Breeding of winter type of Brassica juncea L. in the All-Russia Research Institute of Oil Crops by V.S. Pustovoit

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Abstract

Mustard (Brassica juncea L.) is traditionally cultivated in Russia as an oil crop. It takes the fourth place after sunflower, soybean and rapeseed. Mustard is cultivated mainly in droughty regions of the country on the area of about 100-150 thousand ha. The main objective of cultivating Brassica juncea is production of edible oil and mustard seed meal.

For the purpose of potential crop productivity increase, as well as development of a brand new parental material for breeding a new winter type of mustard not existing in nature was developed in VNIIMK by using a method of resynthesis (winter type of Brassica campestris (A) x Brassica nigra (B)). Potential yield of the winter mustard seeds is higher in average by 30-35%, up to three or more t/ha in comparison with the summer type. The main deficiency of the winter type of mustard is its low (in comparison with winter rapeseed) winter hardiness.

Key words: Brassica juncea L., winter type, method of resynthesis

Introduction

The first attempt to develop the winter type of mustard was made in VNIIMK in 1955-1960 by using the interspecific hybridization of the spring mustard (Brassica juncea L.) and winter rapeseed (Brassica napus L.). Mustard developed on basis of mustard-rapeseed hybrids was characterized by the low winter hardiness (30 % at the average) and low oil content of seeds (38-39 %). Lines with winter hardiness up to 80 % and oil content of seeds up to 45 % were derived through selection from the interspecific hybrid population. At the average, within the period of 1967-1975 the best lines of winter mustard overwintered at rates of 56-62 % and showed seed yield 2.1-2.2 t/ha. Meanwhile, the winter hardiness of winter rapeseed reached 94 %, and seed yield was 2.8 t/ha.

In order to develop more winter-resistant types of mustard there was carried out a resynthesis of winter mustard type on basis of crossing elementary species – winter type of Brassica campestris (2n=20) and Brassica nigra (2n=16)).

Hybrids of the resynthesis had a higher winter hardiness in comparison with the winter type mustard developed on basis of winter-rapeseed and were used as a parental material for the further breeding work with the winter type of Brassica juncea.

Results

The first variety of new oil crop of the winter type Br. juncea – Suzdalskaya – was registered in 1995. Seeds of this variety contained 35-37% of erucic acid in oil, which made its use for dietary purposes impossible. Variety Snezhinka with erucic acid content lower than 3,0% was developed by using method of intraspecific hybridization of winter mustard and erucic-free summer mustard followed by the individual selection (table 1).

In the course of field trial (farm “Kruglik”, 2.0 ha) held in 1989 seed yield of winter mustard variety Suzdalskaya was 3.0 t/ha, comparing with 2.8 t/ha in the case of winter rapeseed and 1.5 t/ha – spring Brassica juncea (by the spring sowing).

Table 1 Characteristic of winter mustard varieties Snezhinka and Suzdalskaya (1999-2001)

Variety	Vegetation period, days	Seed yield, t/ha	Oil content of seeds, %	Essential oil content of seeds, %	Fatty acid content of oil, %	
					$C_{22:1}$	$C_{18:1}$
Snezhinka	273	3.32	42.7	0.73	2.5	43.3
Suzdalskaya	273	3.04	42.5	0.72	36.2	19.5
	LSD 5%	0.25	0.4			

Group of lines exceeding the original variety in yield and seed oil content and characterized by the absence of erucic acid in oil was developed from the variety Snezhinka by using self-pollination technology.

According to the results of the field trials in 2006-2007 a line VN-21766 exceeding variety Snezhinka in yield and seed oil content and characterized by the total absence of erucic acid in oil, plants height evenness, flowering and ripening vigor was derived from these lines. In 2007-2009 line VN-21766 showed seed yield 3.4 t/ha, seed oil content 44%, essential oil content 0.72%, erucic acid content 0.0%, plants height 210 cm, vegetation period 265 days (table 2). Line VN-21766 was named Dzhuna and was registered as a variety in 2010.

Table 2 Characteristic of winter mustard variety Dzhuna (2007-2009)

Variety	Seed yield, t/ha	Oil content of seeds, %	Content, %		Vegetation period, days	Plants' height, cm
			Essential oil	$C_{22:1}$		
Dzhuna	3.38	43.9	0.72	0.0	265	210
Snezhinka	2.43	42.3	0.72	2.1	265	219
LSD 5%	0.45	0.5				

Plants of variety Dzhuna are able to tolerate low air temperatures at level -14°C by the lack of snow cover and soil temperatures at level -7°C at a depth of 3 cm for a short period of time.

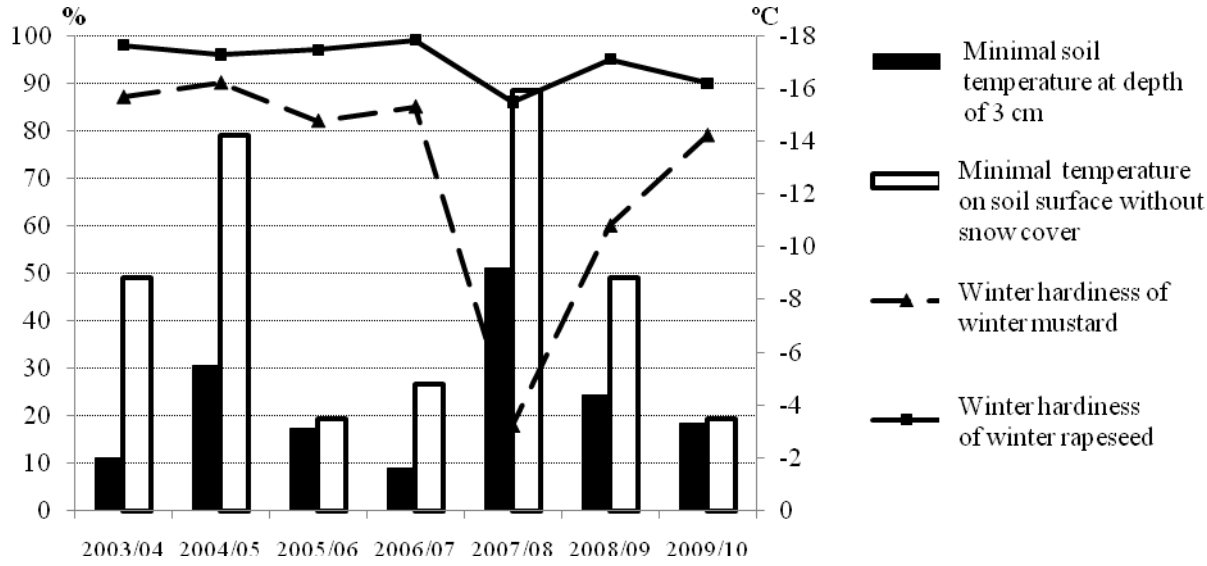

Fig. 1. Influence of the minimal air temperature on the winter hardiness of winter rapeseed and winter mustard

In 2003-2010 following temperature minimums were recorded on the experimental plots: minimal air temperature was -27.0°C in 2005/06 and –20.5°C in 2009/10; minimal air temperature on the soil surface without snow cover was -14.2°C in 2004/05 and -15.9°C in 2007/08; minimal soil temperature at the 3 cm depth sank down to -9.2°C in 2007/08.

By the optimal development of winter mustard plants critical values for the crop are the following ones: minimal air temperature on the soil surface lower than -15.0°C by the absence of snow cover and minimal temperature of soil at depth of 3 cm lower than 9.0°C (Fig. 1).

At average, within seven years of researches seed yield of winter type of mustard was 2.6 t/ha, spring Brassica juncea – 1.4 t/ha, and winter rapeseed – 3.8 t/ha (Fig. 2).

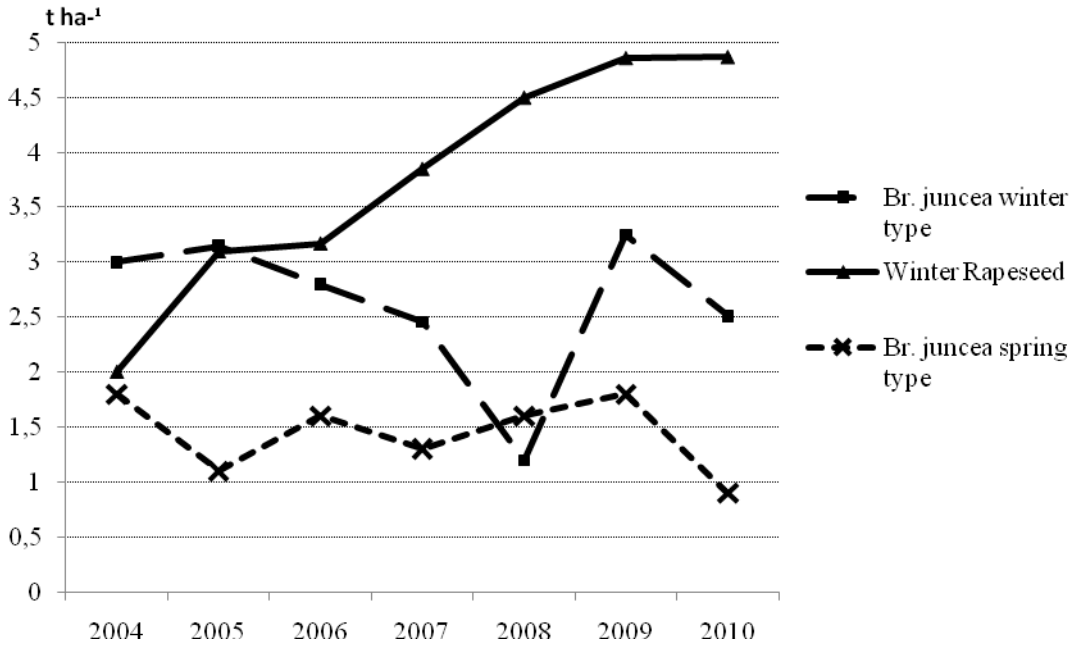

Fig. 2. Comparative analysis of seed yield of winter Brassica napus, winter and spring Brassica juncea

At present, main direction of researches connected with the winter type of mustard in VNIIMK is studying the effectiveness of developing parental material of crop with a set of economically valuable traits: with potential seed yield more than 3.5 t/ha, with oil content more than 45 %, resistant to lodging, tolerant to main pathogens (Phoma, Fusarium, Alternaria).

Conclusion

For the first time in VNIIMK have been developed high-yielding non-erucic varieties of winter type of Brassica juncea, which provide production of edible oil having high dietary rates.

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