Germination of Winterfat Seeds Under Different Moisture Stresses and Temperatures

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Highlight

Germination of winterfat decreased and was delayed as moisture stress increased. Decreases were proportionately less at lower temperatures, which indicates soil drying may not be as detrimental to germination during cool weather. One of the two sources of seed tested germinated better under all moisture stresses. Further research may reveal certain sources are superior for revegetation.

The specific temperature and moisture requirements for germination of winterfat (*Eurotia lanata* (Pursh.) Moq.) are not known. According to the Woody Plant Seed Manual (U. S. Forest Service, 1948), winterfat seeds will germinate at about 50 F (night) and 77 F (day). Hilton (1941) found germination was highest at temperatures from 42 to 76 F. Riedl et al. (1964) reported six lots of seed germinated 47 to 78% at 70 F. Statler (1967) obtained 91% germination at room temperature. No studies have been reported concerning the effects of moisture stress on the germination of winterfat seeds. Several investigators have used mannitol solutions, however, to regulate the water available to germinating seeds of grasses and legumes (Dotzenko and Dean, 1959; Helmerick and Pfeifer, 1954; Knipe and Herbel, 1960; McGinnies, 1960; Powell and Pfeifer, 1956). In a recent study with the shrub *Atriplex canescens,* I found moisture stress had less effect on germination when temperatures were near optimum (Springfield, 1966).

This report summarizes the results of a study of six levels of moisture stress at five temperatures on the germination of two sources of winterfat seeds. Objectives were to determine: (1) if winterfat seeds would germinate under the higher moisture stresses, (2) if temperatures influence the germination responses, and (3) if the responses to moisture stresses and temperatures vary with source of seed.

Materials and Methods

Winterfat seeds from two sources were selected for the study. One source was located near Corona in eastern New Mexico at an elevation of 6,300 ft; the other was near Horse Springs in western New Mexico at an elevation of 6,900 ft. The Corona site is characterized by an open stand of juniper, sandy clay loam soil, and 15 inches annual precipitation, 30% of which falls during winter (October to April). The Horse Springs site is characterized by plains grassland, sandy loam soil, and 11 inches annual precipitation, 34% of which falls during winter.

The seeds were collected in October 1964 and stored in paper bags at room temperatures until July 1966 when the experiment was conducted. Fruit and seed characteristics were as follows:

		Length mm	Width mm	No./lb 1000's
Corona	Fruit	7.6	5.9	78
	Seed	2.9	1.8	211
Horse Springs	Fruit	7.1	4.2	120
	Seed	2.7	1.4	255

The seeds were germinated in plastic dishes on three thicknesses of standard germination blotter paper. Fifty seeds were placed in each dish, and the dishes were randomly arranged in a factorial design with three replications per treatment. At the start of the study, 15 ml of the appropriate water-mannitol solution was added to each dish. Evaporation of the solution was negligible; trays containing the dishes were enclosed in polyethylene bags.

Moisture stresses against the seeds were maintained by using solutions of mannitol, with the concentrations adjusted to give osmotic pressures of 0.0, 0.3, 3.0, 7.0, 11.0, and 15.0 atmospheres. The grams of mannitol required per liter of distilled water to give solutions with these moisture stresses were calculated from the following formula by Helmerick and Pfeifer (1954): $P = gRT/mV$, where P = osmotic pressure in atmospheres, g = grams of solute, R = 0.08205 liter atm/degree per mole, T = absolute temperature, m = molecular weight of solute, and V = volume in liters.

The five temperature regimes for the experiment were: alternating 86 (8 hours, light)–68 (16 hours, dark), alternating 78 (12 hours, light)–58 (12 hours, dark), and constant 53, 43, and 37 F (in darkness).

Germinated seeds were counted daily from the second through the seventh day, and at 3- to 4-day intervals thereafter. Counts were continued for 42 days. Seeds were considered germinated when the radicles and plumules measured one inch or more and were free from the seed coat.

Germination percentages were transformed to arcsin for analysis of variance. Sources of variance list out as a $5 \times 6 \times 2$ factorial, with temperatures as the main effect and moisture levels and source as minor effects. Temperatures were not replicated so there was no explicit error term for testing this factor. Data means were compared at the .05 probability level by means of Duncan's new multiple range test.

Results and Discussion

Germination of winterfat seeds was influenced by moisture stress, temperature, and seed source (Table 1).

As moisture stress increased, germination generally was reduced, regardless of temperature. The

[1] Forest Service, U. S. Department of Agriculture, with central headquarters maintained at Fort Collins in cooperation with Colorado State University; research reported here was conducted at Albuquerque in cooperation with the University of New Mexico.

Table 1. Percent germination of two sources of *Eurotia lanata* seeds under six levels of moisture stress at five temperatures.

Seed source	Germ. temp. (F)	Germination (by moisture stress in atmos.)						
		0	.3	3	7	11	15	Avg.
Horse Springs	86–68	89	90	82	51	17	11	57a*
	78–58	92	94	91	89	79	29	79b
	53	90	94	83	83	67	43	77b
	43	92	83	79	73	69	55	75b
	37	80	81	71	67	47	32	63b
Average		89a	88a	81ab	73b	56c	34d	70
Corona	86–68	84	67	57	37	5	5	42a
	78–58	91	85	83	58	20	18	59b
	53	81	79	79	67	41	29	63b
	43	83	80	77	72	67	51	72b
	37	80	80	76	61	49	29	62b
Average		84a	78a	74a	59b	36c	26d	60

* Values followed by the same letter do not differ significantly at the .05 level using Duncan's multiple range test.

difference between germination under 0.0, 0.3, and 3.0 atm was not significant, but germination under these levels was significantly greater than under 7, 11, or 15 atm.

Germination of both seed sources was less at alternating temperatures of 86–68 F than at the other temperatures.

The Horse Springs source of seed germinated better than the Corona source.

All interactions between seed source, moisture stress, and temperature were significant.

The effects of moisture stress on germination were strongly influenced by temperature. At alternating temperatures of 86–68, germination dropped sharply as moisture stress increased beyond 3.0 atm. This suggests soil moisture approaching field capacity is necessary for appreciable germination of winterfat during the summer when temperatures are in the 80 to 100 F range in New Mexico. The interacting effects of moisture stress and temperatures were less pronounced at the four lower temperatures. Nevertheless, as moisture stress increased to 15 atm, seed germination decreased proportionately more at 78–58 than at 53, 43, or 37 F. These trends indicate the effects of increased moisture stress would be less detrimental at relatively low temperatures, or that drying of the soil might not be as damaging to germinating winterfat seed during cool weather as during warm weather.

Germination was delayed by increasing moisture stress (Fig. 1). The influence of temperature was reflected in these delays. Germination began sooner and progressed more rapidly under stresses of 0.0, 0.3, and 3.0 atm and at temperatures of 86–68 and 78–58 F. Delay in germination was most noticeable under 15 atm stress, and at 37 F. The

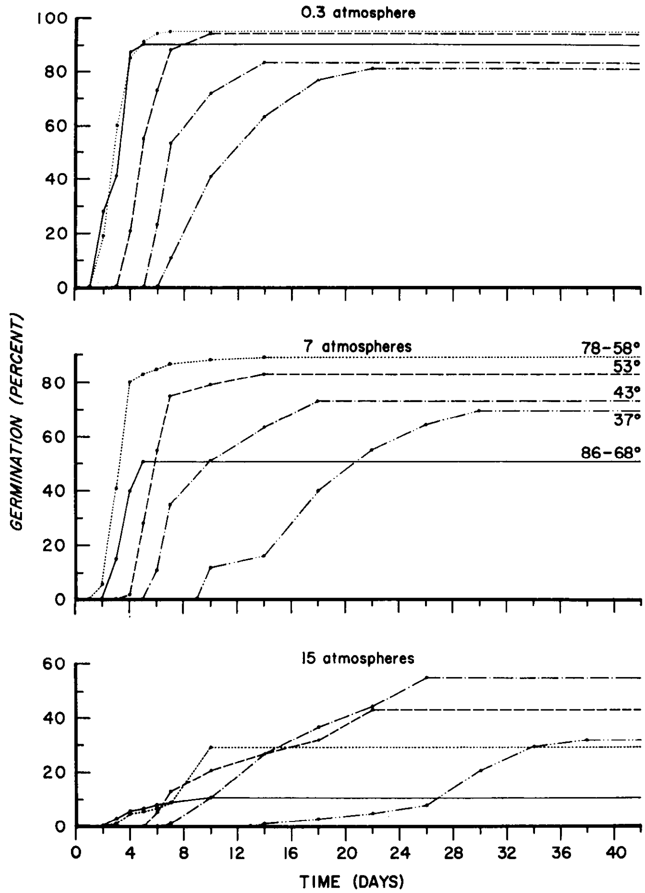

FIG. 1. Trends in the germination of Horse Springs winterfat seed under three levels of moisture stress at five temperatures.

two seed sources responded about the same under stresses of 0.0, 0.3, 3.0, and 15 atm, but somewhat differently under 7 and 11 atm. For example, under 11 atm stress the germination of the Horse Springs seed was most rapid and highest at 78–58 F, whereas for the Corona seed, germination at 43 F, though delayed a few days, was nearly as rapid and markedly higher than at 78–58 F. This suggests that responses of winterfat seeds to different combinations of moisture stress and temperature probably vary somewhat with source of seed. Further research may reveal that certain sources are superior for range revegetation.

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