

Challenges in breeding forage brassicas in Serbia

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Abstract

Fodder brassicas in Serbia are not cultivated to a great extent despite many advantages. The most important forage brassica today is fodder kale (*Brassica oleracea* L. var. *viridis* L.), while there are also oilseed rape (*Brassica napus* L. var. *napus*), hybrid Perko PVH (*Brassica napus* L. var. *napus* x *Brassica rapa* subsp. *chinensis* (L.) Hanelt), turnip rape (*Brassica rapa* L. subsp. *oleifera* (DC.) Metzg.) and white mustard (*Sinapis alba* L. subsp. *alba*). The only native breeding programme on forage brassicas in Serbia today is carried out in the Institute of Field and Vegetable Crops in Novi Sad. In comparison to the breeding programmes of other forage species, this programme is rather young and has begun in early 1980s. It was initiated by an increased popularity of the fodder kale cultivars of older generations, such as Green Angeliter, and Perko PVH. The first outcome of the Novi Sad forage brassicas breeding programme was the cultivar NS-Bikovo, registered in 1983. This cultivar greatly assisted a significant increase in the cultivation area under forage brassicas in Serbia and other neighbouring countries, although fodder kale has remained unknown in many a region of the country. The Novi Sad breeding programme was re-launched in early 2000s and included several forage brassica species. It has produced the latest Serbian cultivar Perast, registered in Serbia in 2007, and a new line of forage white mustard, currently in the process of registration. The future activities of the Novi Sad forage breeding programme will try to enhance it in several levels. The existing collection of forage brassicas will be increased and described, characterized and evaluated. Along with mass and individual selection from local landraces, various methods of selection from hybrid populations will be applied in the progenies. Apart from the green forage yield itself, the new genetic variability will be tested for other numerous important agronomic characteristics, such as winter hardiness in late summer / early autumn - sown genotypes, earliness in both winter and spring ones, resistance to prevailing pests and various aspects of forage quality.

Key words: brassicas, breeding, forage quality, forage yield

Introduction

The family *Brassicaceae* Burnett comprises many species that are used not only as vegetables and in industry but also for animal feeding (Erić *et al.*, 2006). Some fodder brassicas are used primarily for forage production, such as oilseed rape (*Brassica napus* L. var. *napus*), fodder kale (*Brassica oleracea* L. var. *viridis* L.), hybrid Perko PVH (*Brassica napus* L. var. *napus* x *Brassica rapa* subsp. *chinensis* (L.) Hanelt), turnip rape (*Brassica rapa* L. subsp. *oleifera* (DC.) Metzg.) and white mustard (*Sinapis alba* L. subsp. *alba*). Other are cultivated for roots, such as rutabaga (*Brassica napus* L. var. *napobrassica* (L.) Rchb.) and fodder turnip (*Brassica rapa* L. subsp. *rapa*). Regardless of their purpose, all these brassica crops are important in diverse crop rotations, especially those oriented towards the feed production (Erić *et al.*, 1998). They are also highly esteemed in modern trends such as organic farming and sustainable agriculture (Ćupina *et al.*, 2004). Forage brassicas have a prominent ability to produce a considerable amount of aboveground biomass and thus are considered green manure crops too (Erić *et al.*, 2000). Certain forage brassica crops also stand grazing (Koch *et al.*, 1989).

Breeding programme on forage brassicas in Serbia

Breeding programmes on forage brassicas in Serbia were initiated by the introduction of several cultivars and hybrids of foreign origin, most notably the fodder kale cultivar Green Angeliter and the hybrid Perko PVH. So far, the only breeding programme on forage brassicas in Serbia has been carried out in the Institute of Field and Vegetable Crops in Novi Sad. Among its achievements are two autumn-sown fodder kale cultivars, NS-Bikovo, registered in 1983, and Perast, registered in Serbia in 2007 (Mihailović *et al.*, 2007b) and the spring-sown forage white mustard cultivar Gorica, registered in 2010.

The breeding programmes and the development of new cultivars of forage brassica crops in Novi Sad are based upon the complex characterisation and evaluation of all the accessions of the Forage Brassicas Collection (FBCNS). The process of characterisation results in the description of the most significant qualitative traits. The evaluation of the accessions of the Forage Brassicas Collection comprises assessing the data on the most important quantitative characteristics (Mihailović *et al.*, 2008b). Majority of them have a great agronomic significance, such as plant height, number of stems and lateral branches per plant, number of leaves per plant and other forage yield components, green forage yield and forage dry matter yield per both plant and area unit and earliness and tolerance to low temperatures, drought and other forms of both abiotic and biotic stresses (Mihailović *et al.*, 2008a). At the same time, there are examined certain physiological characteristics, such as tolerance to low temperatures and earliness, especially important in winter-sown accessions, and length of growing period, more significant in spring-sown accessions.

The methods used in breeding forage brassicas and developing new genotypes included mass and individual selection from local landraces, characterised with wide genetic variability, and various methods of selection from hybrid populations, with emphasis upon bulk and pedigree methods (Mihailović *et al.*, 2007a).

Breeding fodder kale

It is true that fodder kale is still neglected and underutilised in certain parts of Serbia, but it has surely become the most significant forage brassica crop in the country during the three last decades (Šibalić & Kunc, 1983).

Table 1. Yields in forage brassicas during 2005/06 at Rimski Šančevi (Erić *et al.*, 2007)

Species	Cultivar	Cutting	Green forage yield (t ha ⁻¹)	Forage dry matter yield (t ha ⁻¹)	Forage dry matter proportion
Fodder kale	NS-Bikovo	I	52.3	4.5	0.09
		II	16.1	1.5	0.09
		total	68.4	6.0	0.09
	Perast	I	54.9	4.6	0.08
		II	17.6	1.4	0.08
		total	72.5	6.0	0.08
Average			70.5	6.0	0.09

A long-term evaluation of fodder kale confirmed that this species has a great potential for forage yields, with more nearly 70 t ha⁻¹ of green forage and more than 6 t ha⁻¹ of forage dry matter (Mihailović *et al.*, 2008). One of the goals of contemporary fodder kale breeding is that the newly developed fodder kale cultivars have higher leaf proportion, reaching nearly one half of green forage yield per plant (Mihailović *et al.*, 2009).

If winter fodder kale genotypes are sown in spring, as a rule they will not enter the reproductive stage, although they may form a considerable forage yields, up to 40 t ha⁻¹, consisted mainly of short stems and leaves (Mihailović *et al.*, 2007a). Especially in rainy seasons, fodder kale may produce a second cutting, with average green forage and forage dry matter yields reaching one third in comparison to those in the first cutting (Table 1).

Breeding forage oilseed rape and white mustard

Oilseed rape is widely known as a quality oil crops but it can be cultivated for green forage and silage (Erić *et al.*, 1996). In the conditions of Serbia with its clearly distinguished four seasons, winter-sown cultivars of oilseed rape produce higher forage yields in comparison to spring-sown cultivars (Mihailović *et al.*, 2007a). Oilseed rape has a similar forage dry matter proportion to that in fodder kale. Number of stems and lateral branches has a greatest importance in breeding oilseed rape for forage (Marjanović-Jeromela *et al.*, 2004).

Like already observed in winter fodder kale, the spring-sown winter oilseed rape develop only short stems and leaves, with much lower forage yields in comparison to the autumn-sowing. In general, spring cultivars of oilseed rape are characterised by higher proportion of stems in total forage yield (Mihailović *et al.*, 2007a). The oilseed rape forage yields in the second cutting are between one third and one half in comparison to the first cutting (Erić *et al.*, 2007).

Little is known about the use of white mustard as a forage crop. For this purpose, it is grown primarily as a spring-sown crop, with a growing period from sowing to cutting of up to 60 days (Vučković, 1999). In temperate regions such as Serbia, white mustard is recommended to be grown exclusively as spring-sown crop. In the seasons with more mild winters, white mustard is able to survive frost and a long-term influence of low temperatures, although its regular practice is proven not be economically reliable. In comparison to other forage brassica crops, white mustard is generally characterised by a lower leaf mass proportion in total plant mass (Mikić *et al.*, 2009). The average green and forage dry matter yields in white mustard are lower in comparison to those in fodder kale or oilseed rape, varying between 10 t ha⁻¹ and 15 t ha⁻¹ (Mihailović *et al.*, 2007a). At the same time, a prominent earliness and ability to produce a considerable amount of forage in a relatively brief period of time represents its main advantage as compared to other forage brassica species. In rainy seasons, the second cutting in white mustard makes more than one half of the first cutting (Erić *et al.*, 2007).

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