Seed Biology-Friend or Foe to the Endangered *Physaria ludoviciana*

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ABSTRACT

Physaria ludoviciana (Nutt.) O'Kane & Al-Shehbaz (silvery bladderpod; Brassicaceae), formerly *Lesquerella ludoviciana*, is state endangered in Illinois and Minnesota sand prairies. An overview of how seed biology affects its ability to persist is lacking. Our goal was to evaluate how seed biology (production, afterripening, longevity and seedling establishment) affects the persistence of *Physaria ludoviciana*. Fruits were collected in Mason County, Illinois in June of 1999-2008. Inflorescence structures were counted to estimate seed production. Fruits from lower and upper portions of the inflorescence were separated before removing seeds since seeds on lower portions of stalks mature before those on upper portions. Reproductive plant densities were 1-4 plants/m^2 with ~500 seeds per plant. Seeds were germinated in Petri dishes with moistened filter paper at 25°C with continuous light. Seed vigor was affected more by maturity than date or year of collection. Seeds collected in 2007 were germinated at two month intervals after harvest to determine whether afterripening occurred. In these trials, germination rates increased greatly when seeds were stored for six months compared to seeds without any storage. In other years, seeds stored at 4ºC with 40-50% relative humidity remained viable for at least 6.5 years. Although no seeds were found in soil cores, seedlings still managed to establish as seedling densities ranged from 1-11 seedlings/m^2 during surveys in June 2000-2008. These studies in seed biology allow us to predict the recruitment of *P. ludoviciana* and could be useful in restoration and land management efforts.

INTRODUCTION

Physaria ludoviciana (Nutt.) O'Kane & Al-Shehbaz (silvery bladderpod; Brassicaceae), formerly *Lesquerella ludoviciana*, is state endangered in Illinois and Minnesota sand prairies. The only location where the plant currently exists in Illinois is the Henry Allan Gleason Nature Preserve in Mason County (Herkert and Ebinger, 2002). Flowers bloom in late spring when the flower stalk elongates from a basal rosette of silvery leaves (Judd *et al.*, 2008), and fruits mature in early summer. Several factors affect its seed biology. Seed production per plant in 2002 was 500 (Claerbout, 2003), but it is not known if this number varies from year to year. Seeds do not require any stratification or scarification to germinate (Coons *et al*., 2000) but it is unclear if they need afterripening. Germination in seed is high even after several years in storage as long as seeds are mature when collected (Jernegan and Coons, 2006). Claerbout (2003) did not find any seeds in the seed bank when sifting and planting soil cores, which was not expected given that seedlings are present. Other techniques to quantify seeds in seed bank need to be investigated. A better understanding of the seed biology of this species is important for its survival and to make good management decisions.

P. ludoviciana in Fruit

Study Site

OBJECTIVE

To investigate seed biology (production, afterripening, longevity, and seedling establishment) of *Physaria ludoviciana*.

MATERIALS AND METHODS

? *P. ludoviciana* was studied at the Henry Allan Gleason Nature Preserve from 1999-2008.
? Seed production was estimated by counting reproductive structures on 30-45 plants.
? Afterripening used seed collected in June 2007 from the lower stalk. Germination trials began at 0-10 months after harvest. Three reps of 50 seeds each per trial were germinated in Petri dishes at 25ºC. Seed were considered germinated when the radicle emerged.
? For seed longevity, germination trials included 9 seed lots from upper and lower stalks with different harvests in 1999-2002. Four to 5 reps of 10-50 seeds each per seed lot were used with the same conditions as for afterripening. Germination was tested from 2000-2006.
? For seed longevity in the seed bank, 20 soil cores (2 cm diameter, 5-10 cm deep) were collected near reproductive plants in April, June, September, and January. Cores were sorted by JFNew Seed Nursery using a two step screen seed cleaning machine based on seed weight, size and shape, plus a high air flow in combination with screen sizes.
? For seedling establishment and population density, quadrats (0.25m^2) were placed on alternating sides along a 45 meter transect. Seedlings (= 6 leaves), vegetative (> 6 leaves) and reproductive (flower stalks present) plants were counted.
? Averages and standard errors were calculated using Microsoft Excel. Univariate tests followed by mean separations using Duncan's multiple range tests were done using SPSS.

RESULTS

Seed Production

Year	Month	Flower Stalks/ Plant	Fruits/Stalk	Pedicels/Stalk	Seeds/Fruit [a]	Estimate Seeds/Plant Based on Fruit	Estimate Seeds/Plant Based on Pedicels
1999	June 8	6.9 ± 0.6[b]	12.8 ± 1.2	ND[c]	2.5 ± 0.4	221	ND
1999	June 22	5.9 ± 0.4	14.6 ± 1.2	ND	2.9 ± 0.2*	249	ND
2000	June	3.2	14.4	ND	2.9 ± 0.2*	134	ND
2001	May	4.7 ± 0.4	19.8 ± 1.4	ND	2.9 ± 0.2*	270	ND
2001	June	5.1 ± 0.4	11.4 ± 0.7	ND	2.9 ± 0.2*	168	ND
2001	July	4.9 ± 0.6	1.5 ± 0.2	ND	2.9 ± 0.2*	22	ND
2002	June	6.2 ± 0.6	23.7 ± 1.7	30.9 ± 2.1	3.4	500	651
2007	June	6.2 ± 0.4	22.8 ± 1.1	30.9 ± 1.4	2.5 ± 0.3	353	479
2008	June	6.7 ± 0.6	12.4 ± 1.3	34.7 ± 2.3	3.2 ± 0.1	266	744

[a] seeds per fruit is the average of 25 fruits; for years with *, fruits were not collected, so average calculated from other years
[b] means ± standard error
[c] ND=No data

? Seed production was not a limiting factor.

Longevity/Seed Germination After Storage

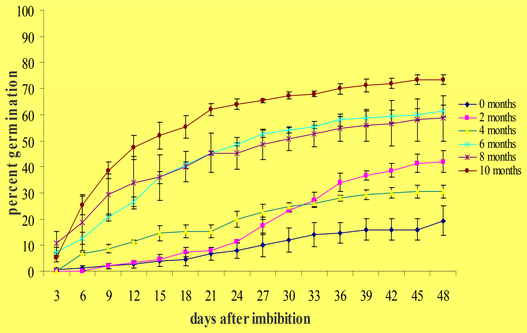
Germination Year-Month	Harvest 6-8-99 Lower Stalk	Harvest 6-8-99 Upper Stalk	Harvest 6-22-99 Upper Stalk	Harvest 6-1-00 Lower Stalk	Harvest 6-1-00 Upper Stalk	Harvest 6-16-00 Upper Stalk	Harvest 6-6-01 Lower Stalk	Harvest 6-6-01 Upper Stalk	Harvest 6-3-02 Mixed Stalk
2000- April	62.0 ± 5.8 a[ab]	20.0 ± 4.5 a	70.0 ± 6.3 a	ND[c]	ND	ND	ND	ND	ND
2000-November	50.0 ± 5.5 ab	22.0 ± 8.0 a	74.0 ± 8.1 a	50.0 ± 8.9 a	34.0 ± 6.8 a	34.0 ± 9.3 b	ND	ND	ND
2001-November	56.0 ± 10.3 a	10.0 ± 4.5 a	72.0 ± 4.9 a	18.0 ± 4.9 b	36.0 ± 2.4 a	30.0 ± 5.5 b	ND	64.0 ± 6.8 a	ND
2002-February	46.0 ± 6.8 ab	16.0 ± 5.1 a	50.0 ± 5.5 b	32.0 ± 5.8 ab	28.0 ± 5.8 a	48.0 ± 8.6 ab	70.0 ± 10.5 a	ND	16.0 ± 6.8 b
2003-February	46.0 ± 6.8 ab	12.0 ± 5.8 a	48.0 ± 5.8 b	30.0 ± 5.5 ab	24.0 ± 4.0 a	40.0 ± 7.7 b	66.0 ± 12.9 a	60.0 ± 4.5 a	16.0 ± 6.8 b
2006-January	29.5 ± 1.7 b	21.0 ± 4.7 a	61.5 ± 2.1 ab	31.5 ± 9.0 ab	38.5 ± 2.6 a	70.0 ± 5.2 a	72.0 ± 5.2 a	65.5 ± 1.5 a	42.0 ± 3.4 a

[a] means within a column followed by different letters are significantly different at p=0.05 level
[b] means ± standard error
[c] ND=No data

? Seeds remain viable in storage for 6.5 years.

Afterripening

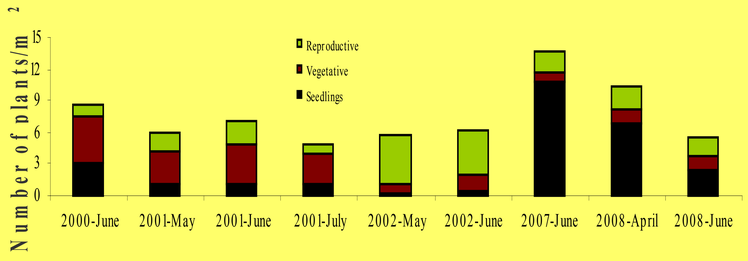
Imbibition Started 0-10 Months after Seed Harvest



? Germination rates at 0-4 months after seed harvest were slow at the beginning whereas at 6-10 months, rates increased and total percentages were higher.

Seedling Establishment

Density of Plants at Different Stages



? Seedling density fluctuated in different years. Seedlings often were in close proximity of a reproductive plant.

P. ludoviciana in Flower

Longevity in Seed Bank

? No seeds were found in the seed bank even while seeds were being shed. Perhaps herbivory is a factor.

IMPORTANCE

Seed Biology - "Friend"
? production of seeds high
? afterripening- not all seeds germinate at once
? longevity- seeds remain viable for at least 6.5 years in storage
? establishment of seedlings variable

Seed Biology - "Foe"
? longevity- seeds not found in seed bank

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