

EFFECTS OF DIFFERENT SUBSTRATES ON SEED GERMINATION OF FOUR PROTECTED SPECIES FROM GENUS *GONIOLIMON*, FAM. *PLUMBAGINACEAE*

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Abstract

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The current study was undertaken in the Institute of Ornament Plants, Sofia during the period 2012-2014. The aim was to establish the influence of six different substrates on seed germination of four wild species of genus *Goniolimon* (*G. besseri-anum*, *G. collinum*, *G. tataricum* and *G. dalmaticum*) germinated under greenhouse conditions. The highest germination rate of 35-45%, for all studied species was recorded when the seeds were sown on perlite which was about 2 times higher compared to the control (soil). In enriched peat the percent of germination exceeded the control 1.5 times. The germination rate in other tested substrates (soil + enriched peat, in a ratio 1:1; soil + enriched peat + perlite, in a ratio 1:1:1; a layer of perlite on the top and a layer of soil beneath in a ratio 1:1) was similar to the control for all studied species (approximately 12-20%). An exception was found for *G. tataricum* which germination rate was 28% to 35% in the substrate perlite/soil. The obtained results suggest that the selection of proper substrate is a prerequisite for improving the germination potential of wild *Goniolimon* species.

Key words: perlite, seeds, germination, wild species

Introduction

Species of the genus *Goniolimon*, distributed in our country are perennial herbaceous plants with spindle-shaped roots, reaching a depth of 20-25 cm. They form leaf rosette and 2-4 inflorescences reaching a high of 25-35 cm. The petals are of pale violet to purple colored. The flowers are used for cut fresh and dried flowers. The seeds are small, brown colored and are harvested in late August and early September (Anchev, 1982; Kaninski et al., 2008). Seed germination depends on environmental conditions such as soil, temperature, rain falls etc. Seeds collected from the same species growing under different conditions may exhibit different germination capacity (Baskin and Baskin, 2014). In addition, individual seeds from the same population can be indifferent physiological state and the germination period can be unequal or prolonged (Izhik, 1976). The studies with seeds

of other wild species such as *Lilium* and *Goniolimon tataricum* pointed to major inequalities for the timing of germination and low germination rate (Graaff, 1970; Vitanova et al., 2000; Kaninski et al., 2008). The problem can be partially solved by various pre-treatments of the seeds. According to authors mentioned above, pre-treatment of *Lilium rhodopaeum* Delip. seeds with physical and chemical agents resulted in increase of germination rate up to 53%. In addition, exposure of *G. tataricum* to high-low-high temperature (18-20°C, 2-5°C, 13-15°C) led to germination rate of 41% (Kaninski et al., 2008). An effective option for improving seed germination can be the use of appropriate substrates. Regarding testing the effect of various substrates on seed germination in wild species, the information is limited. Therefore in the present research the influence of six substrates on seed germination of four species from genus *Goniolimon* was tested.

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Materials and Methods

The experimental work was undertaken in the Institute of Ornamental Plants (IOP), Sofia in the period 2012-2014. Objects of the study were four species from genus *Goniolimon* (*G. besserianum*, *G. collinum*, *G. tataricum* and *G. dalmaticum*) included in the Red Data Book of the Republic of Bulgaria and Annex № 3 of the Biodiversity Act.

The seeds were collected from plants growing in native populations in Bulgaria: *G. tataricum* from the field "Propadnalo blato" in vicinity to Dimitrovgrad, South-East region of the country; *G. collinum* – Chisti kamak, Izvor, Rubchovdol, Slogo, Bachishteto area close to Gradec village – Sofia region; *G. besserianum* from the field nearby "Russalka" resort, North Black Sea Coast, and *G. dalmaticum* from the Omay area close to Nova Lovcha village Slavyanka mountain, South-West Bulgaria. The seeds used for the experiments were harvested in the previous year at stage of full maturity when the seed coat turned yellow. The seeds were then dried under controlled conditions for two weeks, and thereafter stored at 4°C.

In order to test the influence of substrates on the germination rate of the four species under study, six variants of substrates were used:

- I. variant – soil (control)
- II. variant – enriched peat
- III. variant – soil + enriched peat, in a ratio 1:1
- IV. variant – soil + enriched peat + perlite, in a ratio 1:1:1
- V. variant – a layer of perlite on the top and a layer of soil beneath, in a ratio 1:1
- VI. variant – perlite

The soil is alluvial-meadow: pH - 5.1 ÷ 7.1 in KCl (slightly acid to neutral); humus content of 78 g.kg⁻¹; N₂ - 1.6 ÷ 2.1 mg/100 g soil; K₂O - 5.0 ÷ 7.0 mg/100 g of soil; P₂O₅ - 12 mg/100 g soil. The enriched peat contained N₂ - 150-250 mg/l; K₂O - 5.0 ÷ 7.0 mg/l and P₂O₅ - 12 mg/l, pH - 5.8 ÷ 6.3.

The seeds were sown in plastic containers and kept at controlled greenhouse conditions with average minimum temperature 8-10°C and average maximum temperature 20-25°C, 70% relative humidity. Germination rate was recorded after 100 days based on the number of seedlings that reached cotyledon stage.

All experiments were carried out in 6 replicates with 100 seeds per replicate and the whole set of experiments were repeated three times in three consecutive years. Presented data are average for each year. Data were statistically processed with Paired t-test (GraphPad Prism 6, Statistical Software, 2014), confidence level $p \leq 0.05$, $p \leq 0.01$, $p \leq 0.001$.

Results and Discussion

The results obtained from the current study showed that the seed germination of *Goniolimon* species was dependent on the substrate (Figure 1). The highest germination rate for all species was recorded in the variant containing only perlite. No difference of seed response between the years was observed. Average for the three years of research the best results were obtained for *G. tataricum* with average 45% of germinated seeds. The germination rate for the species *G. besserianum* in the variant of perlite was about 41% average for 2012-2014. For the species *G. collinum* and *G. dalmaticum* the germination rate in perlite was 35% and 37% respectively. In general, for all species, the rate of seed germination on perlite was about two times higher than that of the control (soil).

Good results were obtained in enriched peat, where the germination rate was in the range of 16% to 27% average for the three years of study. The yearly variation was in between 3% and 6% for individual species (data not shown). The highest germination rate, in enriched peat variant, was recorded for *G. besserianum* (24% to 29%) and *G. dalmaticum* (23% to 29%) whereas for *G. collinum* it was 22% to 25%. In enriched peat the percent of germination exceeded the control 1.5 times. In comparison to the control *G. tataricum* showed lower germination rate.

For the whole period 2012-2014, the highest germination rate in the substrate perlite/soil was observed for *G. tataricum* - 28 to 35%. Unsatisfactory germination was found for *G. dalmaticum*, which was about 2-3% lower than the control.

In substrate variants – soil + peat; soil + peat + perlite – the established germination rates were closed to the control.

The germination rate of the wild seeds of *G. tataricum* was compared to the germination features of seeds collected from cultivated *G. tataricum* grown in *in situ* collection at IOP, Sofia. Although the satisfactory results in some substrates of seed germination 41-45%, the optimal germination in cultural *Goniolimon tataricum* by 90-96% was not obtained.

To the best of our knowledge, very few studies have dealt with the effect of different substrates on seed germination. The influence of 5 substrates on the production of seedlings of six species of genus *Limonium* has been tested. For all species they have recorded the highest values of seed germination in substrate perlite 42-51% (Kaninski, 2013). Our data substantiate these observations. According to Nikolova (1995), best for sowing are sandy and leafy soils as in stage cotyledons plants need less nutrients. In this regard are par-

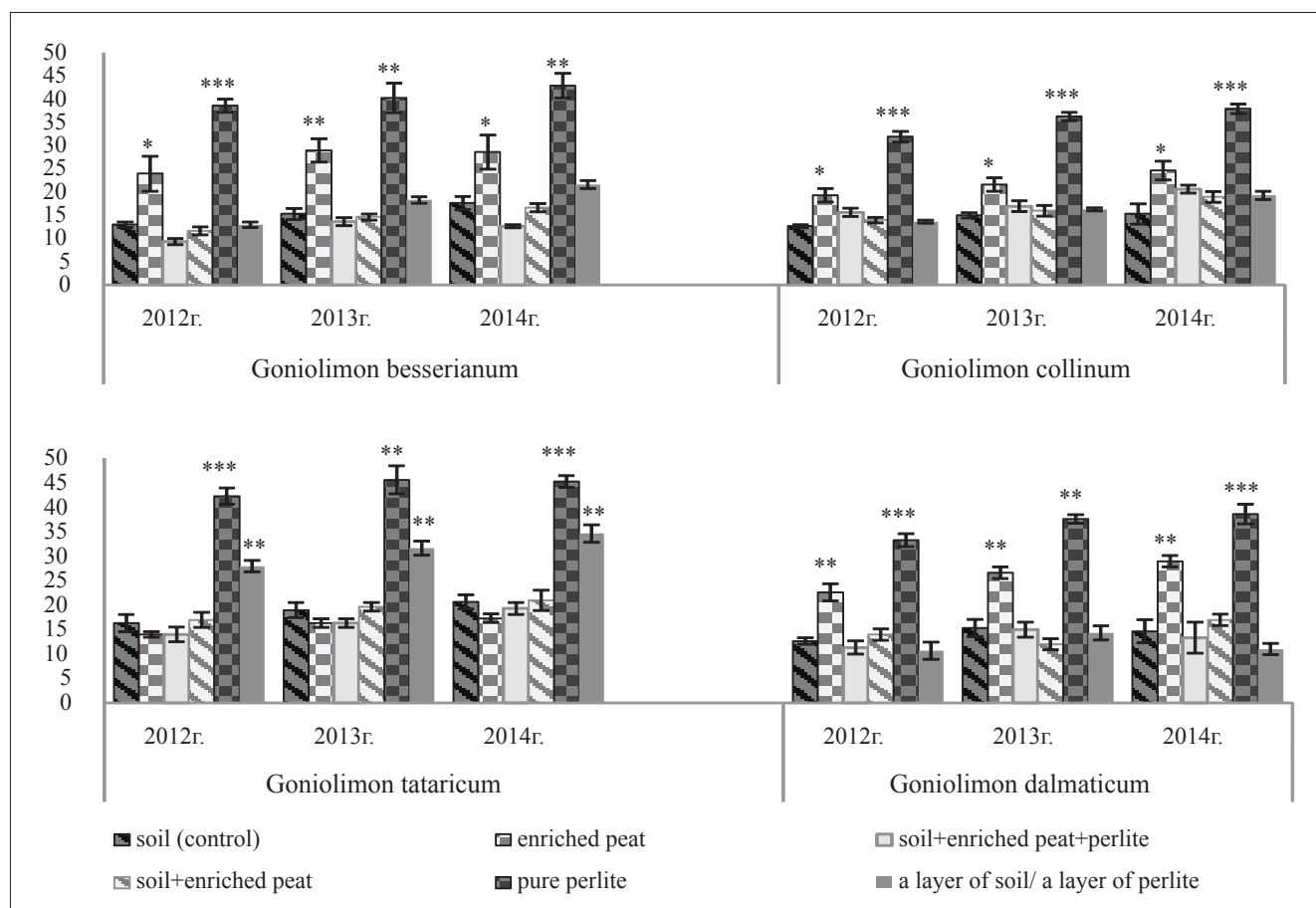


Fig. 1. Effects of different substrates on germination rate of 4 species from genus *Goniolimon*, fam. *Plumbaginaceae*

Values indicated with asterisks are significantly different as follows:

* p value 0.01 to 0.05; ** p value 0.001 to 0.01; *** p value 0.0001 to 0.001

ticularly important good physical qualities - its water and air permeability. The germination rate of *G. tataricum* was tested in greenhouse conditions (Vitanova, 2003), the growing substrate was – soil + peat + sand – in a ratio 1:1:2, the germination rate was 6%. The authors pointed out that the species have long germination period, which is the reason for the low germination.

Hypothetically this might be an adaptive feature of the species for survival at continuous unfavorable weather conditions. Species of genus *Goniolimon* begin to germinate on the seventh day and this continues throughout the growing season.

Conclusions

- On perlite the studied *Goniolimon* species express comparable germination rate of approximately 25-45%, which is about 2 times higher than in the control (soil).
- Good results were obtained when the seeds were germinated in enriched peat where by the germination rate exceeded the control 1.5 times
- In combined substrates of – soil + enriched peat, soil + enriched peat + perlite, a layer of soil/a layer of perlite – the established germination rate of all studied species did not significantly differ from the control.

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