Biology of germination of medicinal plant seeds. Part XXIIa. Seeds of *Rhodiola kirilowii* (Regel.) Maxim from *Crassulaceae family*

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S u m m a r y

Morphological features of *Rhodiola kirilowii* seeds and seedlings were described. A four-year cycle of monthly germination analysis of *Rhodiola kirilowii* was carried out. The analysis was performed every month. The germination of *Rhodiola kirilowii* seeds was available in good light conditions. The determination of the germination capacity was possible after 17 days. During the first year after the harvest the germination of *Rhodiola kirilowii* seeds oscillated up to 80%. Seeds stored in unheated room kept their viability even up to 9 years after the harvest.

Key words: *Rhodiola Kirilowii, germination, seeds*

INTRODUCTION

This work continues the investigation on the biology of germination of species from *Crassulaceae* family [1]. An account of the morphological features of this family was evaluated in previous paper dealing with *Rhodiola rosea* [1].

Rhodiola kirilowii is a perennial plant [2, 3]. The plant reaches a height of 40–50 cm. and has a few vertical rows (1–3) of sessile leaves. The shape of leaves varies from linear to linear-lanceolate, 4–7 cm long and 0.2–0.5 cm wide. The leaf margin is sparsely serrulated or smooth. The apex of leaves is pointed. The flowers are bisexual, acuminate in inflorescence wide up to 10 cm. The cultivated plants bloom in May. Female flowers are longer than petioles, while male flowers are shorter. Sepals are linear, pointed and can attain 1.5 to 3 mm in length. Petals are green, greenish-yellow or red, half as long as sepals. Petals' shapes vary from linear-lanceolate to obovate and get wider towards their top. Stamens are yellow and are of the same length as petals. *Rhodiola kirilowii* fruit is hard, brown and dry, containing a big amount of tiny seeds.

Rhodiola kirilowii originates from China, Japan and the Central Asia (Pamir and Tian Shan Mountains) [2, 3]. Nowadays, the *Rhodiola kirilowii* species is an object of scientific interest due to its medicinal properties. Oral administration of *Rhodiola kirilowii* can significantly reduce pathological damages in rat's viscera due to hypoxic environment of altitude and can efficiently protect people in the mountains from abnormalities in their cardiopulmonary function caused with change of altitude [4]. The main pharmacological active substances of *Rhodiola kirilowii* are phenyloethanoids, phenylopropanoids and flavonoids [5].

MATERIALS AND METHODS

For a long time, the Garden of Medicinal Plants in Plewiska has been carrying out the experimental cultivation of *Rhodiola kirilowii* in order to obtain raw material, mainly seeds, for research. Every year, generative stems with fruits were cut down. After drying in natural conditions and cleaning, the *Rhodiola kirilowii* seeds were collected. This material was used to estimate the following characteristics: thousand-seed weight, the morphology of seeds, germination capacity in laboratory conditions and the viability of seeds during the years of storage.

Investigations were performed in 2004–2010. As no data concerning the germination – capacity of *Rhodiola kirilowii* seeds were found – an initial attempt to test the diasporas was made. According to the methodology of estimation of seeds worked out by ISTA [6] in laboratory conditions, three variants of analyses were used. The physical conditions used during the analyses of germination ability were as follows: light and variable temperature, darkness and variable temperature, light and constant temperature. The seeds germinated on Petri dishes at a constant temperature of 20°C in daylight. The climate chamber was applied to obtain darkness and changing temperature (30°C for 6 h and 20°C 18 h), while the Jacobsen apparatus was used to make the temperature change (30°C for 8 h and 20°C for 16 h). Blotting chromatography paper (Whatman 3) was used as a basis.

Diagnostic features of seeds and seedlings

Rhodiola kirilowii seeds ripen before the end of summer (August/September). They are usually harvested at the beginning of September. The seed shape is elongated, sometimes slightly bent and tapering towards one end. The colour of seed is brown. The seed shell is striped lengthwise and the length varies between 1.1 and 1.4 mm. At its widest point, the seed is between 0.5 and 0.8 mm wide and approximately 0.3 mm thick. The thousand-seed weight is between 0.8 and 1.0 g.

The *Rhodiola kirilowii* seedling consists of two bare, visibly marked out cotyledons. The shape of the cotyledons is from oval to oblong with rounded apex. The upper and the bottom surface of the smooth-margin cotyledon is light green. Its structure is a fine network.

The radicle appears in day 8–11 from the beginning of the test. The radicle is whitish-green, thin and gets longer on consecutive days. A primary root area is hardly noticeable (fig. 3, 4).

Germination of seeds

In laboratory conditions, the first and the most abundant germination of seeds occurred after day 5–7 from the beginning of the analysis. The second supplementary counting was made on day 14–17. The seeds that had not sprouted were left for the following 14 days. Afterwards none of the seeds were able to germinate. Therefore, the seed germination ability can be determined after 17 days from the beginning of the analysis.

The abovementioned laboratory conditions were applied in a one-month study on seed material collected in 2004–2007. The results are shown as the average of 4 years (fig. 1).

No significant influence of harvest year on seed germination was found. *Rhodiola kirilowii* plant is well adapted to quite severe conditions of the natural growth. Therefore, probably the climate fluctuations of the lowland region of Poland have no influence on seed material value.

The results show slight differences between analyses carried out on Petri dishes and in Jacobsen apparatus. The increase in the proportion of sprouted seeds was little more considerable after applying different temperatures. In the first years after the harvest, in 2004–2007, the seeds germinated very well – usually reached nearly 80%, often 90%.

Germination of seeds in darkness was considerably low – it ranged from about 30 to over 60%. The findings obtained in the studies show the optimal conditions for germination of *Rhodiola kirilowii* seeds such as blotting chromatography paper as a basis, variable temperatures (of $20^{o}C$–$30^{o}C$) and light accessibility.

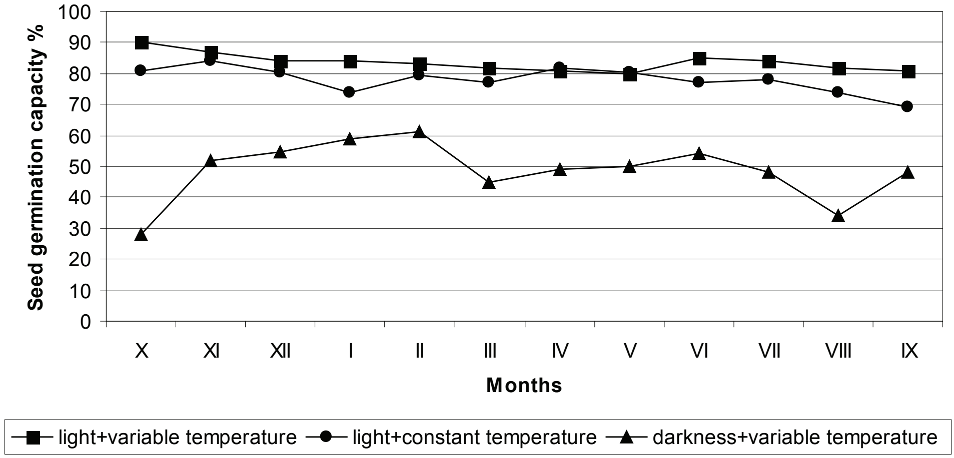

Figure 1. Germination capacity of *Rhodiola kiriolwii* seeds in the first year after harvest (average of 2004–2007)

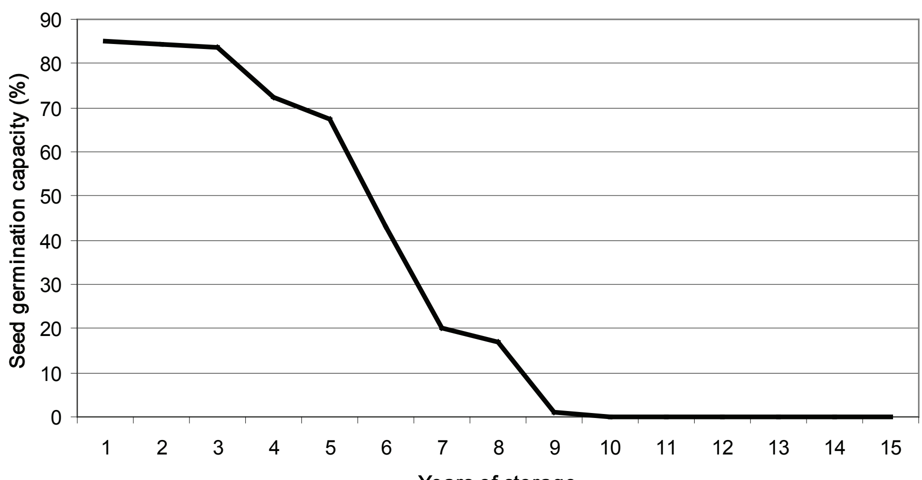

Figure 2. Germination capacity of *Rhodiola kirilowii* seeds stored in unheated room

Figure 3. *Rhodiola kirilowii* seedlings on Petri dish in day 9 from the beginning of the test

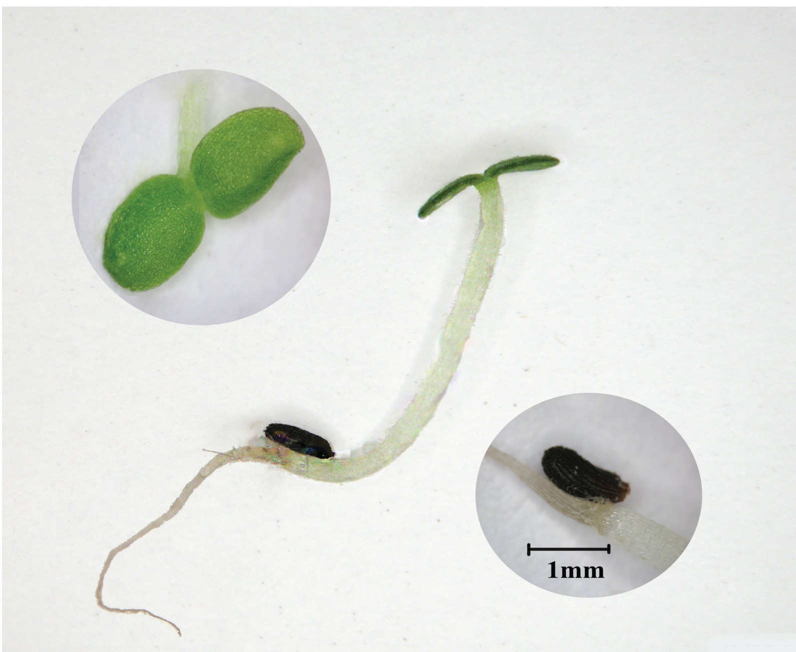

Figure 4. Seed, cotyledons and seedling of *Rhodiola kirilowii*

The viability of stored seeds

The seeds viability tests were carried out in 2009 and 2010 on the basis of the seed material collected in 1995–2008 (fig. 2). Seeds samples were analyzed in variable temperatures and light accessibility. In whole period of storage, the seed samples were kept in the darkness in unheated room conditions.

The germination of seeds stored for two and three years was about 80%, just as seeds in the first year after the harvest. In the following two years, the seed viability decreased to 70%. The seed material stored for 6 years was quite viable. Although, after 9 years of storage, the seed germination reached only 1%. The seeds stored for 10 years and longer did not germinate.

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S t r e s z c z e n i e

Opisano cechy morfologiczne nasion i siewek różeńca Kiryłowa. Przeprowadzono czteroletni cykl comiesięcznych badań zdolności kiełkowania nasion różeńca Kiryłowa. Stwierdzono, że nasiona różeńca Kiryłowa do kiełkowania wymagają dostępu światła. Zdolność kiełkowania można ustalać po 17 dniach od rozpoczęcia analizy. W pierwszym roku po zbiorze nasiona różeńca Kiryłowa kiełkują w około 80%. Przechowywane w nie ogrzewanym magazynie zachowują żywotność nawet do 9 lat po zbiorze.

Słowa kluczowe: *Rhodiola kirilowii, kiełkowanie, nasiona*