oleracea (2n = 18, CC), is recognised to be very difficult. If accomplished it would necessitate much further breeding to improve the unadapted synthetic. Therefore, the procedure adopted was the production of the artificial species B. napocampestris followed by backcrossing to recover the desired recurrent parent type.

PROCEDURE

Flower buds of a small population of Nevin were emasculated and immediately pollinated with pollen from the Flemish turnip variety Waaslander, previously shown to possess the desired resistance to race 3 plus resistance to races 1, 2 and 4 as in Nevin. As a result of these pollinations, siliquae containing numbers of seed approximating normal were obtained. Some of the seed was used for artificial inoculation tests with race 3 inoculum derived from Nevin (JOHNSTON, 1968). The hybrids showed immunity to the symptoms of the disease although Nevin itself showed 100% infection.

The remainder of the F₁ seed was germinated and treated with colchicine as soon
as the cotyledons were expanded. Application consisted of one drop per day of 1% aqueous solution applied in the axil of the cotyledons for 4-5 days according to the apparent reaction of the seedlings. A number of plants grown from treated seed developed into plants with visible symptoms of chromosome doubling and produced large quantities of viable pollen. Chromosome numbers were not counted, but these *B. napocampestris* plants have been now maintained through a number of generations and remain stable.

The progenies of the chromosome doubled plants after selfing were examined for agronomic performance. Although highly resistant to the disease, their yield potential appeared to be inadequate. They were also very susceptible to mildew (*Erysiphe cruciferarum*). A number of them were, therefore, backcrossed to Nevin. In some instances seed set was about 50% normal.

The first backcross progenies were again tested for resistance to race 3, and those with resistance self-pollinated and again backcrossed to Nevin. Tests on the self progenies and the second backcross gave the following results.

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<th>Resistant</th>
<th>Susceptible</th>
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<td>First backcross self progenies</td>
<td>536</td>
<td>131</td>
</tr>
<tr>
<td>Second backcross plants</td>
<td>70</td>
<td>109</td>
</tr>
<tr>
<td>Nevin</td>
<td>0</td>
<td>15</td>
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The selfed progenies of the first backcross show some morphological variability, but the second backcross progenies are virtually identical with the recurrent parent. Further backcrossing should be readily possible, but in view of the already close similarity to Nevin, it is proposed to select for homozygosity in the progenies of this generation and conclude the breeding programme at this point.

DISCUSSION

Interspecific hybridization for the transfer of resistance into swede cultivars was described by Lammerink (1970). The present procedure differs mainly in that the fully fertile artificial amphiploid species *B. napocampestris* (*2n* = 58 AAAACC) is created as an intermediate step. This can be maintained indefinitely and studied before use in the backcrossing programme. It may itself prove useful, and there is no problem in the production of progenies by backcross to *B. napus*. Undoubled hybrids may be very highly sterile (McNaughton, 1973), and complete or partial loss of its C genome appears to be more probable.

In the programme described, two generations of backcrossing were carried out without difficulty and at this stage the progenies were indistinguishable from Nevin, the recurrent parent. A small number of chromosome counts carried out by the Cytology Department of the Station showed a normal *B. napus* complement in these progenies. Further backcrossing could readily be carried out if considered necessary to achieve even closer identity with the recurrent parent.

The method proves well adapted to the transfer of a readily identifiable major factor such as the resistance to race 3. Transfer of a number of major genes could also be achieved, preferably by carrying separate populations for each gene and combining at the end of the backcross series.