Germination of Range Plant Seeds after Long Periods of Uncontrolled Storage

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Highlight: *One hundred sixty-six lots of seed representing 60 species were stored from 14 to 41 years in unheated sheds. After 14 years storage only 36 of the 102 lots of grass produced seedlings. Of the 68 lots stored for 20 years, only 16 emerged. After 27 years of storage no grass seeds were viable. All 24 lots of legume seed produced seedlings after 14 years storage. Fifteen lots stored 20 years or more were all viable. Of the 21 lots of forb seed stored from 23 to 41 years only* Erodium cicutarium *produced seedlings. Stored for 37 years, this was the oldest seed to germinate. None of five lots of shrub seed stored 20 years were viable.*

Some seeds remain viable for several hundred years, while others have a short life span. Seeds with good longevity are usually heavy, with hard and impervious coats. Seeds with permeable seed coats, such as many cereals and grasses, seldom retain their viability more than a few years. Longevity of most seeds is increased by storage at low temperatures, low moisture content and humidity, and absence of oxygen (Barton, 1953, 1961; Crocker, 1945).

Mirov and Kraebel (1939) recommended storing seeds of native western plants in well-ventilated rooms at ordinary temperatures. Tiedemann and Pond (1967) tested seeds of 12 southern Arizona range grasses that had been stored without humidity or temperature control for 22 to 28 years. Four of the 12 species were viable and germinated from 3 to 34%. Blake (1935) found that seeds of prairie plants stored at room temperatures in Nebraska had little viability at the end of 5½ years.

Windle et al. (1966) state that the cool, dry climatic conditions in southern Idaho are ideal for seed storage and that most grass seeds stored here will maintain high viability for several years. Hafenrichter et al. (1965) stored seeds of 21 grasses in unheated warehouses at four locations in the West. At the end of 14 years eight grasses germinated 70% at Aberdeen, Idaho, but no species germinated 70% at the other three locations. They listed the Aberdeen climate as cool and dry compared to that in the other locations.

The seeds of the range plants and some weeds used in this study were obtained for experimental and large-scale range seedlings or for beet-leafhopper studies. Seeds were stored in unheated sheds, the usual procedure for seed storage in the West. The seeds were tested during 1969-71 to determine their viability after storage for 14 to 41 years.

Description of the Storage Areas

In 1969, we moved over 250 lots of seed from Twin Falls, Idaho, to Logan, Utah. The older seeds had been stored continuously at Twin Falls. About half the lots were stored at LaGrande, Ore., until 1960 and then moved to Twin Falls. Storage at both locations was in wooden frame sheds that had tin sides and roofs. Seeds were kept in paper or cloth sacks inside wooden, mouse-proof lockers. Neither seed containers nor lockers were air-tight. Some characteristics of the two storage areas follow:

Characteristics	Twin Falls	LaGrande
Elevation (ft)	3,750	2,760
Average annual precipitation (inches)	8.7	20.3
Average relative humidity (%)		
January	75	70
July	35	28
Average temperatures (°F)		
January	27	30
July	72	71
Temperature extremes (°F)		
Maximum	105	109
Minimum	−26	−22

Summer air temperatures are several degrees higher inside the sheds than outside. For example, during August 1971 at Twin Falls, the extreme maximum and minimum inside were 101 and 50°F, compared to 94 and 40°F, outside.

Procedures

All seeds which had been stored at least 14 years were tested for viability. Recent collections of 10 species were used as checks. There were 166 lots, representing 60 species.

We determined emergence by planting 50 seeds 0.2 inches deep in moist sand in a greenhouse where night and day temperatures usually ranged between 52 and 70°F and 75 and 90°F, respectively. Temperature ranges during the study did not appear to influence seedling emergence. Starting two days after seeding and continuing for 30 days, emerged seedlings were counted and removed daily. For 31 to 42 days seedlings were counted every 3 days, and from 43 to 60 days, every 6 days. Treatments were replicated four times, and replications were run consecutively during the winters of 1969-71. Many species had been tested for germination shortly after collection. These germination percentages are listed with the present tests.

Results and Discussion

Seed lots with the early germination and percent seedling emergence in 1969-71 are shown in Table 1. Seed lots with no emerged seedlings in 1969-71 are listed below. (The numbers in parentheses indicate the number of seed lots for that species. An *a* indicates storage at LaGrande until 1960):

Species	Years storage
Grasses	
Agropyron cristatum	29
A. dasystachyum[a] (3)	18 to 26
A. desertorum (3)	19 to 24
A. elongatum[a]	20
A. inerme[a]	22
A. intermedium[a] (2)	22 to 23

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A. intermedium Amur[a]	22
A. repens[a] (3)	26 to 29
A. sibiricum[a] (3)	18 to 25
A. smithii[a] (3)	27 to 41
A. spicatum[a] (3)	22 to 23
A. subsecundum[a] (2)	20 to 24
A. trachycaulum[a] (3)	19 to 23
Bromus carinatus (3)	16 to 18
B. erectus[a]	22
B. inermis[a] (2)	19 to 20
B. tectorum[a] (9)	28 to 42
B. tomentellus[a]	19
Elymus glaucus[a] (4)	18 to 21
E. junceus[a] (2)	19 to 25
E. salina	30
E. triticoides[a]	23
Festuca arundinacea[a] (2)	21 to 24
F. rubra[a] (3)	18 to 20
Orysopsis hymenoides	41
Phleum phleoides[a]	25
Poa bulbosa	36
P. secunda (5)	28 to 39
Forbs	
Descurainia sp. (10	23 to 41
Salsola kali tenuifolia (5)	38 to 41
Sisymbrium altissimum (5)	39 to 41
Shrubs	
Artemisia tridentata	40
Atriplex sp.	40
Cerocarpus ledifolius[a]	23
Chrysothamnus nauseosus	40
C. viscidiflorus	40

After 14 years storage, 36 of the 102 lots of grass seed produced seedlings. Of the 68 lots stored 20 years only 16 emerged. The two best at 20 years were: *Agrostis alba* (50%) and *Oryzopsis hymenoides* (38%). Twenty-one seed lots of eight grasses were stored 27 years or more and all failed to emerge.

Seeds with hard seed coats, such as the legumes, retained their viability longer than soft-coated seeds, such as many grasses. All 24 lots of legume seed produced seedlings after 14-years storage. Fifteen lots stored 20 years or more were all viable when tested. The best viability was *Trifolium repens*, 73% after 25 years, and *Lotus corniculatus*, 65% after 28 years. No legume seeds were stored beyond 28 years.

After 23- to 41-years storage only one of the 21 forb seed lots emerged. Seeds of *Erodium cicutarium* germinated 5.5% after 37-years storage. This was the oldest seed to germinate. After 14-years storage two of the seven lots of shrub seed were viable. After 20-years storage, none of the five lots were viable.

Speed of germination is a species characteristic. Within each species, however, the younger seeds emerged more rapidly than did the older seeds. The most rapidly emerging seedlings were the annuals, notably: *Salsola kali tenuifolia, Sisymbrium altissimum, Bromus tectorum,* and *B. arvensis.* Close behind were some

Table 1. Age (years) and emergence (%) of range plant seeds stored at Twin Falls, Idaho and LaGrande, Oregon for long periods in uncontrolled environments.

Species	Years storage	Emergence	
		Year grown	1969-71
Grasses			
Agropyron desertorum	19[a]	85	1.5
	17	86	3.5
	14		11
	2	96	83
A. elongatum	19	85	3.5
	18[a]	83	1.0
	18[a]		1.0
A. intermedium	26[a]	80	2.0
	22[a]	84	2.5
	2[a]	95	93
A. intermedium Amur	21[a]		0.5
	18[a]		9.0
A. sibiricum	18[a]		1.0
	3		94
A. spicatum	4		80
A. trichophorum	20[a]		4.5
	20[a]	79	4.0
	18[a]		15
Agrostis alba	20	90	50
A. tenuis oregonensis	25[a]	82	7.0
Alopecurus arundinaceus	20[a]		21
	17		8.5
A. pratensis	19[a]		15
Arrhenatherum elatius	23[a]	90	4.5
Bromus arvensis	17[a]		65
B. erectus	21[a]		2.0
	18[a]		4.5
B. inermis	19[a]		1.5
	3	88	87
B. tectorum	10	100	100
	9		98
	1		100
Dactylis glomerata	20[a]		29
	18[a]		8.0
Festuca arundinacea	19[a]	93	4.5
Hordeum bulbosum	17		1.0
Oryzopsis hymenoides	26		38
Phleum phleoides	19[a]	91	24
P. pratense	18[a]		7.0
Poa ampla	22[a]	85	6.0
	21[a]	82	8.5
	20[a]	85	5.5
	19[a]		15
P. longifolia	20[a]		1.0
Legumes			
Astragalus cicer	22[a]	91	43
	19[a]	92	54
	18[a]		55
A. falcatus	23[a]	98	10
	23[a]	97	8.0
	22[a]	92	3.5
	21[a]	93	1.5
	17		3.5
Lathyrus sylvestris	17		21
Lotus corniculatus	28[a]		3.0
	28		65
Medicago sativa	24[a]	83	26
	20		35
	19	91	46
	19[a]	85	54
	19[a]	98	81
	2		86
Melilotus alba	19	91	30
Trifolium fragiferum	26[a]	80	30
T. repens	25[a]	88	73
T. subterraneum	25[a]	79	29
Vicia tenuifolia	22[a]	77	40
	20[a]		21
	20[a]		40
	19[a]		25
Forbs			
Erodium cicutarium	37		5.5
Salsola kali tenuifolia	1		67
Sisymbrium altissimum	1		93
Shrubs			
Artemisia tridentata	2		53
Atriplex canescens	19		3.5
Purshia tridentata	14		45

[a]Stored at LaGrande until 1960.

legumes: *Medicago sativa, Melilotus alba,* and the *Trifoliums.* The slowest seedlings to emerge were those from large, thick-coated seeds, such as *Lathyrus sylvestris, Vicia tenuifolia,* and *Purshia tridentata.*

Each lot of 50 seeds was weighed to the nearest .01 g. Within or between species, seed size could not be correlated with seed longevity.

Conclusions

Even under the cool, dry, and relatively favorable storage conditions in this study, the percentage and speed of seedling emergence decreased with age. Seeds of grasses, legumes, forbs, and shrubs stored for range seeding should be checked for germination. The seeding rates can then be adjusted to compensate for low viability.

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