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GERMINATION AND DORMANCY IN CEDAR GLALE PLANTS. II. *DELPHINIUM VIRESCENS*

JERRY M. BASKIN[1] AND CAROL CAUDLE
Vanderbilt University, Nashville, Tennessee 37203

ABSTRACT

Germination of seeds of *Delphinium virescens* Nutt. (Ranunculaceae) was studied. Germination tests were performed on freshly-harvested, one-, two-, three-, four-month-old seeds at six constant temperatures ranging from 5 to 30 C. Seeds of all ages tested failed to germinate at 5, 25, and 30 C, but germinated at 10, 15, and 20 C. Germination at 20 C, however, was significantly lower than at 10 and 15 C, except in the four-month-old seeds. The highest percentage germination was in one-month-old seeds where 85.3%, 84.7%, and 27.3% of the seeds germinated at 10, 15, and 20 C respectively. After one month of storage, seeds showed a steady decline in germination with age; after four months of storage, germination had decreased to 10.7%, 10.0%, and 12.0% at 10, 15, and 20 C respectively.

The failure of *D. virescens* to germinate at the higher temperatures is interpreted as an ecologic adaptation which delays germination until October and November, thus allowing the seeds to germinate when moisture and temperature are favorable for seedling establishment.

INTRODUCTION

Delphinium virescens Nutt. (Ranunculaceae), a perennial herb, is a common spring aspect dominant of grassy areas in cedar glades of Middle Tennessee, which are dominated by *Sporobolus vaginiflorus* (Torr.) Wood and *Aristida longespica* Poir. (Quarterman, 1950). *D. virescens* flowers in April and the mature seeds are shed in June. However, germination does not occur until October and November. This paper is concerned with the reason(s) for the failure of seeds of *D. virescens* to germinate in the summer.

METHODS

Seeds of *Delphinium virescens* were collected from a cedar glade in Davidson County, Tennessee, near Nashville in June, 1967. After collections were made, seeds were removed from the follicles and stored in plastic containers in an air-conditioned laboratory until used. Germination tests were performed in 10 cm petri dishes containing two sheets of Whatman No. 1 filter paper moistened with distilled water. Three replications of 50 seeds each were used for each treatment. All germination tests were carried out in constant temperature incubators. The temperatures used were 5, 10, 15, 20, 25, and 30 C. The photoperiod was 12 hours. The age of the seeds when placed on moist filter paper is taken as the length of time since collection. Final germination counts were made after one month, and the seeds were considered to have germinated when the radicle emerged from the seed coats.

RESULTS AND DISCUSSION

The results indicate (Table 1) that germination of seeds was mostly at the lower temperatures (10 and 15 C) tested, with some germination occurring at 20 C. Germination in freshly-harvested seeds was 46.0% at 10 C, 54.7% at 15 C, and only 6.0% at 20 C. There was no germination at 5, 25, or 30 C. The highest percentage germination obtained was in one-month-old seeds, where 85.3% germinated at 10 C, 84.7% at 15 C, and 27.3% at 20 C. After one month of storage, seeds showed a steady decrease in germination with age at 10, 15, and 20 C, and, after four months, germination had decreased to 10.7%, 10.0%, and 12.0% at 10, 15, and 20 C respectively. For seeds of any given age, there was little difference in germination at 10 and 15C, while germination at 20 C was noticeably lower than at 10 and 15 C, except in the four-month-old seeds where germination was about the same.

The results presented here indicate that the seeds of *Delphinium virescens* have no internal mechanism causing dormancy. Freshly-harvested seeds of this species germinated readily at the lower temperatures tested. Other than high temperature, no inhibitory factors were evident.

The seeds of *Delphinium virescens* are shed in June and germination occurs the following fall. During the summer, germination is prevented by high temperatures. With the advent of lower temperatures during October and November, there is an overlap between the prevailing temperatures and the temperatures required for germination, and the seeds germinate. Unlike germination of some winter annuals studied (Caudle and Baskin 1968), the maximum temperature at which germination can occur does not increase as the length of storage increases.

As the seeds age, there is a percentage decrease in germination. In our experiments, few four-month-old seeds germinated. Thus, it is expected that a low percentage of the seeds in each seed crop germinate, since seeds are approximately four months old when germination begins in the field.

High temperature dormancy of *Delphinium virescens* is an ecologic adaptation which prevents germination during the hot, dry season when there is little chance for establishment. Inhibition by high temperature prevents germination until October and November, thus allowing the seeds to germinate when moisture and temperature are favorable for seedling establishment.

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[1] Present address: Department of Botany, University of Kentucky, Lexington, Ky. 40506.

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Literature Cited

Caudle, C. and J. M. Baskin. 1968. The germination pattern of three winter annuals. Bull. Torrey Club 95:331-335.

Quarterman, Elsie. 1950. Major plant communities of Tennessee cedar glades. Ecology 31:234-254.

Table I

Percentage Germination of Freshly-Harvested, One-, Two-, Three-, and Four-Month-Old Lab-Stored Seeds of Delphinium virescens At Six Temperatures

Duration of Storage (Months)	5 C	10 C	15 C	20 C	25 C	30 C
0	0	46.0	54.7	6.0	0	0
1	0	85.3	84.7	27.3	0	0
2	0	70.0	70.0	17.3	0	0
3	0	44.0	40.0	18.0	0	0
4	0	10.7	10.0	12.0	0	0

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GERMINATION AND DORMANCY IN CEDAR GLADE PLANTS. III. *LOBELIA GATTINGERI*

Carol Caudle and Jerry M. Baskin[1]

Vanderbilt University, Nashville, Tennessee 37203

Abstract

Germination and dormancy of the seeds of *Lobelia gattingeri* A. Gray were studied. Upon maturity practically all the seeds were dormant. Concentrations of gibberellic acid ranging from 100 to 800 ppm promoted germination of dormant seeds; whereas, 50 ppm gibberellic acid, potassium nitrate (0.02M) and thiourea (0.01M) had little or no effect. Seeds of *L. gattingeri* germinated well (66.7%) after 16 to 18 weeks of stratification at 5 C. On the other hand, the highest percentage germination in lab-stored seeds was 16.7%, after 14 weeks of storage. The minimum temperature requirement for germination was 15 C, and the optimum was 20 C.

The stratification and minimum temperature requirements for germination are adaptations which prevent germination until spring, when conditions are favorable for seedling establishment.

Introduction

Lobelia gattingeri A. Gray (Campanulaceae) is a common spring aspect dominant of grassy areas in cedar glades of Middle Tennessee, which are dominated by *Sporobolus vaginiflorus* (Torr.) Wood and *Aristida longespica* Poir. (Quarterman 1950). This herbaceous annual is endemic to the cedar glades of Middle Tennessee (McVaugh 1936, p. 346). *L. gattingeri* flowers in May and the mature seeds are shed in June. Germination apparently occurs the following spring, after the seeds have over-wintered in the field. The present study is an investigation of seed germination and dormancy in this species.

General Methods

Seeds of *Lobelia gattingeri* were collected from a cedar glade in Davidson County, Tennessee, near Nashville. After collections were made, seeds were removed from the capsules and stored in plastic containers in an air-conditioned laboratory until used. Germination tests were performed in 10 cm petri dishes containing two sheets of Whatman No. 1 filter paper moistened with distilled water, except in the experiments on chemical treatments where solutions of gibberellic acid, thiourea, and potassium nitrate were also used. Three replications of 50 seeds each were used for each treatment. Unless otherwise stated, germination tests were carried out in constant temperature incubators at 25 C and at a 12 hour photoperiod. The seeds were considered to have germinated when the radicles emerged from the seed coats.

Experimental Procedures and Results

Initial Experiment

To test for germination in freshly-harvested seeds of *Lobelia gattingeri*, seeds were placed at 10, 20, and 30 C at a 12 hour photoperiod and in constant darkness. After one month, no germination had occurred, except at 20 C in the light, where only 8% of the seeds germinated. It was concluded that freshly-harvested seeds of *L. gattingeri* were dormant.

Chemical Treatments

To test the effect of certain chemicals on germination of dormant seeds (Mayer and Poljakoff-Mayber 1963), freshly-harvested seeds of *Lobelia gattingeri* were placed on filter paper moistened with five concentrations of gibberellic acid ranging from 50 to 800 ppm, thiourea (0.01M), and potassium nitrate (0.02M). Germination in these chemically-treated seeds was then compared to germination in a water control. After one month, some germination had occurred in the seeds treated with gibberellic acid and potassium nitrate, as well as in the water control (Table I). Seeds treated

[1] Present address: Department of Botany, University of Kentucky, Lexington, Ky. 40506

with 100, 200, 400, and 800 ppm gibberellic acid germinated to a noticeably higher percentage than the water control. Whereas, there was very little increase in germination over the water control in seeds treated with 50 ppm gibberellic acid or potassium nitrate. There was no germination in the thiourea-treated seeds. The highest percentage germination in this experiment was 54.7% (800 ppm GA) and the lowest was 0.0% (thiourea). The water control germinated to 8.0%.

Table I

Effect of Gibberellic Acid, Thiourea, and Potassium Nitrate On The Germination of Freshly-Harvested Seeds of *Lobelia gattingeri*

Treatment	Germination (%)
Thiourea (0.01M)	0.0
KNO_3 (0.02M)	16.0
GA (50 ppm)	13.3
GA (100 ppm)	44.7
GA (200 ppm)	42.7
GA (400 ppm)	46.7
GA (800 ppm)	54.7
Water Control	8.0

Stratification and Afterripening

An experiment was set up to test the effect of stratification and of afterripening in dry storage on subsequent germination. One lot of freshly-harvested seeds of *Lobelia gattingeri* was placed in petri dishes on filter paper moistened with distilled water and stored in a cold room at 5 C for intervals of 4 to 22 weeks. A second lot was stored dry in the laboratory for intervals of 4 to 22 weeks (Table II). After each treatment (interval of time), seeds were placed at 25 C and a 12 hour photoperiod for two weeks. From Table II, it may be seen that stratification was quite effective in promoting germination. The highest percentage of germination (66.7%) in this experiment was in those seeds receiving 16 to 18 weeks of stratification. Increasing the length of stratification, up to 22 weeks, did not result in an increase in germination. The lowest percentage (8.7%) in the cold-treated seeds was in those seeds which received six weeks of stratification. Dry storage in the laboratory was much less effective than stratification in overcoming dormancy. The highest percentage germination (16.7%) in lab-stored seeds was after 14 weeks of storage. Increasing the length of storage, up to 22 weeks, did not result in an increase in germination. The lowest percentage germination (2.0%) in lab-stored seeds was after four weeks of storage.

Table II

Percentage Germination In Cold-Moist-Stored and In Lab-Stored Seeds of *Lobelia gattingeri*

Duration of Storage (Weeks)	Percentage Germination Stratified	Lab-Stored
4	16.7	2.0
6	8.7	2.7
8	26.0	5.3
10	47.3	15.3
12	31.3	14.0
14	52.7	16.7
16	66.7	13.3
18	66.7	11.3
20	43.3	4.0
22	54.7	13.3

Table III

Germination In Cold-Moist-Stored and In Lab-Stored 22-Week Old Seeds of *Lobelia gattingeri* At Five Temperatures

Temperature (C)	Percentage Germination Stratified	Lab-Stored
5	0.0	0.0
10	0.0	0.0
15	60.7	7.3
20	66.7	16.0
25	54.7	13.3

Germination at Five Temperatures

To test the effect of temperature on germination, seeds of *Lobelia gattingeri* which had been stratified for 22 weeks and seeds which had been lab-stored for 22 weeks were placed at temperatures ranging from 5 to 25 C at 5° intervals (Table III). After two weeks, some germination had occurred in both stratified and in lab-stored seeds at 15, 20, and 25 C. Germination in stratified seeds, however, was noticeably higher than germination in lab-stored seeds at all three temperatures. There was no germination at 5 or 10 C. The optimum temperature for germination in both stratified and lab-stored seeds was 20 C, where 66.7% of stratified and 16.0% of the lab-stored seeds germinated.

Discussion

The results presented in this paper indicate that most of the seeds of *Lobelia gattingeri* require a period at low temperature, or treatment with gibberellic acid, in order for germination to occur. In nature the cold requirement of *L. gattingeri* is satisfied during the winter, and by the following spring they are capable of germinating. The minimum temperature requirement for germination of *L. gattingeri* seeds (approximately 15 C) prevents them from germinating until temperatures are favorable for seedling survival.

The possible role of low temperatures in breaking the dormancy of seeds of *Lobelia gattingeri* may be the production of endogenous gibberellins, since gibberellic acid caused dormant seeds to germinate. In seeds of *Corylus avellana* L. gibberellins were found to be present after chilling, but not in non-chilled seeds (Frankland and Wareing 1962).