Natural Reproduction of Winterfat (*Eurotia lanata*) in New Mexico[1]

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Highlight

***In situ* ecological factors influencing the natural reproduction of the important Western browse species winterfat (*Eurotia lanata*) were investigated in central and west-central New Mexico from summer 1967 to spring 1969. Seed of winterfat germinated in late winter and early spring on all slopes and in soils varying widely in origin and texture. Survival was greatest on disturbed soils which supported low vegetation that afforded some shelter but little shading for seedlings. The disturbed soils indicated greater moisture availability. Seedlings were tolerant to competition, and were often found in living clumps of grass. A comparison of vegetation on heavily grazed and protected ranges indicated winterfat was susceptible to heavy grazing, and reproduced when on protected or lightly grazed range dominated by low-growing grasses.**

Winterfat (*Eurotia lanata* (Pursh) Moq.), a low-growing, palatable, and nutritious shrub, is used as browse by livestock and big game on rangelands in western North America. Exploitation of New Mexico rangelands by the white man has led to the decrease, and in some cases the extermination, of valuable browse species, thereby limiting the carrying capacity of the range. Currently, in attempts to improve big game habitat, state and federal agencies are investigating the re-establishment of browse on depleted rangelands. This study was initiated to determine some of the *in situ* ecological factors influencing the natural reproduction of winterfat in the pinyon-juniper and ponderosa pine vegetational types in central and west-central New Mexico. The principle factors considered were life cycle, climate, site, soil, plant association, and animal association. The results of this study are intended to supplement

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Table 1. Analysis of sites in areas of reproduction of winterfat (*Eurotia lanata*).

	Sandia Mtns., Sandoval Co.				Zuni Mts., McKinley Co. Fort Wingate	Gallinas Mtns., Socorro Co. Magdalena
	Watershed-A	Watershed-B	Fish hatchery-A	Fish hatchery-B		
Elevation (m)	1,705	1,800	1,875	2,070	2,150	2,090
Topography	Drainage bank on alluvial fan	Bottom of slope, head of alluvial fan, adjacent to head of arroyo	Slope on inside of curve of road	Slope	Canyon floor	Drainage bottom
Slope direction & percent	W 5–10	W 10–15	W 15–20	E-NE 100	N 4	SW 0–10
Parent material	Alluvium	Alluvium	Madera Ls.	Madera Ls.	Alluvium	Dune sand
Mineral soil depth (cm) and horizons	>45 A 0–11 B 11–36	>45 A 0–22 B 22–42	25	25	>45 A 0–15 B 15–?	>45 No development
Soil texture	Cherty, sandy loam	Stony, (angular) gravelly, clay loam	Stony, cherty heavy clay loam	Rocky, stony, coarse cherty, cherty, loam	Heavy clay loam	Sandy loam
Soil pH	7.6–7.8	7.6	7.4	7.6	7.6–8.0	7.9
Vegetation, total cover, all strata (%)	45	63	43	45	44	46
Trees, total cover (%)	0	0	4	1	0	0
Shrubs, total cover (%)	2	5	5	22	19	27
Herbs, total cover (%)	45	58	34	15	29	21

general knowledge of the reproduction of this important browse species, and thus lead to improved techniques of re-establishment and management practices.

Winterfat is found from Manitoba and Saskatchewan to the Pacific Coast states, east to western Texas, and north through the Great Plains. It is common in certain areas up to approximately 2,450 m (about 8,000 ft) elevation and rarely to approximately 3,000 m (about 10,000 ft). Dayton (1931) and others agree that, because of overgrazing by livestock, the species is less abundant and covers a narrower range now than previously.

Winterfat is found most abundantly in the foothills, plains, and valleys of the West. It grows in dry soils that range from sands to clays and which are often impregnated with white alkali and other salts. Associated vegetational types range from desert plains and scrub to ponderosa pine, mountain parks, and mixed-grass prairie. The species is usually associated with desert scrub, semidesert bunchgrasses, sagebrush, and pinyon-juniper. It is frequently abundant and widespread, sometimes becoming the dominant (Dayton, 1931).

Winterfat is very nutritious and palatable for all classes of livestock and game herbivores (Van Dersal, 1938; Jameson, 1952; Cook et al., 1959). All parts of the plant above the woody base are eaten by the animals. Riedl et al. (1954, p. 10) state, "in August the nutritive content (of winterfat) may be higher than that of a good grade of alfalfa hay."

Field Work and Methods

This study was made from the summer of 1967 through the spring of 1969. Detailed investigations were conducted during the summer, and supplementary field observations were continued throughout the year.

The predetermined study areas were on, or adjacent to, the Cibola National Forest in the Sandia Mountains in Bernalillo and Sandoval counties, Gallinas Mountains in Socorro County, and the Zuni Mountains in western Valencia and southern McKinley counties. These areas were selected because they provide a wide variety of surface rock formations, soils, and topography (Table 1).

Two terms, as used in this study, require definition: *Microenvironment* is the environment within a 1 m² quadrat frame centered over a seedling. *Seedling* is a plant up to about two years old growing in a microenvironment similar to the one in which it germinated. Determination of seedling age by counting terminal bud scale scars is not possible with this species. Age determination in the absence of cotyledons is indecisive without careful inspection of annual rings, which are indistinct in winterfat. Plants were not cut for ring counts since seedlings were scarce on some sites and were needed for long-term survival studies. Less reliable but non-injurious examination of morphological characteristics was used to determine approximate seedling age.

Soil profiles of the upper 45 cm, or to bedrock if shallower, were characterized by describing pits near the study plots. Soil classifications of texture, coarse fragments, stoniness, and rockiness were based on the U.S. Dep. Agr. Soil Survey Manual (1951). Soils were classified primarily by observation, with verifications of texture made by the hydrometer method of Bouyoucos (1936). Information on Zuni Mountain soils was supplemented by Williams (1967). The pH of soils was determined with a La Motte-Morgan soil testing kit.

Two methods were used for analyzing total cover of vegetational foliage, rock or large stones, and litter. Total foliage cover was measured rather than basal cover because the foliage of the surrounding plants is generally the dominant feature providing shelter and shade for the seedling microenvironment. A 1 m² quadrat frame was centered around a seedling, with the sides oriented to the four cardinal compass points. The plot thus delineated the seedling microenvironment defined above, and chart quadrats were then drawn. Representative plots were selected to be used in seedling survival studies, and were permanently marked by painted metal stakes with plastic flagging at two diagonal corners of the plot. These permanent plots were examined periodically from the time of location through early spring 1969, and notes were taken regarding survival and the observable factors affecting survival. Plants were identified whenever possible and placed in one of three strata: 1) *grass-forb layer*—grasses, forbs, and young shrubs and trees

FIG. 1. Fenceline contrast of range condition and winterfat reproduction between Bernalillo Watershed and Sandia Indian Reservation.

not taller than the surrounding grasses and forbs, 2) *shrub layer*—all shrubs and those trees taller than stratum (1) but less than 1.83 m (6 ft), and 3) *tree layer*—trees taller than 1.83 m (6 ft).

The second method of analysis utilized four 10-m line intercepts, all originating from the seedling at the center of the quadrat and running to each of the cardinal compass points. Total cover in the three strata mentioned above was measured and recorded as to distance from the seedling.

The same intercept method was used for a vegetational comparison of protected range on the Bernalillo Watershed and adjacent overgrazed range on the Sandia Indian Reservation in Sandoval County; however, plots were located in the following way rather than originating at a seedling. Three sites were selected along the fence which forms the boundary between the two ranges. Sampling plots, within each site, were placed in physiographically equivalent locations on either side of the fence at the three sites. Plots were placed so that vegetation within 1 m of the fence was not sampled to avoid the effect evident in Fig. 1. In addition to the largely quantitative methods described, detailed subjective notes were taken regarding germination and seedling environments.

Results and Discussion

Climatological Data

Precipitation and maximum-minimum temperature data for representative weather stations in central and west-central New Mexico were evaluated. Due to the great variability of summer rainstorms from one site to another and, to a lesser degree, winter snowstorms, these data were evaluated for trends rather than actual quantitative values. Before discussing the specific implications of the climatological factors to the principal species, several generalizations are warranted.

January through May of 1967 was a period of drought with generally higher temperatures than normal at all stations. The drought was broken in June with abnormally early, general rainstorms. Numerous storms occurred throughout the summer, bringing precipitation far in excess of normal amounts. October and November precipitation was below normal. December precipitation was near normal at all stations except those of western New Mexico, which received a nearrecord snowstorm. Little or no precipitation fell at any of the stations in January 1968, but from February to April totals were well above normal. June rainfall was very low at all stations. July and August precipitation totals were above normal and September and October totals were below normal. Data were unavailable for the period January to March 1969 but casual observation indicated above average precipitation in the form of snow.

Table 2. Seedling survival (%) of *Eurotia lanata* at the Fish Hatchery-A, Fish Hatchery-B, Watershed-B, and Fort Wingate sites.

		First counting		Second counting		Last counting		
Site	Plot	Date	No. of seed-lings	Date	No. of seed-lings	Date	No. of seed-lings	Sur-vival
Fish Hatchery-A	1	6/14/68	4	8/5/68	1	3/28/69	0	0
	2		8		1		1	13
	3		9		4		2	22
Fish Hatchery-B	1	6/14/68	ca. 300	7/17/68	ca. 200	3/28/69	20	7
	2		50		21		7	14
Watershed-B	1	7/8/68	ca. 50			3/28/69	22	44
	2		20				3	15
	3		27				3	11
Fort Wingate	1	4/12/68	ca. 500	10/23/68	125	3/30/69	75	15
	2		ca. 200		20		10	5
	3		ca. 200		0		0	0
	4		ca. 200		9		5	3

Germination and Survival

Winterfat usually germinates in late winter and early spring (Plummer et al., 1968; Bleak et al., 1965; Strickler, 1956; U.S. Forest Service, 1948; and Hilton, 1941). Springfield (1968a) and Strickler (1956) agree soil moisture at or near field capacity gives maximum germination; nevertheless, Springfield found a fair percentage of the seeds will germinate under high moisture stresses if the temperature is held near 40 F. Pechanec (1964), discussing seedlings of western plants, and Hubbard (1957), discussing seedlings of bitterbrush, stressed adequate soil moisture must be available following germination to assure seedling success. Thus, as a result of the severe winter and spring drought in early 1967, no seedlings were found when this study was begun in June of that year. Germination did occur in late February and early March 1968 during a period of above-normal precipitation. The number of seedlings produced at that time was enormous at all sites. In areas of seed accumulation (ditches, roadsides, etc.) as many as 2,000 to 3,000 seedlings per square meter were produced. Germination conditions were probably near ideal. Seeds even germinated under several inches of snow at the Fish-Hatchery-B site. Seeds were available from the abundant crop produced in 1967 (probably stimulated by above-normal rains that summer) and from carry-over crops of seeds from previous years. Springfield (1968b) found little loss of viability in winterfat seeds up to three years old, but retention of viability varied from year to year depending on environmental conditions during the time the seeds were forming and maturing and on certain undefined physiological characteristics of the seed. Germination of large numbers of seedlings can be a definite ecological advantage. Ferguson and Basile (1967) found production of large numbers of seedlings of bitterbrush greatly increased the probability of successful establishment. This same conclusion is undoubtedly true for winterfat. However, on properly managed ranges the species can advance even under poor germination conditions (Statler, 1967).

Germination occurred on or near the soil (and litter) surface in all microhabitats, even on bare rocks. This observation agrees with the findings of Springfield (1967), Statler (1967), and Riedl et al. (1964) who suggest winterfat should be planted no deeper than 0.25 inches. Initial establishment was successful wherever the seedling radicles were able to penetrate the soil. Seedlings were able to withstand temperatures at least as low as 12 F (Fry, 1969; and Hilton, 1941) and were probably not limited by subfreezing temperatures that occurred in late winter and early spring 1968. Loss of seedlings by frost-heaving was not apparent in 1968, but observations in March 1969 indicated some of the 1968 plants would be lost due to this action. Strickler (1956) and Biswell et al. (1953) have stressed the importance of this factor. Cracks caused by frost-heaving were observed to serve as germination sites.

Seedlings were successful both near and far (at least 250 m) from mature plants, illustrating excellent wind dispersal. As the spring dry season advanced large numbers of seedlings perished, especially those on bare soil. June 1968 was very dry, but apparently the soil contained enough residual moisture to support large numbers of seedlings. Root growth of survivors during dry periods may have been stimulated by moisture stress (Weaver, 1958). By the time July rains started, only seedlings protected by mature plants of winterfat, those in or very near grass clumps, or those in litter were alive. Observations of the survival plots (Table 2) indicated low survival percentages after one year, but actual numbers of seedlings still alive were rather high.

Seed germination and seedling success of winterfat (Table 2), as occurred in 1968, were rare phenomena that depended upon numerous, complex interactions of plant growth habits and environments. Pechanec (1964) states, ". . . good seed years are infrequent. And the association of good seed years with subsequent climatic conditions favorable to germination and survival is even less frequent." Observations indicate 1967 was an excellent seed production year for winterfat, possibly due to the very wet summer. Certainly, summer moisture conditions were favorable during 1968. Thus, Pechanec's requirements for the establishment of new plants seem to have been met.

Early germination, for plants that can survive subfreezing temperatures, permits the seedlings to become established before other plants, especially grasses, commence growth and start using large quantities of soil moisture. Weaver (1958) states some plants have the ability to germinate, put out several sets of leaves, and then cease shoot growth and undergo rapid root elongation. Winterfat has that type of growth habit. The roots of successful seedlings all penetrated below the grass root-level. Most of the initial root elongation was completed before the grasses started rapid summer growth. Some grasses do show spring growth and as Schultz et al. (1955) report, sufficient moisture from spring precipitation must be present in the soil to allow for both grass and shrub seedling growth. Hubbard (1957) also stresses the importance of sufficient soil moisture in the development of bitterbrush seedlings. An interesting paradox, probably relating to soil moisture, is the dependence of seedlings of winterfat upon their harshest competitor, grass. Seedlings develop best in full sunlight, but not on bare soil because the late spring-early summer soil surface temperatures are very likely lethal to the young, tender plants. Low-growing grasses offer a more hospitable microclimate and act as a "living mulch" even though they reduce maximum development of winterfat. This hypothesis is supported by the following observations. Occasionally seedlings of winterfat are found in litter, although litter, except for dead Russianthistle (*Salsola kali* L.), is scarce on Southwestern ranges. These seedlings, in the presence of mulch and the absence of competition from grass, appear more vigorous than seedlings in grass clumps. H. W. Springfield (personal communication), in studies involving blue grama (*Bouteloua gracilis* (H.B.K.) Lag.) range, found seed germination, seedling survival, and vigor of winterfat to be greater on mulched plots than on unmulched plots. He also observed that seedlings seldom are found on bare soil. Thus, it is apparent that seedlings are more vigorous in mulch or litter than in grass. But, since litter is not common, seedling survival is most often dependent on grass ("living mulch").

Vigorous, expanding stands of winterfat were observed on all slopes and parent materials where livestock use was light to negligible. However, best stands were found on gentle slopes and relatively well-drained alluvial substrate. Soil reactions were slightly basic (pH 7.4 to 8.0). Texture and rockiness varied greatly. These results support the findings of workers in Utah who concluded the species is probably restricted only by high salinity, high alkalinity, and by poorly drained soils (Workman and West, 1967; Gates, Stoddart, and Cook, 1956; Strickler, 1956; and Fautin, 1946). Without exception, in these studies, the vigorous, expanding stands of these plants were found on soils exhibiting some signs of erosion or disturbance, e.g., drainage bottoms, arroyo heads or banks, steep slopes, roadsides, rodent mounds, or sites of active sheet erosion. However, none of these sites were so severely eroded or disturbed that substantial vegetation, especially grass, was not present. Increased water availability, together with some protection for seedlings, appear to be the key factors involved in the success of the species on these sites. Fautin (1946) stated winterfat has relatively high water requirements and often occurs on ". . . soils where watercourses spread out over flat areas and where the normal amount of precipitation is augmented by runoff from higher places." In areas of well-developed caliche layers, the more severe types of erosion and disturbance, such as arroyo heads or banks, drainage channels, or rodent holes, disrupt the caliche and allow water to more readily penetrate the subsoil, and also allow greater opportunity for seedling root development. The direct effect of erosion or other disturbances in removing competing plants is probably of secondary importance since the species is quite tolerant to competition.

Big game use of winterfat was not evident in this study, but livestock use was observed on many ranges. Statler (1967), Kinsinger and Strickler (1961), Eckert (1954), and Hutchings and Stewart (1953) discussed livestock use of the species and all agree overgrazing is detrimental to the plants. The relationship of the degree of utilization to vigor of the species is striking.

Range Vegetation Comparison

A vegetation comparison study was made on the Bernalillo Watershed and the adjacent Sandia Indian Reservation to determine the influence of range condition on reproduction of winterfat (Fig. 1). The comparison was made after summer rains had begun but before significant summer growth started. The watershed was closed to livestock use in 1956 and was subjected to extensive land treatment, e.g., terracing, ripping, discing, etc., (Aldon, 1966). The reservation land has been continually overgrazed for many years. The right side of Fig. 1 shows vegetation on the protected watershed side of the boundary fence and the left side shows vegetation on the overgrazed reservation side.

Heavily grazed ranges, e.g., Sandia

Indian Reservation, may be void of plants of winterfat. Lightly grazed ranges may support stable stands and protected ranges, e.g., parts of Bernalillo Watershed, often support rapidly expanding stands. The Fort Wingate site has been protected only since 1966, yet the stand is advancing rapidly. Contrary to the above, some protected ranges support such vigorous stands of grass that winterfat is excluded (Fig. 1). A precise explanation of the excluding factors involved is not known, but several possibilities merit discussion. Potter and Krenetsky (1967) indicated some grasses, especially black grama (*Bouteloua eriopoda* Torr.) can make dramatic increases in cover on protected ranges. Important influences of different growth forms of grass, indeed species of one genus (*Bouteloua*), may be evident at the Bernalillo Watershed. Watershed-B and Watershed Site 1 are similar in site characteristics. Total vegetational cover and total herbaceous cover are similar at both sites; but the sampling plots of Watershed Site 1 (right side of Fig. 1), having mature, seed-producing plants of winterfat nearby, contained no reproduction of the species. The dominant grass at Watershed-B is blue grama (50% relative cover) with sand dropseed (*Sporobolus cryptandrus* (Torr.) Gray) (27%) as subdominant. At Watershed Site 1 black grama (58%) is dominant and sand dropseed (30%) is subdominant. The crown foliage of blue grama is low (0–10 cm) and tufted, and produces very little ground shade. Crown foliage of black grama, in contrast, is tall (30–45 cm) and compact and often produces dense ground shade, possibly limiting winterfat. Another explanation is the possibility that black grama is a better competitor for spring moisture than blue grama, and in this way deprives winterfat of available water. This latter premise is difficult to accept, however, because both grasses appear to be dormant until after summer rains begin. Seedlings of winterfat were not found even during the period of dormancy.

Watershed Site 2 is similar to Watershed Site 1 in vegetational characteristics and also in the exclusion of winterfat. Watershed-A and Watershed Site 3 both contain low-growing, open-crowned grass species and also winterfat reproduction.

Summary

Drought in the winter and spring of 1967 in central and west-central New Mexico limited spring germination and probably killed many seedlings of winterfat. As a result, little recent reproduction was found when the study was begun in June 1967. Above-normal precipitation in the summer of 1967 and the winter of 1967–1968 proved to be beneficial for reproduction.

Winterfat germinated in February and March 1968 in large numbers and at all sites containing parent plants. Large numbers, but a low percentage, of the seedlings that germinated in 1968 had survived at all sites after one year. In typical winterfat habitat, seedlings did not survive the high summer temperatures produced on bare soil; and survival was limited to the shelter of older plants, clumps of low-growing grasses, and litter. Litter was not abundant on most ranges, and grasses offered the "mulch" necessary for seedling success.

Reproducing stands of winterfat were found on all well-drained slopes, parent materials, and soils that were slightly basic in reaction. The best stands were found on gentle slopes of alluvial origin. All sites were eroded or disturbed but supported a substantial vegetative cover, especially grass. It is the greater amount of available moisture resulting from erosion and disturbance, together with some protection offered by low-growing grasses, that favors establishment of winterfat in the sites observed.

The overgrazed Sandia Indian Reservation land with foliage cover reduced to 22–33% contained no winterfat. The protected Bernalillo Watershed range with 50–60% foliage cover dominated by grasses with low, tufted, open-growth habit contained numerous stands of reproducing winterfat. However, two protected ranges with 61 and 62% cover, dominated by grasses with tall, compact growth habits producing dense ground shade, suppressed reproduction of winterfat.

Literature Cited

Aldon, Earl F. 1966. The Bernalillo Watershed protection project—10 years later. U.S. Dep. Agr., Forest Service, Rocky Mtn. Forest and Range Exp. Sta., Albuquerque, N. Mex. Office Report.

Bidwell, G. L., and E. O. Wooton. 1925. Saltbush and their allies in the United States. U.S. Dep. Agr. Bull. 1345. 40 p.

Biswell, H. H., A. M. Schultz, D. W. Hedrick, and J. I. Mallory. 1953. Frost heaving of grass and brush seedlings on burned chamise brushlands in California. J. Range Manage. 6:172–180.

Bleak, A. T., N. C. Frischknecht, A. Perry Plummer, and R. E. Eckert, Jr. 1965. Problems in artificial and natural revegetation of the arid shadscale vegetation zone of Utah and Nevada. J. Range Manage. 18: 59–65.

Bouyoucos, G. J. 1936. Directions for making mechanical analysis of soil by hydrometer method. Soil Sci. 42:225–229.

Cook, C. Wayne, L. A. Stoddart, and Lorin E. Harris. 1959. The chemical content in various portions of the current growth of salt-desert shrubs and grasses during winter. Ecology 40:644–651.

Dayton, William A. 1931. Important western browse plants. U.S. Dep. Agr. Misc. Publ. 101. 214 p.

Eckert, R. E. 1954. A study of competition between whitesage and halogeton in Nevada. J. Range Manage. 7:223–225.

Fautin, Reed W. 1946. Biotic communities of the northern desert shrub biome in western Utah. Ecol. Monogr. 16:251–310.

Ferguson, Robert B., and Joseph V. Basile. 1967. Effect of seedling numbers on bitterbrush survival. J. Range Manage. 20:380–382.

Fry, William C. 1969. The response of *Atriplex canescens* and *Eurotia* *lanata* to sub-freezing temperatures. M.S. Thesis, The Univ. of N. Mex., Albuquerque.

Gates, Dillard H., L. A. Stoddart, and C. Wayne Cook. 1956. Soil as a factor influencing plant distribution on salt-deserts of Utah. Ecol. Monogr. 26:155–175.

Hilton, James W. 1941. Effects of certain micro-ecological factors on the germinability and early development of *Eurotia lanata*. Northwest Sci. 15:86–92.

Hubbard, Richard L. 1957. The effect of plant competition on the growth and survival of bitterbrush seedlings. J. Range Manage. 10: 135–137.

Hutching, S. S., and George Stewart. 1953. Increasing forage yields and sheep production on intermountain winter ranges. U.S. Dep. Agr. Circ. No. 925. 63 p.

Jameson, Donald A. 1952. Nutritive value of browse on Montana winter ranges. J. Range Manage. 5:306–310.

Kinsinger, F. E., and Gerald S. Strickler. 1961. Correlation of production with growth and ground cover of whitesage. J. Range Manage. 14: 274–278.

Pechanec, Joseph F. 1964. Progress in research on native vegetation for resource management. Trans. Twenty-Ninth North Amer. Wildlife and Natural Resources Conf., Trans. 1964:80–89.

Plummer, A. Perry, Donald R. Christensen, and Stephen B. Monsen. 1968. Restoring big-game range in Utah. Utah Div. Fish and Game, Publ. No. 68–3. 183 p.

Potter, Loren D., and John C. Krenetsky. 1967. Plant succession with released grazing on New Mexico range. J. Range Manage. 20:145–151.

Riedl, W. A., K. H. Asay, J. L. Nelson, and G. M. Telwar. 1964. Studies of *Eurotia lanata* (winterfat). Wyoming Agr. Exp. Sta. Bull. 425. 18 p.

Schultz, A. M., J. L. Launchbaugh, and H. H. Biswell. 1955. Relationship between grass density and brush seedling survival. Ecology 36: 226–238.

Springfield, H. W. 1967. Progress report: germination and growth of game forage species. U.S. Dep. Agr., Forest Service, Rocky Mtn. Forest and Range Exp. Sta., Ft. Collins, Colo., (Processed).

Springfield, H. W. 1968a. Germination of winterfat seeds under different moisture stresses and temperatures. J. Range Manage. 21:314–316.

Springfield, H. W. 1968b. Age and year of collection affect germination of winterfat seeds. Rocky Mtn. Forest and Range Exp. Sta., U.S. Forest Serv., Res. Note. RM-112. 2 p.

Statler, Glen D. 1967. *Eurotia lanata* establishment trials. J. Range Manage. 20:253–255.

Strickler, Gerald S. 1956. Factors affecting the growth of whitesage (*Eurotia lanata* (Pursh.) Moq.). Masters thesis. Univ. Nevada, Reno. 125 p.

U.S. Dep. Agr. 1951. Soil Survey Manual. U.S. Dep. Agr. Agr. Handbook No. 18. 503 p.

U.S. Forest Service. 1948. Woody plant seed manual. U.S. Dep. Agr. Misc. Publ. 654. 416 p.

Van Dersal, William R. 1938. Native woody plants of the United States, their erosion control and wildlife value. U.S. Dep. Agr. Misc. Publ. No. 303. 362 p.

Weaver, J. E. 1958. Classification of root systems of forbs of grassland and a consideration of their significance. Ecology 39:393–401.

Williams, John A. 1967. Soil Survey of Zuni Mountain area, New Mexico. U.S. Dep. Agr., Forest Service and S.C.S., U.S. Government Printing Office, Washington, D.C. 86 p.

Workman, John P., and Neil E. West. 1967. Germination of *Eurotia lanata* in relation to temperature and salinity. Ecology 48:659–661.

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