Development of yellow-seeded *Brassica napus* in Siberia

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ABSTRACT

The development of yellow-seeded summer cultivars of *Brassica napus* is a high priority for the Oilseed Breeding Program of Siberia. All cultivars of *B. napus* currently grown in Russia are black-seeded. Research towards the development of yellow-seeded *B. napus* has been conducted at the Siberian Institute of Fodder Crops since 1987. The research was concentrated on the character of the yellow seed coat, the seed yield, and stability to the extreme climatic conditions of Siberia. Interspecific hybridization and inbreeding have been utilized as major methods. *In vitro* propagation was used to accelerate breeding of the most valuable selected forms. A range of yellow-seeded interspecific hybrids and inbred lines has been developed up to the present. Several prospective inbred lines were tested from 1999 to 2002. The average oil, protein and carbohydrate contents of the new SNK-32 line exceeded the corresponding values of a black-seeded standard check cultivar SibNIIK 198 by 7%, 7% and 31%, respectively, while the fibre content was 19% lower and the seed yield was 47% higher.

Key words: *Brassica napus* – canola - yellow seed – interspecific hybridization – inbreeding

INTRODUCTION

The development of yellow-seeded forms has been proposed as a means to improve the quality of the canola meal by reducing fibre and increasing protein content. Yellow seeds of *B. napus* may have 2.6 and 5.0% more oil and protein, respectively, than black seeds (Shirzadegan and Röbbelen 1985; Liu et al. 1991). Meal from light-pigmented genotypes of rapeseed may have 3.0-4.0% lower fibre content than meal from their dark-pigmented counterparts (Shirzadegan and Röbbelen 1985). In addition, it is much easier to determine the degree of ripening in the yellow seeds, as the occurrence of chlorophyll is not masked by the dark seed coat (Jönsson 1977). However, in *B. napus*, only dark-pigmented types occur naturally. Different strategies have been developed worldwide to transfer the "yellow seediness" character from other *Brassica* species to *B. napus*. Yellow-seeded forms of *B. rapa*, *B. juncea* and *B. carinata* were utilized in various crossing combinations (Shirzadegan and Röbbelen 1985; Racow et al. 1999; Rahman 2001).

All cultivars of *Brassica napus* currently grown in Russia are black-seeded. Research towards the development of yellow-seeded *B. napus* has been conducted at the Siberian Institute of Fodder Crops (Novosibirsk, West Siberia) since 1987. General approach included interspecific hybridization and the inbreeding of the heterozygous material as a method of genotypical differentiation. Up to the present, a number of inbred lines with different seed coat colour, have been created (Fig. 1) (Osipova 1995; Potapov and Osipova 2000). Here we report selected results of this work.

MATERIALS AND METHODS

Brassica napus variety Andor, Regent, SibNIIK 198 and yellow-seeded or light-pigmented genotypes of *B. campestris* (cv. Vostochnaya, Candle, Tobin), *B. juncea* (line 13H-11 from All-Russia Research Institute of Oil Crops, VNIIMK, and line 21 from All-Russia Institute of Plant Industry, VIR), *Sinapis alba* (line 13H-162 from VNIIMK and line 24 from VIR) have been employed as materials for interspecific crosses. Seventy-two cross combinations were made from 1993 to 1995.

Fig. 1. Variation of seed coat colour in the developed *B. napus* lines

The inbreeding was conducted in combination with selections on varieties of summer rapeseed Agat, Regent, Salut, forms ww-312, ww-428, ww-1583, ww-1586, ww-1591 from Svalöf AB, and our breeding material.

Plants were grown, crossed and selfed by usual techniques.

RESULTS AND DISCUSSION

The yellow seed coat character was transferred from other *Brassica* species through reciprocal interspecific crosses. The success of interspecific crosses substantially depends on relationship between *Brassica* species according to the triangle of U. The greatest amount of seeds was received from crossing *B. napus* and *B. campestris*. 12.5 to 19.0% of the hybrid seeds which resulted from this combination were well developed. The most successful crosses were where *B. napus* was used as female.

The research on the creation of new lines was concentrated on the character of the yellow seed coat, the seed yield, and stability to the extreme climatic conditions of Siberia. The selections were most effective in inbred populations No. 109, 39, 14/162 and 283 (Table 1).

Table 1. Variation of seed coat colour (% yellow seeds per plant) in different *B. napus* inbred lines

Lines	Pedigree	Generation of inbreeding	Plants (n)	Coefficient of variation (%)	Limits of coefficient of variation
No. 109	ww-1591	6	20	6.6	2.9-8.4
No. 39	ww-1591	6	28	2.4	0.0-7.2
No. 14/162	Andor x Candle	4	25	80.8	63.2-103.4
No. 283	ww-1588	4	18	42.9	32.5-51.7

The development of genetically stable yellow-seeded forms is limited by allotetraploidy, the complex genetic system of seed coat colour, and maternal effects (Jönsson 1977; Shirzadegan 1986; Van Deynze et al. 1993; Potapov and Osipova 2000; Somers et al. 2001). The inbreeding selection program made it possible to obtain, starting from the sixth generation of inbreeding, practically stable yellow-seeded lines in summer rapeseed.

In the initial stages of the breeding work, most yellow-seeded forms of *B. napus* exhibited low yields and low vitality. In order to accelerate breeding of the most valuable forms, *in vitro* propagation was used. This method made it possible to increase the number of seeds per plant by 89% and thus to increase the efficiency of selection of the character of the yellow seed coat.

The research on variability of the new lines, conducted from 1995 to 1998, has demonstrated that the selection of the yellow-seeded forms, with higher value of quantitative characters than for the black-seeded forms, is possible. Six prospective inbred lines, out of

1314, were selected for breeding of yellow-seeded cultivars of *B. napus*. These lines were tested from 1999 to 2002 (Table 2). All these lines demonstrated high productivity, early maturing and enhanced disease resistant. The average oil, protein and carbohydrate contents of the new SNK-32 line exceeded the corresponding values of a black-seeded SibNIIK 198 cultivar by 7%, 7% and 31%, respectively; the fibre content was 19% lower and the seed yield was 47% higher.

Table 2. Average seed yield and oil and protein content in the seeds of prospective lines of *Brassica napus* canola

Lines	Seed yield (1999-2002)		Oil content (1999-2000)		Protein content (1999-2000)	
	Average (tons/ha)	Rel. to standard	Average (%)	Rel. to standard	Average (%)	Rel. to standard
SibNIIK 198[1]	2.67	100	44.5	100	25.3	100
SNK-32	3.92	147*	47.5	107*	27.1	107*
SNK-37	3.29	123	45.8	103	28.2	111*
SNK-38	3.46	129	46.8	105*	27.1	107
SNK-106	3.53	132	45.0	101	28.6	113
SNK-51	3.90	146*	47.9	108*	26.6	105
SNK-54	2.92	110	42.2	95	29.8	118*

[1] Standard check cultivar; * significant with $0.01<P<0.05$

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