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## VIABILITY OF SEED FROM THIRTY-TWO SHRUB AND FORB SPECIES THROUGH FIFTEEN YEARS OF WAREHOUSE STORAGE

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**ABSTRACT.**— Germination results were obtained from seed stored in an open warehouse in Sanpete County, Utah, over a 15-year period for 18 shrub and 14 forb species. Seed viability was not appreciably affected for 14 species stored at least 15 years. Seed viability did, however, significantly decrease for two species stored 10 years, for five species stored 7 years, for seven species stored 5 years, for three species stored 4 years, and for one species stored only 3 years.

A major limiting factor in range rehabilitation and improvement projects is the availability of seed of wildland species. Seed of most native shrub and forb species used in habitat improvement projects is available only from wildland sources and must be collected by hand. Lack of adequate soil moisture during critical flowering and seed development periods, frost, insect infestation, or other natural causes prevent yearly production of good seed crops. Seed is high priced or unavailable in years of low production. To have on hand adequate seed when needed at reasonable cost, seed must be stockpiled. In a seed storage program, it becomes imperative to know the maximum length of time each species can be stored and still retain appreciable amounts of viability.

Comprehensive germination studies have been done with a number of species using seed from the collection year. Germination of the seed of some agricultural crops and grasses stored a number of years has been studied extensively (Hafenrichter et al. 1965, Little 1937, Tiedemann and Pond 1967), but germination studies of wildland shrubs and forbs have been limited. Springfield (1968, 1970, 1973, 1974) worked with germination and longevity of stored winterfat and four-wing saltbush seed. Longevity reports on germination of stored winterfat (Stevens et al. 1977) and bitterbrush seed (Giunta et al. 1978) also have been made.

Plummer et al. (1968) lists the duration of good viability for 44 shrubs, 24 forbs, and 5 grasses. A report on results after relatively

short periods of storage on seed of a number of native shrubs and forbs was made by Plummer et al. (1970). Two works including information on germination and longevity studies for many native trees and shrubs were published by the USDA Forest Service (1948, 1974).

Wildland seed is commonly stored in unheated and uncooled warehouses and granaries, sometimes for extended periods of time, and little information is available as to the length of life of stored seed.

### METHODS

During the fall of 1963, seed of 18 shrub and 14 forb species (Table 1) were hand collected from native stands. Seed was hand cleaned to 85 percent purity or higher, placed in cotton bags, and deposited in metal file cabinets in an open, unheated, and uncooled warehouse in Ephraim, Sanpete County, Utah, for the duration of the study. Over 15 years (1963 through 1978), temperature in the warehouse ranged from a low of  $-29.9$  C ( $-21$  F) to a high of  $38.3$  C ( $101$  F). Mean daily temperatures during winter, spring, summer, and fall periods were  $-3.3$  C ( $26$  F),  $6.7$  C ( $44$  F),  $20$  C ( $68$  F),  $7.2$  C ( $45$  F), respectively.

Germination tests began in February of 1965, 1966, 1967, 1968, 1970, 1973, and 1978. These years marked the beginning of the 2nd, 3rd, 4th, 5th, 7th, 10th, and 15th year of storage. For each species in each year of sampling, four random samples of 100

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seeds each were selected and individually placed between damp newspapers, wrapped in plastic, and placed in a refrigerator. Temperature in the refrigerator ranged between 1.1 and 3.3 C (34 and 38 F). Care was taken to ensure that only undamaged seed with good fill was selected and used. Results then were based on over 98 percent fill and 100 percent purity for all species except fourwing saltbush (52 percent fill) and Martin ceanothus (59 percent fill). Seed samples were checked at 14-day intervals. All germinated seeds were removed and the number germinated was recorded. Seed samples remained in an unlighted refrigerator, and germination checks were made on schedule for up to 16 months. Seeds were considered germinated when the hypocotyl length reached 5 mm.

Analysis of variance and Newman-Keul's (Steel and Torrie 1960) comparison of mean test (0.05 level of significance) was used to determine where germination significantly changed.

## RESULTS AND DISCUSSION

There is a possibility that up to 16 months of incubation at temperatures ranging from 1.1 to 3.3 C (34 to 38 F) in cool, moist stratification may increase germination for some species above what can be expected from field seedbeds.

In 10 species, percent germination did not drop significantly over 15 years of storage. Silky lupine maintained the highest germination with an overall mean of 94 percent (Table 1); germination means of small burnet, Nevada ephedra, green ephedra, cliffrose, and antelope bitterbrush did not drop significantly over 15 years, and all were between 79 and 94 percent. Overall mean germination of curleaf mountain mahogany remained at 70 percent and that of fourwing saltbush did not vary significantly through 15 years. Gooseberry globemallow germination had an overall germination mean of 7 percent over the 15-year test period. Martin ceanothus had a mean for the first 7 years of only 7 percent; with 10 and 15 years of storage, germination increased to a mean of 38 percent. This could possibly be explained because insect-damaged seed was more easily recognized when samples were selected later in the study.

By the 15th year of storage, percent seed germination of desert bitterbrush, Saskatoon serviceberry, Utah serviceberry, and Palmer penstemon had decreased significantly but was still at acceptable levels for each species. Percent germination for desert bitterbrush ranged from a high of 86 percent down to 65 percent, Saskatoon serviceberry from 91 to 76 percent, Utah serviceberry from 99 to 67 percent, and Palmer penstemon from 83 to 50 percent. Lewis flax germination dropped off significantly after the 10th year of storage. Between the 7th and 10th year of storage, seed of squawapple lost almost 50 percent of its viability, going from 39 percent germination to 21 percent. Seed of showy goldeneye also decreased between the 7th and 10th year, dropping from 13 percent to only 1 percent germination.

From the 5th to the 7th to the 10th year of storage, germination percent in true mountain mahogany seed dropped from 68 to 46 to 25 percent. Percent germination of vegetable oyster salsify seed decreased from 66 to 46 to 31 percent by the 10th year of storage and that of mountain snowberry went from 80 percent the 7th year to 44 percent the 10th year, to 8 percent after 15 years of storage.

Significant decrease in percent germination occurred between the fifth and seventh years of storage of basin big sagebrush seed (70 to 24 percent), spineless hopsage (57 to 13 percent), arrowleaf balsamroot (37 to 20 percent), Porter ligusticum (36 to 13 percent), Utah sweetvetch (55 to 25 percent), Wyeth eriogonum (90 to 64 percent), and cutleaf balsamroot (20 to 4 percent).

Four years of storage appears to be the point at which seed viability drops significantly for winterfat, black sagebrush, white rubber rabbitbrush, and five years for Nuttall lomatium. Seven and 8 percent germination was obtained in two- and three-year-old cowparsnip seed, but only 2 percent was recorded after four years' storage.

Checks on seed of antelope bitterbrush, cliffrose, Lewis flax, and Porter ligusticum showed that percent germination significantly increased with two to three years of storage, an indication that these species may have afterripening periods.

TABLE 1. Mean percent germination\* of seed from 32 shrub and forb species after 2, 3, 4, 5, 7, 10, and 15 years storage in an open, unheated, and uncooled warehouse.

Species	Source	Years of storage						
		2	3	4	5	7	10	15
		Percent germination						
<b>Shrubs</b>								
Antelope bitterbrush ( <i>Purshia tridentata</i> )	Mt. Dell, Utah	79	86	87	94	88	88	85
Basin big sagebrush ( <i>Artemisia tridentata tridentata</i> )	Ephraim, Utah	73	82	67	70	24	1	0
Black sagebrush ( <i>Artemisia nova</i> )	Manti, Utah	81	66	55	34	5	1	0
Cliffrose ( <i>Cowania mexicana stansburiana</i> )	American Fork, Utah	80	89	—	89	84	89	91
Curleaf mountain mahogany ( <i>Cercocarpus ledifolius</i> )	Mayfield, Utah	67	63	—	80	76	69	64
Desert bitterbrush ( <i>Purshia glandulosa</i> )	Bishop, California	78	86	80	80	69	73	65
Fourwing saltbush ( <i>Atriplex canescens</i> )	Panaca, Nevada	32	47	40	40	50	43	37
Green ephedra ( <i>Ephedra viridis</i> )	Manti, Utah	88	92	92	84	80	82	88
Martin ceanothus ( <i>Ceanothus martinii</i> )	Manti Canyon, Utah	3	5	5	12	10	40	36
Mountain snowberry ( <i>Symphoricarpos oreophylceus</i> )	Spanish Fork Canyon, Utah	80	64	—	92	80	44	8
Nevada ephedra ( <i>Ephedra nevadensis</i> )	Wah-Wah Valley, Utah	90	93	91	85	89	91	85
Saskatoon serviceberry ( <i>Amelanchier alnifolia</i> )	Spring City Canyon, Utah	91	80	—	91	85	84	76
Spineless hopsage ( <i>Grayia brandegei</i> )	Escalante, Utah	87	92	86	57	13	6	0
Squawapple ( <i>Peraphyllum ramosissimum</i> )	New Canyon, Utah	42	42	42	37	39	21	10
True mountain mahogany ( <i>Cercocarpus montanus</i> )	New Canyon, Utah	63	65	61	68	46	25	3
Utah serviceberry ( <i>Amelanchier utahensis</i> )	Henrieville, Utah	97	99	—	99	96	90	67
White rubber rabbitbrush ( <i>Chrysothamnus nauseosus albicaulis</i> )	Richfield, Utah	80	65	34	14	11	7	0
Winterfat ( <i>Ceratoides lanata</i> )	Corona, New Mexico	90	83	74	18	7	0	0
<b>Forbs</b>								
Arrowleaf balsamroot ( <i>Balsamorhiza sagittata</i> )	Paradise Valley, Nevada	40	42	—	37	20	1	0
Cowparsnip ( <i>Heracleum lanatum</i> )	Pleasant Creek Canyon, Utah	7	8	2	1	0	0	0
Cutleaf balsamroot ( <i>Balsamorhiza macrophylla</i> )	Bountiful, Utah	35	28	17	20	4	0	0
Gooseberry globemallow ( <i>Sphaeralcea grossulariaefolia</i> )	Benmore, Utah	7	7	6	9	6	7	6
Lewis flax ( <i>Linus lewisii</i> )	Ephraim, Utah	66	72	85	93	83	70	25
Nuttall lomatium ( <i>Lomatium nuttallii</i> )	Ephraim Canyon, Utah	69	73	—	73	37	8	2
Palmer penstemon ( <i>Penstemon palmeri</i> )	Ephraim Canyon, Utah	83	81	—	80	79	65	50
Porter ligusticum ( <i>Ligusticum porteri</i> )	Ephraim Canyon, Utah	11	28	24	36	13	0	0
Showy goldeneye ( <i>Viguiera multiflora</i> )	Ephraim Canyon, Utah	18	17	11	18	13	1	0

\*Results based on 98 percent or better fill and 100 percent purity, except fill for fourwing saltbush (52 percent fill) and Martin ceanothus (59 percent fill).

Table 1 continued.

Species	Source	Years of storage						
		2	3	4	5	7	10	15
Silky lupine ( <i>Lupinus sericeus</i> )	Ephraim Canyon, Utah	97	99	100	99	86	85	92
Small burnet ( <i>Sanguisorba minor</i> )	Ephraim, Utah	88	93	91	96	82	87	88
Utah sweetvetch ( <i>Hedysarum boreale germinale</i> )	Orem, Utah	59	67	58	55	25	40	16
Vegetable oyster salsify ( <i>Tragopogon porrifolius</i> )	Mt. Pleasant, Utah	65	65	66	66	46	31	13
Wyeth eriogonum ( <i>Eriogonum heracleoides</i> )	Brigham City, Utah	51	87	—	90	64	16	5

## SUMMARY

Germination results from seed stored over a 15-year period indicate that seed of fourwing saltbush, curlleaf mountain mahogany, cliffrose, Nevada and green ephedra, antelope bitterbrush, silky lupine, small burnet, Martin ceanothus, and gooseberry globemallow can be stored at least 15 years without any significant loss in percent germination. Results indicate that seed of Palmer penstemon, Utah and Saskatoon serviceberry, and desert bitterbrush start to lose viability by the 15th year of storage. Ten years appears to be a maximum storage period for seed of mountain snowberry and Lewis flax. Where reasonable germination is expected, storage exceeding 7 years is not recommended for seed of true mountain mahogany, squawapple, showy goldeneye, vegetable oyster salsify, and Wyeth eriogonum. Storage longer than 5 years results in a significant drop in seed viability of basin big sagebrush, spineless hopsage, arrowleaf and cutleaf balsamroot, Porter ligusticum, Nuttall lomatium, and Utah sweetvetch.

Four years is the maximum storage period recommended for seed of black sagebrush, winterfat, and white rubber rabbitbrush. Maximum storage of cowparsnip seed should not exceed three years.

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