THE PRODUCTION OF ALIEN MONOSOMIC ADDITIONS IN BETA VULGARIS AS A SOURCE FOR THE INTROGRESSION OF RESISTANCE TO BEET ROOT NEMATODE (HETERODERA SCHACHTII) FROM BETA SPECIES OF THE SECTION PATELLARES

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SUMMARY

Experiments were carried out for adding the chromosome carrying resistance to beet root nematode (Heterodera schachtii) from the wild Beta species of the section Patellares (B. procumbens, B. webbiana and B. patellaris) to the genome of B. vulgaris. Preliminary experiments indicated that crosses between the wild species and B. vulgaris cultivars of the mangold type yielded on average more viable F1 hybrids than crosses with sugar and fodderbeet. However, crossability varied strongly between individual parental combinations. It was concluded that most types of B. vulgaris can be hybridized with the wild species of the section Patellares if a sufficient number of pair-crosses is made. Crosses between diploid cultivars or species of the section Vulgares and diploid wild species of the section Patellares yielded many hybrids which, however, were highly sterile. From crosses between tetraploid B. vulgaris and the wild species a great number of viable allotriploid and allotetraploid hybrids was obtained. In the backcross progenies of allotriploid hybrids 26% alien monosomic additions occurred, of which 4.1% carried the resistance bearing chromosome of B. procumbens or B. patellaris. The programme will be continued by screening progenies of the resistant monosomic addition plants for the occurrence of resistant disomic introgression products.

INTRODUCTION

Since 1937 many crossing experiments have been carried out for the transmission of resistance to beet root nematode (Heterodera schachtii Schm.) from the Beta species belonging to the Patellares section, B. procumbens Chr. Sm. (2n = 18), B. webbiana Moq. (2n = 18) and B. patellaris Moq. (2n = 36), into B. vulgaris L. Coons (1975) and Savitsky (1975) presented extensive reviews of the literature dealing with this subject. The resistance is based on one dominant gene (Savitsky & Price, 1965) or is conditioned by three closely linked genes (Yu, 1977).

Transmission of the resistance into B. vulgaris is hampered mainly by two obstacles. First, the majority of the hybrids that arise from interspecific hybridization suffer from root necrosis and generally die in the seedling stage. Kuzdowicz & Szota (1973) studied deficient hybrids anatomically, but did not observe any changes in the roots that could explain the reason of the deterioration. Johnson (1956) developed a grafting
method for obviating the poor growth of the hybrid seedlings, however, the method
did not give the essential solution. Half of the grafts reached the flowering stage, but
the BC₁ seedlings also had an impaired root system. Grafting experiments at the Foun-
dation for Agricultural Plant Breeding with *B. vulgaris × B. procumbens* seedlings
failed through insufficient fusion between grafts and rootstock (CLEY & DE BOCK,
1968, pers. comm.).

The second main obstacle for gene transmission is that in such hybrids pairing of
alien chromosomes is a rare event. Nagl (1969) and Walia (1970) observed sporadic
association of alien chromosomes in pachytene of *B. vulgaris × B. procumbens* and
*B. vulgaris × B. webbiana* hybrids respectively. However, the scarce viable BC₁ prod-
ucts obtained from such crosses were invariably of the *B. vulgaris* type without exotic
characters (Johnson & Wheatly, 1961), except for occasionally occurring triploids,
generated through restitution (Bosemark, 1969; Oldemeyer, 1970).

Savitsky (1978) obtained viable allotriploid products from crosses between one
*B. vulgaris* accession and *B. procumbens*. Through backcrossing the resistance bearing
chromosome was added to the *B. vulgaris* chromosome complement. After numerous
additional backcross and extensive screening procedures three disomic plants, true
breeding for resistance, were obtained.

In 1974 a programme was started at the Foundation for Agricultural Plant Breeding
to achieve a number of resistant alien monosomic additions, based on a broad genetic
and plasmatic variation. Such monosomic additions will be used as a source for stable
resistant introgression products, effected through allosyndetic pairing.

**MATERIAL AND METHODS**

The plant material consisted of various types of *B. vulgaris*, five other species of the
section *Vulgares* and several accessions of the three wild *Beta* species. The mangold
and Swiss chard material consisted of ancient landraces of various types and were
supplied by the Government Seed Testing Station at Wageningen. The sugarbeet and
fodderbeet material as well as the wild species were taken from our breeding collection,
the latter originally obtained from the USA, USSR and DDR. The accession Gr.
5622 was kindly furnished by Drs W. Heijbroek of the Institute for Rational Sugar
Production (IRS), Bergen op Zoom, the Netherlands, and originated from the material
described as Turkish wild beet, *B. vulgaris* spp. *maritima* (Savitsky, 1960a). The 4x
cytotype of this material was achieved by Drs Heijbroek through colchicine treatment.

In a series of space-isolated pair-crosses, crossability of the different diploid *Beta*
forms with the three wild species was tested. On account of results in the literature,
the majority of the crosses was made with mangold and Swiss chard as seed parents.
To a lower extent crosses were made with fodder and sugarbeets. Synchronous flower-
ing was achieved by an adapted temperature regime during the raising of the crossing
partners. All seed parents were harvested individually. In addition seed was harvested
from bagged inflorescences for maintaining the genotype of the seed parents. Progenies
were screened in the seedling stage for the presence of hybrids, recognizable by narrow,
red spotted leaves and stunted growth. Hybrids were denoted as viable when they
reached the flowering stage.

To achieve allopolyploid hybrid material pair-crosses were made in a similar way be-