

## SHORT COMMUNICATIONS

# On the Ecology of Seed Germination in *Adonis vernalis* L.

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Received May 14, 2005

DOI: 10.1134/S1067413608010116

*Key words:* spring adonis, seeds, germination rate.

*Adonis vernalis* L. (the spring adonis) is a herbaceous perennial of the family Ranunculaceae with a specific rhythm of development involving early flowering and active vegetative development throughout summer. Its seeds germinate underground, with the pericarp remaining in the soil and seed leaves emerging on the surface (Kulpa, 1960). Seed productivity and the time of emergence of sprouts depend on ecological conditions of plant growth (Poshkurlat, 1971). The range of *A. vernalis* extends over the forest-steppe and, partially, steppe zones of Europe and Asia. This species prefers calcium-rich chernozem soils of different types but also grows on meadow chernozems and gray forest soils.

*Adonis vernalis* is a highly valuable medicinal plant with a cardiotropic effect. The aboveground parts of plants at the stage of flowering or fruiting are harvested as a raw material for the pharmaceutical industry. With respect to the amount of this material, *A. vernalis* is high on the list of wild-growing medicinal plants. However, natural populations of this species in Russia are rapidly being depleted. This brings up the urgent problem of its cultivation on a commercial scale, which would be also useful for its conservation. However, research teams dealing with this problem for many years have encountered major difficulties accounted for by the biological features of this relict plant (Bogdanovskaya-Gienef, 1954; Fitul'ska, 1957; Tsibanova, 1960; Poshkurlat, 1969, 1971, 1975; Strokova, 1970). Plants grown on experimental plots are characterized by low seed productivity: the seeds have a low germination rate (below 20%), and seedlings die of drought in summer and cold in winter (Ivashin, 1962). Specialists agree that constant and sufficient soil moistening is a necessary condition for improving the germination capacity of seeds and the quality of seedlings in *A. vernalis* culture. It is recommended to sow the seeds as soon as they mature. If this is impossible, Fitul'ska (1957) proposes to store them in moist sand in a cool place.

In this study, we consider the results of observations on *A. vernalis* seeds (freshly collected and stored for different periods of time) germinating under laboratory conditions (in vitro or in containers with soil) and in open ground.

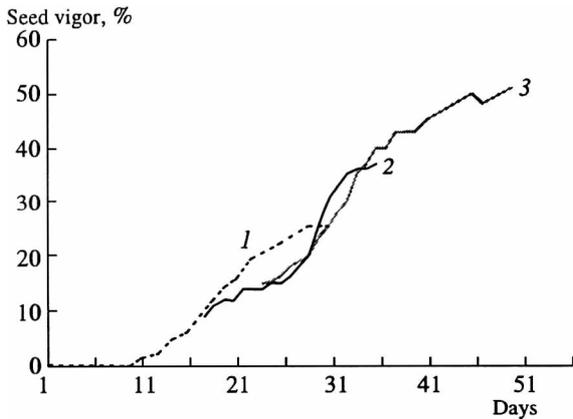
The seeds were collected in early June 2003 from 30 *A. vernalis* plants grown in fertile, moderately moist light-texture soil containing a small amount of lime. They were germinated under different conditions in three variants: immediately after sampling and after storage for 30 and 120 days. In the first laboratory experiment, only freshly collected seeds were used. They were placed to germinate in Petri dishes, on filter paper soaked in a  $\text{KMnO}_4$  solution, at 20-21 °C and were examined every day.

In the second laboratory experiment, freshly collected seeds and seeds stored for 30 and 120 days were sown to a depth of 1 cm in a peat mixture placed in 1-m<sup>2</sup> containers, which were kept in an unheated room at constant air humidity and temperature (20-21 °C). The mixture was treated with  $\text{KMnO}_4$ .

In the open-ground experiment, freshly collected seeds were sown to different depths (1, 2, 3, and 4 cm). Another batch of seeds collected in July was exposed to stratification at different temperatures (20-25, 13-15, 3 to -5, and -5 to -7°C) for 120 days. Thereafter, the seeds were sown in 2-m<sup>2</sup> plots laid in a well-illuminated area with moderate soil moistening. To preserve natural conditions in the plots as much as possible, we did not dig up the soil but made furrows for seeds by cutting sod with a sharp spade. No physical or chemical treatment of seeds was used, and the soil was not watered after sowing. The germination rate of *A. vernalis* seeds under these conditions was estimated in spring.

As the formation of soil crust could be deleterious for seeds, the plots were mulched with a 1-cm layer of fermented manure. The sprouts of *A. vernalis* are intolerant of weeding, and the plots were thoroughly cleared of undesirable plants. In each variant, groups of

## ON THE ECOLOGY OF SEED GERMINATION



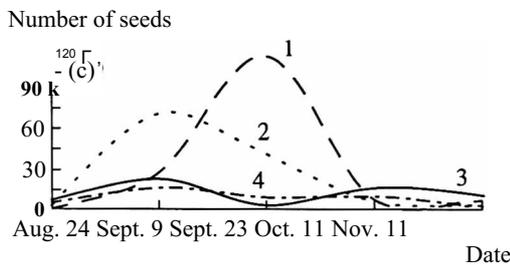
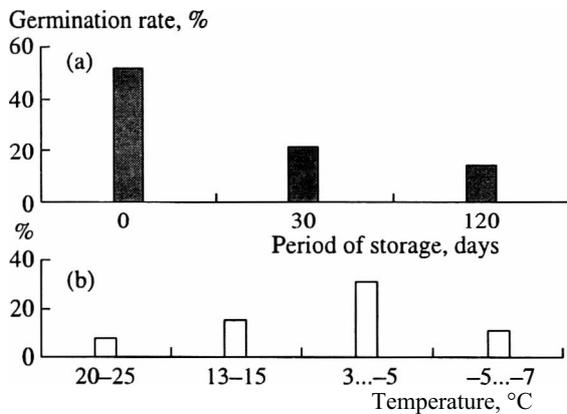
**Fig. 1.** Seed vigor of freshly collected *Adonis vernalis* seeds (1) germinated in the laboratory and sown (2) in containers and (3) in open ground.

100 seeds were sown in three replications. The results of experiments were processed statistically.

In the laboratory, some seeds in Petri dishes became overgrown with mold and rotted within a short time. The first sprouts in the remaining seeds appeared on day 11, but most of them perished. In other experiments, the first sprouts were recorded on day 15 in con-

tainers and on day 23 in open ground. The respective germination rates averaged 25, 36.1, and 51%. Data on seed vigor are shown in Fig. 1. The period before the emergence of first seedlings proved to increase considerably depending on the time of seed storage prior to sowing in the ground. After storage for 30 days, the first seedlings appeared on day 43 and the germination rate (21.1%) was lower than in the variant with freshly collected seeds. After storage for 120 days, the first seedlings appeared on day 58 and the germination rate was still lower, only 14% (Fig. 2a). In stratified seeds sown in the ground, the germination rate after stratification at 3 to -5 °C was 30%, compared to only 7% after stratification at 20-25°C (Fig. 2b). The effect of sowing depth on seed vigor is shown in Fig. 2c. The seeds were sown on July 15, the first sprouts emerged in late August, and mass sprouting was observed in September. When seeds were placed at a depth of 1-2 cm, they produced three times more sprouts than in the variant with a sowing depth of 3 cm and six times more sprouts than in the variant with a sowing depth of 4 cm. This result agrees with data reported by Fitulska (1957) and other authors.

Thus, the germination rate of *A. vernalis* L. seeds sown in the ground is higher than that under laboratory conditions and depends on the period of their storage prior to sowing, the depth of seed placement, and the range of stratification temperatures.



**Fig. 2.** Germination rate of *Adonis vernalis* seeds sown in open ground as a function of (a) the period of storage prior to sowing, (b) storage temperature, and (c) sowing depth (numbers of curves correspond to sowing depth in cm).

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