New Genotypes of *Basella rubra* and *Basella alba* Acclimatized and Bred at Vegetable Research and Development Station Buzău

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Abstract

Basella alba is an underutilized plant with great food and medicinal potential, newly acclimatized in Romania at Vegetable Research and Development Station (VRDS) Buzau. For over 10 years, the Genetic, Breeding and Biodiversity Laboratory has studied a number of 12 genotypes from *Basella* spp. of these, two accessions (L5 and L8) showed distinct phenotypic feature. The experience has been done in randomized blocks with three replications, and the number of plants analyzed for each variant was 50. On L8 accession, the anthocyanin coloration was not present, unlike accession L5 which features a strong anthocyanin coloration, especially along the stem and on the dorsal side of the leaf. Specifically *B. alba var. rubra* shows a leaf width of 14.8 cm and a weight of 20 g, and the *B. alba* shows a leaf width of 21.4 cm and a weight of 27.5 g. *Basella alba* recorded the highest percentage in dry matter in the smallest leaves, namely 7.69% and *Basela alba var. rubra* registered the highest percentage in dry matter also in the small leaves, of 7.98%. The aim of this study was to assess the morphological traits in order to patent a new acclimatized species in Romania. The study was finalized with one variety (L5) that has been successfully qualified for DUS test (Distinction, Uniformity and Stability) and soon will be registered in the Official Catalogue of Species and Varieties of Cultivated Plants.

Keywords: *Basella* spp., breeding, feature, phenotype

Introduction

Basella alba L. (Synonym: *Basella rubra Roxb*.) is an extremely heat tolerant (Grubben and Denton, 2004), fast growing perennial vine which belongs to the *Basellaceae* (*Chenopodiaceae*) family (Rathee *et al.,* 2010). It is commonly known as Malabar spinach, Indian spinach, Ceylon spinach, vine spinach (Roy *et al*., 2010), climbing spinach (Sen *et al*., 2010), East-Indian spinach, Chinese spinach (Bamidele *et al.,* 2010) and cyclone spinach (Nirmala *et al*., 2011). The plant has numerous secondary shoots (over 100). It's thick, semi-succulent, heart-shaped leaves have a mild flavor and mucilaginous texture. It is rich in vitamins A and C, iron and calcium. It has been shown to contain certain phenolic phytochemicals, and it has antioxidant properties. *Basella* is known for its medicinal properties. Hydroxy-benzoic acids, hydroxyl-cinnamic acids, flavone groups were identified and characterized from the aqueous extract of *Basella alba* and *Basella alba var. rubra* species, values of phenolic as well as antioxidant activities were noted from *B. alba* species extract (Kumar *et al.,* 2018). The roots are astringent but can be prepared and used as a treatment for the stomach. Natural dye can be

extracted from the fruits, the reddish purple color being used in the pigmentation of various cakes, sweets, candies. The plant can be successfully cultivated for ornamental purposes, especially the red form, due to its vigorous appearance and lush and beautifully coloured foliage (Vînătoru *et al*., 2019).

The aims of this study were: acclimatization of the species, obtaining stable genotypes, elaboration of culture technology and finally approval and patenting of the accessions.

Materials and methods

VRDS Buzau has tradition in acclimatizing and breeding new species in Romania. Research began with the acquisition of the initial basic material for acclimatization and breeding. The main sources of genetic material were cultivars from India, New Zealand, Germany and China. For over 10 years, 12 accessions were subjected to intensive breeding work and after phenotypic evaluation two accession were retained L5, variety *of B.alba var. rubra* and L8, variety of *B. alba*. The experience has been done in randomized blocks with three repetitions, and the number of plants analyzed for each variant was 50.

The experiment was conducted in the research site of VRDS Buzau. The seeds were sown in the second decade of March, in alveolar pallets with 70 cubes and volume of 50 mL/cube in a mixture of peat. The planting was made in May and the planting scheme used was 100 cm between rows and 40 cm between plants/row, in fenced system.

Throughout the vegetation period, biometric observations were made for 13 qualitative descriptors and 12 quantitative descriptors according to UPOV Guidelines.

The quantitative traits analyzed were: plant height (PH), stem diameter (SD), number of leaves/plant (NL/P), leaf length (LL), leaf width (LWi), leaf weight (LWe), petiole length (PL), petiole diameter (PD), number of flowers (NF), flower length (FL), fruit diameter (FD), yield/ plant (Y/P) and the qualitative traits were: plant growth habit, stem pubescence, stem branching, leaf shape, blade shape of mature leaf, intensity of anthocyanin coloration, leaf colour, intensity of green colour of leaf, flower colour, fruit colour at physiologic maturity, fruit shape, main colour of seeds, seed coat texture.

In order to establish the relationship between accessions, statistical analysis was performed and ANOVA was used, followed by the Duncan's multiple range test.

The content in dry matter was measured on three different maturity stages of leaves (small leaf - 14 days after transplanting; medium leaf - 37 days after transplanting; large leaf - 60 days after transplanting), using the moisture analyzer Kern DBS60-3. The total soluble solid content of the leaf was measured with Optech refractometer.

Results and discussion

The analysis of climatic conditions of 2019 (Tab. 1) showed that the mean monthly temperatures increased from 22.5°C in May to 29.5°C in August, in contrast, the rainfall has experienced a decline from 71 mm in May to 25 mm in September. In comparison with the multiannual mean, it was noticed that the year 2019 had lower temperature than mean, but it was registered a greater amount of precipitations.

Following biometric measurements and descriptive analyzes, it was found that there is a significant difference between *B.alba* and *B.alba var. rubra* both in terms of quantitative and qualitative characters. Thus, the descriptive analysis of the quantitative characteristics are presented in Table 2 and that of the qualitative characteristics, in Table 3.

Significant differences in the size and weight of the leaf can be observed as a result of the measurements and determinations.

Specifically *B. alba var. rubra* shows a leaf width of 14.8 cm and a weight of 20 g, and the *B. alba* shows a leaf width of 21.4 cm and a weight of 27.5 g. The colour of leaf is light green in L8 and dark green in L5. The number of leaves per plant varies from 249 to 256 in the case of cultivar L5, and in the case of cultivar L8 from 175 to 182, which means that production per plant is between 4608 and 5478 g for L5, and for cultivar L8 is between 4550 to 5775 g.

In order to establish a correlation between quantitative traits, a correlation matrix (Tab. 4) was made. It was observed that there was a strong correlation between number of leaves and plant height. The stem diameter has a positive influence on leaf and fruit length. On the other hand, leaf weight has strong positive correlation with leaf width, petiole diameter, flower length and, of course, yield.

Table 1. Climatic conditions during the vegetation period

Temperatures/rainfall	May	June	July	August	September
Mean monthly temperatures (°C) 2019	22.5	27	30	29.5	19.5
Multiannual monthly temperature (°C)	23	26	29	29	18.5
Sum of rainfall (mm) 2019	71	92	75	53	22
Multiannual mean of rainfall (mm)	68	84	65	51	25

Table 2. Mean values and standard deviation of quantitative plant characteristics

Character	L5±sd	L8±sd
Plant height (cm)	266±5,29b	249±6,55a
Stem diameter (cm)	1,37±0,22a	1,77±0,19b
Number of leaves/plant (pcs)	251,66±3,78b	179±3,60a
Leaf length (cm)	18,26±1,15a	22,66±1b
Leaf width (cm)	14,8±1,56a	21,4±0,91b
Leaf weight (g)	20±2a	27,5±4,04b
Petiole length (cm)	3,43±065a	2,86±0,75a
Petiole diameter (cm)	0,60±0,02a	0,80±0,14b
Number of flowers/inflorescence (pcs)	21±3a	23,33±1,15a
Flower length (cm)	0,29±0,01a	0,7±0,01b
Fruit diameter (cm)	0,79±0,01a	0,83±0,02b
Yield/plant (g)	5,028,66±435,70a	5241,66±627,66a

Note: Different letters denote significant differences (Duncan test, $p < 0.05$).

Table 3. Qualitative plant characteristics

Morphologic trait	L5 rubra	L8 alba
Plant growth habit	Erect	Erect
Stem pubescence	Sparse	Sparse
Stem branching	Mixed	Mixed
Leaf shape	Cordate	Ovate
Blade shape of mature leaf	Circular	Circular
Intensity of anthocyanin coloration	Strong	Absent
Leaf colour	Green	Green
Intensity of green colour (leaf)	Dark	Medium
Flower colour	Dark pink	White-pink
Fruit colour at physiologic maturity	Black-purple	Black-purple
Fruit shape	Oblong	Oblong
Main colour of seeds	Black	Dark maroon-black
Seed coat texture	Rough	Rough

Table 4. Correlation matrix of main characters

Variable	PH	SD	NL/P	LL	Lwi	Lwe	PL	PD	NF	FL	FD	Y/P
PH	**1**											
SD	-0,422	**1**										
NL/P	0,891	-0,702	**1**									
LL	-0,729	0,915	-0,896	**1**								
Lwi	-0,850	0,698	-0,949	0,918	**1**							
Lwe	-0,908	0,399	-0,905	0,646	0,769	**1**						
PL	0,425	-0,568	0,404	-0,570	-0,385	-0,340	**1**					
PD	-0,708	0,553	-0,753	0,701	0,709	0,748	-0,799	**1**				
NF	-0,120	0,579	-0,520	0,447	0,371	0,446	-0,065	0,378	**1**			
FL	-0,882	0,747	-0,997	0,927	0,957	0,874	-0,434	0,746	0,502	**1**		
FD	-0,479	0,962	-0,735	0,947	0,806	0,396	-0,523	0,573	0,483	0,780	**1**	
Y/P	-0,451	-0,344	-0,305	-0,122	0,103	0,672	0,033	0,362	0,186	0,233	-0,385	**1**

Note: Values in bold are different from 0 with a significance level alpha=0.05

Figure 1. Plant details of *Basella alba var. rubra* (L5)

Figure 2. Plant details of *Basella alba* (L8)

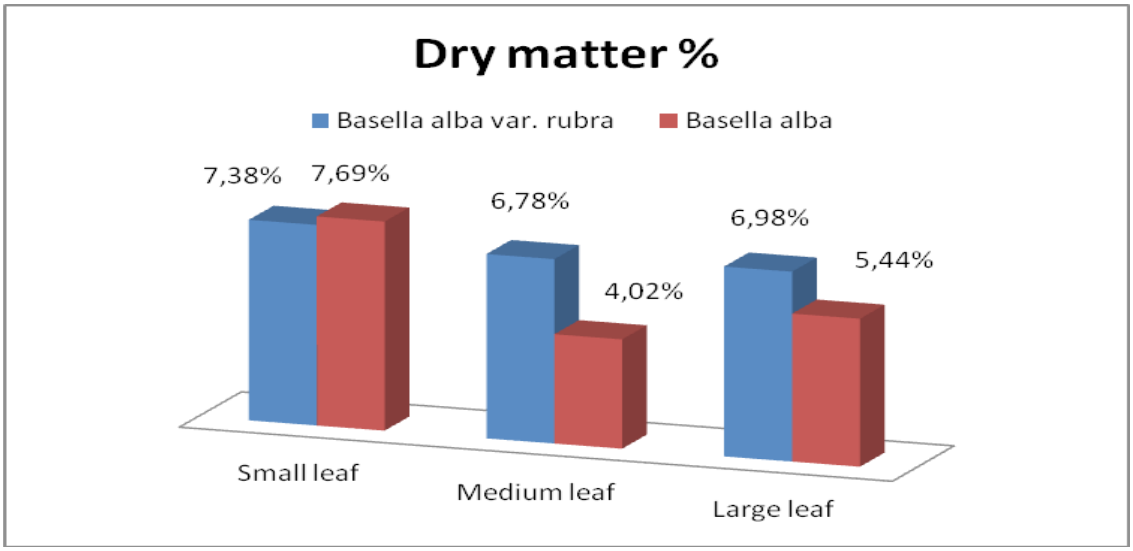

Figure 3. Dry matter content in *Basella* leaves

Regarding the qualitative traits, it was observed that on L8 accession, the anthocyanin coloration was not present (Fig. 2), unlike accession L5, which features a strong anthocyanin coloration especially along the stem and on the dorsal side of the leaf (Fig. 1). Seeds are black, globose, indehiscent and the coat texture is rough. Similar results were obtained by Deshmukh *et al.* (2014).

For both cultivars a number of three leaves of different maturity stages and size (small leaf - 14 days after transplanting; medium leaves - 37 days after transplanting; large leaves - 60 days after transplanting) were analyzed and it was found that *Basella alba* recorded the highest percentage in dry matter in the smallest leaves, namely 7.69%, while the lowest percentage was recorded in medium-sized leaves, with a percentage of 4.02%. *Basella alba var. rubra* registered the highest percentage in dry matter in the small leaves, of 7.98%, while the lowest percentage was registered in the medium leaves, more precisely 6.78% (Fig. 3).

The total soluble solid content did not vary from one accession to another, or from one leaf to another. The recorded values ranged from 10-11°Brix.

Conclusion

The research ended with the establishment of a valuable germoplasm collection of *Basella* species. Two accessions have been acclimatized and bred, and of these L5 *B.alba var. rubra* is in the last year of tests at ISTIS Bucuresti. This varieties show distinct phenotypic feature that have successfully passed the DUS (Distincbility, Uniformity and Stabilization) test.

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