Preliminary test results of 15 species of Bulgarian flora cultivated as ornamental plants*

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Abstract. The paper presents the results obtained from the first year of cultivation of perennial herbaceous species and subshrubs of the Bulgarian flora for testing the possibilities for their use as ornamental plants. The study includes 15 species belonging to seven botanical families. The species were evaluated on their vegetative growth, average height of the plants, flowering period, plants' visual state during the vegetation period and state of the plants in winter. The plants of all tested species overwintered successfully under Sofia climate conditions.

Key words: Ornamental plants, perennials, subshrubs, wild plants

Introduction

Ornamental plants are the largest group of flora that encompasses between 15 and 30 thousand species. The exact number of ornamental species is unclear, because of the difficulty of distinguishing this group of plants. Unlike food and industrial crops for which a certain quantity of yield is pursued at certain quality and costs, the criteria by which one species is considered ornamental are more or less subjective.

A serious review of the local species in the Bulgarian flora, which could be used as ornamental plants, was made by Yanev (1959). He examined in detail 444 species and reviewed 327 more. In total, Yanev mentioned 771 as potential ornamental species, which constitutes approximately 1/5 of the plant diversity in the country. There are some missed species that could be of interest as ornamental plants, which makes the focus species account for up to ¼ of all species of the Bulgarian flora (Delipavlov & al. 2003). The number of species which are relevant as genetic resources of ornamental plants is even greater. In modern selection of ornamental plants, remote hybridization still plays a major role (Atanassova & al. 2010; HuiTang & al. 2000). From this perspective, a significant number of native species, which in themselves do not possess high ornamental qualities could be used for improving the closely related ornamentals (Atanassova 2013; Atanassova & al. 2010; Kaninski & al. 2009; Kaninski & Nencheva 2003).

Although the first ornamental plants have been introduced in culture from the immediate surroundings, even since ancient time plants with high ornamental qualities and wealth of ornamental forms were transported to a long distance. This process had become much more intensive in the 18th and 19th century. In the 20th century, most of the cultivated ornamental plants in Bulgaria were non-native (Angeliev 1965; Nikolova 1999; Shtiliyanova 2005). The trend towards using some foreign and presumably more exotic plants in gardens and parks is clearly expressed not only in Bulgaria. Meanwhile, widespread cultiva-

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tion of ornamental non-native species poses serious and well-known risks. Many invasive species are carried to new places thanks to their cultivation as ornamentals (Dehnen-Schmutz & al. 2007a, b; Reichard & White 2001). Moreover, often alien species have to be adapted to different soil and climatic conditions, which makes maintenance more difficult and expensive than for the well-adapted locals (Franco & al. 2006). The use of native species in gardens is not dangerous to the environment; on the contrary, their dispersal in the environment can have a positive effect on the numbers and vitality in their natural populations. On the other hand, some authors argue that the flow of genes from the strongly-modified cultural to wild populations can have serious effects on them (Ellstrand & al. 1999).

Studies on the cultivation and use of indigenous species of the Republic of Bulgaria as ornamental plants are relatively limited (Ivanova & al. 2003, 2014; Kaninski & al. 2003, 2005, 2012). Most of the available studies are focused on rare and endangered species. Along with this, the access to a wide range of beautiful local plant species must be facilitated, but their natural populations should be protected. That is why, the study of species and their varieties suited for cultivation as ornamental plants and the development of appropriate technologies for the propagation and production of seedlings from them should be fostered (Manolova & al. 2014, 2015; Atanasova & al. 2001; Zapryanova & al. 2001).

In the present work, we investigate the behaviour of 15 species of the flora of the Republic of Bulgaria, when in culture: *Anthemis tinctoria* L., *Digitalis lanata* Ehrh., *Geranium sanguineum* L., *Helianthemum nummularium* (L.) Mill., *Inula britannica* L., *Lamium maculatum* L., *Leucanthemum vulgare* (Vaill.) Lam., *Origanum vulgare* L., *Potentilla recta* L., *Pulmonaria officinalis* L., *Salvia verticillata* L., *Satureja coerulea* Janka, *Tanacetum parthenium* (L.) Sch.Bip., *Teucrium chamaedrys* L., and *Veronica officinalis* L. They belong to seven botanical families: *Asteraceae* Dum. (*Compositae* Giseke), *Boraginaceae* Juss., *Cistaceae* Juss., *Geraniaceae* Juss., *Lamiacea*e Martynov (*Labiatae* Juss.), *Rosaceae* Juss., and *Scrophulariaceae* Juss. These species are relatively common in the country. They are selected for their good adaptability to various climatic conditions. Most of the studied species are cultivated as ornamental plants abroad. Hessayon (1999) indicates nine of the species as ornamental plants grown in Britain: *A. tinctoria, D. lanata, G. sanguineum, H. nummularium, L. maculatum, O. vulgare, P. officinalis, T. parthenium* and *T. chamaedrys*. Besides these nine species, the following are cultivated in the United States as ornamental plants: *L. vulgare, P. recta* and *S. verticillata* (Bruckell & Cathey 2004). Information on the cultivation of ornamental plants such as *I. britannica*, and *V. officinalis*, especially their ornamental forms in different European countries, could also be found. The only species for which no information was found for cultivation as ornamental anywhere is *S. coerulea*, and probably the reason for this is its limited distribution in Southeast Europe and the existence of other species of its genus (*Satureja montana* L., *S. thymbra* L. and *S. spicigera* (K.Koch) Boiss.) grown in Western Europe and the USA (Bruckell & Cathey 2004).

Some of the studied species are well known as medicinal plants. Petkov (1982) mentions six of the tested species: *A. tinctoria, G. sanguineum P. officinalis,, O. vulgare, T. chamaedrys,* and *V. officinalis* as medicinal plants, and *D. lanata* as a well known therapeutic and toxic plant. Attempts have been made to cultivate some of the species as medicinal plants for scientific or commercial purposes, but the results are only partially applicable for the assessment of their suitability as ornamental plants.

This study aims at determining the phenological and morphological characteristics of 15 species from the Bulgarian flora cultivated with high agrotechnics; and at assessing them for suitability for cultivation as ornamental garden plants.

Material and methods

The plants used in this study were propagated using material collected from natural habitats of the species concerned. The floristic regions from which the starting material was collected for any of the studied species are given in Table 1. For some of the species, the material was collected from two or more locations. *D. lanata* and *S. coerulea* were propagated by seeds, *P. recta, L. maculatum, S. verticillata, T. chamaedrys, P. officinalis, G. sanguineum,* and *I. britannica* were propagated by separating the side shoots of the plants. *O. vulgare* and *V. officinalis* were propagated by rooting parts of the stems. By separating part (between ¼ and ½) of the old plant were propagated plants of

L. vulgare species. *A. tinctoria* and *T. parthenium* were propagated by rooting cuttings. *H. nummularium* was transferred to the Institute by rooting cuttings from old plants or as young plants.

Table 1. Origin of propagation material of the target species.

Species	Origin
Asteraceae (Compositae)	
Anthemis tinctoria	Rhodopi Mts (W,N)
Inula britannica	Black Sea Coast (N)
Leucanthemum vulgare	Rhodopi (W); Sofia region
Tanacetum parthenium	Black Sea Coast (N)
Boraginaceae	
Pulmonaria officinalis	Rhodopi (W,N); Mt Vitosha
Cistaceae	
Helianthemum nummularium	Rhodopi (W,N)
Geraniaceae	
Geranium sanguineum	Rhodopi (W,N)
Lamiaceae	
Lamium maculatum	Rhodopi (W,N)
Lamium maculatum f. *album*	Rhodopi (N)
Origanum vulgare	Rhodopi (W,N)
*Salvia verticillat*a	Rhodopi (W)
Satureja coerulea	Rhodopi (N)
Teucrium chamaedrys	Rhodopi (W,N); Mt Vitosha
Rosaceae	
Potentilla recta	Rhodopi (W,N)
Scrophulariaceae (Plantaginaceae)	
Digitalis lanata	Rhodopi (N)
Veronica officinalis	Rhodopi (W)

At least five plants were planted from each species. Plants of different geographic origin were monitored separately, so as to establish whether there were phenological or morphological differences between them. The plants were transferred to the Institute in 2014. They spent the winter in seedling pots in uncontrolled conditions. The plants were planted in the first half of April 2015 in an open area with sandy soil with a slightly acid reaction (Ph ~ 6–6.5), at an altitude of 516 m. Shallow tillage was implemented on the area in spring (~ 18 cm depth), followed by cultivation and making of beds. The plants were planted in three straight rows of high beds, with 50 cm spacing (row to row) and 20 cm spacing inside the lines (plant to plant). The area was irrigated during most of the vegetation season (May to September) with drip irrigation. Weed control was applied by soil cultivation, manual weeding and direct treatment in vegetation with herbicides (Dual Gold 960 EC (0.15 ml/m^2); New Stomp 330 EC (0.40 ml/m^2)). The plants were not treated with fertilizers, and pests and diseases were not combated.

A monitoring in winter and spring was aimed at establishing the extent to which the target species keep their vegetative mass. The height of vegetative mass of the plants was measured at the beginning of the budding phase and when in full bloom. In both cases the height was measured from soil surface to the highest part of the plants. Weekly observations were carried out on plant development dynamics of flowering, foliar condition, damage from pests and diseases, etc. Data presented in Table 2 and 3 are averaged for all cultivated plants of the species.

Table 2. Average size of the plants from the studied species.

Species	Height (sm.)	Height in bloom (sm.)	Width (sm.)
Asteraceae (Compositae)			
Anthemis tinctoria	39.2±5.2	—	52.4±4.9
Inula britannica	24.8±5.3	79.8±12.5	127.2±18.22
Leucanthemum vulgare	17.2±3.3	33.6±5.2	24.4±5.7
Tanacetum parthenium	23.8±5.1	42.6±6.1	45.2±5.3
Boraginaceae			
Pulmonaria officinalis	13.4±3.9	31.2±4.5	21.6±4.2
Cistaceae			
Helianthemum nummularium	5.6±1.8	26.8±4.7	47.4±8.6
Geraniaceae			
Geranium sanguineum	16±5.1	—	34±4.1
Lamiaceae			
Lamium maculatum	29.6±4.3	32.8±3.6	24.2±5.8
Lamium maculatum f. *album*	21.9±3.6	27.2±2.8	19±4.3
Origanum vulgare	6±1.5	28.2±3	41±4.5
Salvia verticillata	24±4.7	46.8±7.5	41.6±4.5
Satureja coerulea	23.6±4	—	29.4±5.9
Teucrium chamaedrys	8.6±2.4	14.4±3	26±6.3
Rosaceae			
Potentilla recta	26.2±4.8	60±7.8	35.2±4.1
Scrophulariaceae (Plantaginaceae)			
Digitalis lanata	27±3.2	53.8±5.4	34.4±4.2
Veronica officinalis	6.6±1.9	11.2±1.5	34.6±3.4

Note: The data for width are recorded at the end of the first vegetation.

Results

All studied species have spent the winter successfully, without visible damage from the low winter temperatures. The species showed significant differences in their ability to retain their foliage: only the aboveground parts of *G. sanguineum* died out completely. The old stems of *S. coerulea* died out and in their basis there was a great number of young shoots with reddish leaves, which developed in spring and summer into new floral stems. *A. tinctoria* and *P. recta* formed compact young

rosettes at the base of the plants which spent the winter green and undamaged, but their old leaves and stems died out. *I. britannica* spent the winter as young leafy shoots lying on the soil. *L. maculatum* remained relatively well-leaved by shoots in the basal part of the old stems, with small leaves with large white spots. *L. vulgare, T. parthenium, P. officinalis,* and *S. verticillata* gradually lost some of their leaves. *D. lanata* spent the winter as well-developed rosette of leaves. *H. nummularium, O. vulgare, T. chamaedrys,* and *V. officinalis* kept their leaf mass almost entirely in the winter months.

During vegetation, the plants from all studied species increased significantly their total volume and blossomed. All species, with the exception of some *A. tinctoria* plants, kept their leaf mass green and in good condition by the time of the last observation in early November. The average size of the plants under Bulgarian conditions is listed in Table 2. The plants of *A. tinctoria* had the highest vegetative mass of app. 40 cm. It is impossible to distinguish the height of vegetative mass from the height in blossom for this species.

The smallest height of the vegetative mass was recorded for species that cover the ground in mats or prostrate stems: *H. nummularium*, *V. officinalis* and *T. chamaedrys*. Their height outside of bloom is under 10 cm. The greatest height in blossom was measured for *I. britannica* – nearly 80 cm, followed by *P. recta* with 60 cm. All other species, except for *D. lanata* and *S. verticillata*, had height significantly below 50 cm. The shortest of the surveyed species in blossom are *V. officinalis* – 11 cm, followed by *T. chamaedrys* – 14.5 cm high. The height of plants from *H. nummularium* was measured on the average at 27 cm in blossom, which is close in height to a significantly larger species, owing to its high flowering stem.

The studied species showed significant differences in timing and duration of flowering (Table 3). First, *P. officinalis* started flowering in early April; somewhat later, in mid-April, the first flowers of *L. maculatum* opened; and at the end of the month *T. chamaedrys* started to bloom. *I. britannica* was the latest in flowering: at the end of July. During the last measurement of plants included in this work (held on 1 November), six species continued to bloom: *I. britannica, H. nummularium, O. vulgare, S. verticillata, S. coerulea,* and *P. recta*. Regarding the duration of flowering, the shortest flowering period was reported for *P. officinalis* and *T. parthenium,* with total duration of flowering for these plants of about 50 days. They were followed by *L. vulgare* and *V. officinalis* with 60 days. The longest flowering period was recorded for *P. recta* and *O. vulgare,* more than 150 days for both species. *H. nummularium* was also long blooming, with 130 days, and *S. verticillata* and *S. coerulea* with more than 120 days.

Table 3. Blooming duration.

Month	April			May			June			July			August			September		
Ten-day	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
A. tinctoria																		
D. lanata																		
G. sanguineum																		
H. nummularium																		
I. britannica																		
L. maculatum																		
L. maculatum f. *album*																		
Leucanthemum vulgare																		
Origanum vulgare																		
Potentilla recta																		
Pulmonaria officinalis																		
Salvia verticillata																		
Satureja coerulea																		
Tanacetum parthenium																		
Teucrium chamaedrys																		
Veronica officinalis																		

The period with the greatest concentration of flowering species was from late May to late July. In the 2nd decade of June, we have recorded simultaneous flowering in 13 out of the 15 studied species, and this was the period with the most simultaneous flowering species.

There were no significant differences between the specimens of different geographical origin. We have found significant differences only between *L. maculatum* and *L. maculatum f. album* in terms of size and duration of blossoming. Therefore, *L. maculatum f. album* is presented separately in Tables 1, 2 and 3. During vegetation, we did not observe any strong (lowering the ornamental qualities of the plants) attack by diseases and pests. With the exception of some plants of *A. tinctoria* species in which we observed sudden deterioration of the general appearance and death. The reasons for this have not been identified. Presumably, this was probably due to the reaction of the species to regular irrigation, combined with an attack of soil pathogens.

Discussion

In accordance with literature data (Bruckell & Cathy 2004; Hessayon 1999), the studied species spent winter undamaged and showed good development in

spring. It should be noted that the propagation material from which the plants were obtained was taken from areas with different soil conditions (including calcareous and acid soils); however, all types have developed well in the slightly acidic soil at the Institute. This shows their good adaptability in terms of soil conditions.

Most plants did not keep a significant volume of their vegetative mass in winter, or their leaves suffered greatly, which worsened their ornamental qualities. Therefore, we could consider most species as deciduous. However, appearing as half-evergreen, *L. vulgare*, *T. parthenium* and *P. officinalis* have retained some ornamental effect during the winter months. Only *D. lanata*, *H. nummularium, O. vulgare, T. chamaedrys,* and *V. officinalis* could be considered evergreen, retaining a sufficient volume of their above-ground mass, which allows for some ornamental effect in the winter months. After severe pruning to clean the old stems in early autumn, *L. maculatum* forms beautifully variegated foliage that overwinters without losing its ornamental value.

During vegetation, all tested species have kept their leaf mass fresh and vibrant until fall. This is a very important quality, considering the fact that many of the widely cultivated perennial flower species degrade strongly in appearance in the warmer regions of Bulgaria, including in Sofia (personal observations).

Depending on the type of flowering (Table 3), we can divide the studied species in two relatively distinct groups. The first group includes species with clearly distinct time of flowering: *D. lanata, G. sanguineum, L. maculatum, L. vulgare, P. officinalis, T. parthenium, T. chamaedrys,* and *V. officinalis*. Plants of all species in this group have stopped their flowering, although conditions at the end of the flowering period were favorable for growth and continued flowering. The second group includes species that blossom continuously – once started, the flowering continues until conditions are favorable for growth and development. This group comprises: *H. nummularium, I. britannica, Origanum vulgare, Potentilla recta, Salvia verticillata,* and *Satureja coerulea*. The species in this group continued their flowering in response to the ensured appropriate conditions for their development. At this stage, *A. tinctoria* cannot be referred to any of these groups, manifesting somewhat transitional characteristics. Most of the early blossoming species could be referred to the first group, while almost all species with continuous blossoming begin to bloom in May–June and even July. Although species with limited blossoming bloom briefly, their blossom is much more abundant. In species with extended flowering, the bloom in the beginning is usually plentiful, but subsequently relatively poor.

The average size that was measured and the type of growth have indicated that it is possible to use these species in the gardens. *H. nummularium, O. vulgare, T. chamaedrys,* and *V. officinalis* are particularly suitable for use as a soil-covering species, including on dry and poor soil. *P. officinalis* could be also used as a soil-covering species, especially in partially shaded and moist areas. Higher species that reach a maximum height of 40–50 cm can be also used as soil-covering plants. Species with medium height, such as *D. lanata, Lamium maculatum, P. recta,* and *S. verticillata* are suitable for use in flower beds of a different type. Some of these species, especially *A. tinctoria* and *D. lanata,* are suitable for areas without irrigation or with a diluted irrigation mode. *L. vulgare* and *T. parthenium* showed a shorter flowering period than most other species, but in contrast, they have an interesting vegetative mass and, therefore, can be used in rock gardens and in flower beds with perennial flowers. On the basis of accumulated knowledge on *S. coerulea,* it could be maintained that the species is suitable for planting in rock gardens, in creating flower beds and single-species groups in the grass and flower areas.

The differences between *L. maculatum* and *L. maculatum* f. *album* are probably due not only to genetic traits, but to their reaction to the conditions under which they are grown. Since *L. maculatum* and *L. maculatum f. album* were planted in an open sunny area, we could assume that the typical form of the species is better adapted to these conditions.

With the exception of *Inula britannica,* the study of all other species will continue to accumulate data on their perennial development in culture. *Anthemis tinctoria* has developed very well and blooms profusely, but most plants quickly soured their appearance in early August and part of them died out. Due to rich flowering and good development in spring and early summer, the species would continue to be studied, taking into account the observed problems. *Inula britannica* has shown aggressive behavior as each plant covered more than 1 m^2 with root cuttings. This aggressive reproductive capability makes it inappropriate for use in flower areas, so further experiments will not continue.

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