Production and Conditioning of

Winterfat Seeds (*Krascheninnikovia lanata*)

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ABSTRACT

The USDA Bridger, Montana, Plant Materials Center has just released Open Range Tested Class germplasm of winterfat (*Krascheninnikovia lanata* [Pursh] Guldenstaedt [Chenopodiaceae]). We produce seeds of this native shrub using standard commercial seed production equipment. Processed naked utricles are seeded at a rate of 50 seeds per linear meter (15 seeds/linear ft) of row at a depth of 6 to 10 mm (0.25 to 0.5 in) with a double disk drill equipped with depth bands. Seed production fields are maintained under cultivated and irrigated conditions. Seeds are harvested by swathing mature plants and combining out of cured windrows. Seeds are processed using a series of seed cleaning equipment including 3- and 2-screen fanning mills, a hammermill, an indent separator, and a gravity table. Seeds of winterfat are very short lived, maintaining acceptable viability for only 2 y when stored under ambient conditions.

KEY WORDS

seed production, native shrub, restoration, Chenopodiaceae, *Ceratoides lanata*, *Eurotia lanata*

NOMENCLATURE

USDA NRCS (2001)

Figure 1. Mature winterfat plant.

Photo by Mark Majerus

Winterfat (*Krascheninnikovia lanata* [Pursh] Guldenstaedt [Chenopodiaceae]; syn. *Ceratoides lanata* [Pursh] J.T. Howell; syn. *Eurotia lanata* [Pursh] Moq.) has also been referred to as whitesage, lambstail, or sweetsage. The native range of this low-growing shrub extends from Saskatchewan and Manitoba south to Nebraska, Colorado, west Texas, and west to California, Oregon, and Washington. In the desert basins of Utah and Nevada it can be found growing in dense, relatively pure stands; in the Great Plains, however, winterfat is generally a minor component of bunchgrass–sagebrush rangelands. From a woody base, the plants produce numerous erect, annual branches. Stems and leaves are covered with soft, wooly hairs that give the plants a whitish to gray-green appearance. Sessile short-petioled leaves have enrolled edges and persist through the winter season. Plants are monoecious. Flowers are arranged in dense clusters in the leaf axils on the upper portions of the stems. Winterfat seeds are subtended and enclosed by 2 closely united bracts. Fine silky hairs arise externally from the bracts forming 4 dense tufts (Hilton 1941). The conspicuous horseshoe-shaped endosperm is encased in a thin, somewhat transparent testa (seedcoat). The embryo lies obovoid around the perisperm (food storage tissue); the acute end of the seed, located at the point of attachment, is formed by adjacent radicle and cotyledon tips (Booth 1988). Fluffy seeds with the bracts intact have approximately 106 seeds/g (48 000 seeds/lb), while processed seeds have approximately 352 seeds/g (160 000 seeds/lb). Seed is dispersed by wind, by rodent caching, and by clinging to animals. Hilton (1941) found that winterfat seeds are actually digested by sheep, and therefore deduced that seeds of this species are not distributed by animal feces as are seeds of many hard-seeded shrubs and forbs.

Winterfat is grazed with relish by all classes of domestic livestock and is an important food for deer, antelope, and elk. The persistent leaves and the high, late-season crude protein content make this plant an exceptional winter browse species. When utilized as winter forage, winterfat provides crude protein levels of 7% to 11% and is relatively high in calcium, phosphorus, and potassium (Hamilton and Gilbert 1972; Sowell and others 1985). Winterfat, along with moundscale (*Atriplex* x *aptera* A. Nels. (pro sp.) [*canescens* x *nutallii*] [Chenopodiaceae]) and sickle saltbush (*Atriplex falcata* (M.E. Jones) Standl.), are at the head of a short list of arid land shrub species that can be commercially produced using standard seed production techniques and are able to be established by direct seeding in native restoration seed mixtures. USDA farmland conservation programs that require the inclusion of a native shrub component to benefit wildlife and/or to enhance plant community diversity are utilizing these 3 shrub species. Availability of winterfat seed is limited, with most seeds of northern adapted ecotypes currently being wildland collected. Development of commercially produced winterfat seeds will greatly enhance the supply and quality of seeds needed for inclusion in native seed mixtures.

WINTERFAT RELEASES

In 1985 'Hatch' winterfat was released from the Los Lunas, New Mexico, Plant Materials Center (PMC). This particular germplasm was extensively tested at northern latitudes as accession NM-333, but it survived poorly in rangeland plantings north of the 40th parallel, creating interest in development of northern adapted ecotypes. In spring 2002, the Aberdeen, Idaho, PMC released Northern Cold Desert Selected Class germplasm of winterfat and the Bridger, Montana, PMC released Open Range Tested Class germplasm of winterfat. Open Range is a composite of 3 collections from eastern Montana (Custer County), south-central Montana (Carbon County), and southern Wyoming (Carbon County). These 3 accessions were selected from 32 native Wyoming and Montana collections for seedling vigor, biomass production, stand longevity, and uniformity in maturation.

Photo by Mark Majerus

Figure 2. Unprocessed winterfat seeds encased in 2-tufted bracts and naked processed utricles.

The remainder of this paper describes how we produce, process, and store seed of Open Range winterfat at Bridger PMC.

SEED FIELD ESTABLISHMENT

Our Foundation (G_1) seed production fields are established in 0.9-m (36-in) rows to facilitate cultivation and access for hand roguing. Commercial growers would more commonly use 0.75-m (30-in) or 0.6-m (24-in) row spacing (standard planting/cultivating widths for rowcrops). Processed seeds (naked utricles) are planted in the early spring (1 April to 10 May) using a double disk drill equipped with depth bands. Seeds are placed at a depth of 6 to 10 mm (0.25 to 0.50 in) in a firm weed-free seedbed. Seeds are planted at a rate of 50 seeds per meter of row (1.5 kg/ha with 0.9-m row spacing) (15 seeds/ft or 1.3 lb/ac with 36-in row spacing). Springfield (1972) found that winterfat has an after-ripening requirement of at least 9 wk, but with dormant fall or early spring planting, this does not pose an establishment problem. Because of the thin seed coating and the

Photo by Mark Majerus

Figure 3. Establishment year Open Range seed production field (0.9-m row spacing).

preformed cotyledons and root radicle, seeds of winterfat germinate rapidly (often within 48 h with soil moisture at field capacity). These seed characteristics also result in shelf life of < 3 y.

Research results conflict as to whether seeds should be processed down to naked utricles or if the fluffy bracts should be left intact. Booth and Schuman (1983) determined that threshed seeds have lower germination and emergence, and that there is a risk of damaging the radicle tip when processing with a hammermill. Stevens and others (1977) noted the importance of the bracts in protecting seeds and reducing precocious germination. Springfield (1970), comparing germination and survival of winterfat seedlings established from fruits and naked seeds, found that threshed seeds sown on the soil surface germinate best. Most research indicates that seeds, whether intact fruits or naked utricles, need to be planted at or near the soil surface. In one study, Springfield (1970) found that seeds spread on the soil surface established the best, while in a subsequent study Springfield (1971) found that a 1.5-mm (0.06-in) planting depth produced maximum emergence. Booth and Schuman (1983) and Woodmansee and Potter (1971) both recommended planting at 6 mm (0.25 in) or less. Optimum germination has been found with soil moisture conditions at field capacity and temperatures ranging from 10 to 30 °C (50 to 86 °F). Springfield (1968) found that winterfat will germinate under moisture stress if the temperature is at or near 5 °C (41 °F). Fry (1969) showed that winterfat seedlings will survive at temperatures as low as –11 °C (12 °F). Hilton (1941) found that air was critical for germination, that winterfat will not germinate under saturated conditions, and that light was not a factor in germination.

FIELD MAINTENANCE

Seed production fields of Open Range germplasm are seeded in mid-April and rows of emerging plants can be seen about 6 d after planting. We control the early flush of weeds with close cultivation, using a belly-mount cultivator with shields. As plants increase in size, the stand is cultivated with a between-row rototiller or an unshielded, rear-mount cultivator. Established stands of winterfat (2+ y old) can be cultivated early in the season with a rotary-hoe or an aggressively set spike-tooth harrow. Mature stands can also be crosscultivated (450 angle) with a Triple-K™ vibra-shank cultivator (Kongskilde, Soro, Denmark) equipped with narrow spikes.

We apply supplemental water via furrow irrigation with gated pipe. Avoid water-stressing the plants at 3 developmental stages: 1) early growth just prior to flowering; 2) post-anthesis as seeds are developing; and 3) post-harvest before winter freeze. Twenty-four hour irrigation sets result in the application of approximately 80 mm (3 in) of supplemental moisture for each application. In the Clarks Fork Valley of south-central Montana, natural precipitation (300 mm [11.3 in] average annual) is unreliable, making irrigation necessary for good seed production. Although winterfat is a drought-tolerant plant, it does respond to supplemental irrigation with increased seed viability and productivity. Winterfat fields are fertilized in late fall each year with a broadcast application of 45 kg/ha (40 lb/ac) nitrogen and 22 kg/ha (20 lb/ac) phosphorus.

We have yet to conduct any research on chemical weed control in seed production fields of winterfat. Currently, no herbicides are specifically labeled for use on winterfat, but chemicals developed for use on fruit trees and conservation shrubs are being considered as possible candidates. For example, we use a late fall application of 2.2 kg/ha (2.0 lb/ac) rates of Princep™ (Simazine) on four-wing saltbush for control of broadleaf weeds and early spring application of 168 kg/ha (150 lb/ac) Casoron™ (Dichlobenil) on shelterbelt trees and shrubs for control of annual weeds.

SEED HARVEST

Our average date of seed harvest has been 22 October. Seeds are considered mature enough to harvest once cotyledons begin to dehydrate and change from a dark green to a brownish color. Before seeds begin to shatter, the stand is swathed and windrows are allowed to dry for 3 to 5 d. Dried windrows are run through a standard grain combine with only minor modifications. The wind must be restricted by reducing the fan speed and/or by limiting the air that

Photo by Susan Winslow

Photo by Joe Scianna

Figure 4. Swathing (top) and combining (bottom) ripe winterfat seeds.

Photo by Mark Majerus

Figure 5. Winterfat seeds: (Left to right) combine run, once over fanning mill, and fully processed seeds.

enters the fan housing (depending on the model of combine). Our combine is equipped with a Petterson™ sieve, which must be set wide open to allow passage of the extremely fluffy seed. Standard grain sieves may require partial closure. Seeds are readily threshed from the plant so the cylinder/concave setting can be at least half open and the cylinder speed set at about 800 rpm. Because of the fluffy nature of the seed, the grain bin should not be allowed to fill completely as the "in-dirt" seeds are difficult to auger out of the bin. The harvested product is usually dry enough to store in bins or large cargo bags. With the often inclement weather of late October, the harvested product may require some drying (to ≤ 12% moisture) prior to sacking or storage.

Open Range winterfat has actually produced viable seeds (35 kg/ha [31 lb/ac] naked utricles or 115 kg/ha [102 lb/ac] fluffy fruits) in the establishment year. Open Range winterfat, and the 3 accessions from which it is derived, have exhibited seed production ranging from 35 to 210 kg/ha (31 to 187 lb/ac) of processed naked seeds. Although we have not had large stands in production for more than 3 y, the original breeders block was productive for the first 5 y and is only marginally productive at 8 y old. After the seed crop has been harvested, the stand is rotomowed to a uniform 10-cm (4-in) stubble.

SEED CONDITIONING AND STORAGE

Unprocessed seeds are difficult to dispense through a drill, requiring a carrier such as rice hulls and extra large drop tubes to prevent plugging, therefore we process seeds down to naked utricles so that commercial seed growers can easily meter seeds through a drill. Seeds are processed through a series of 7 steps using 5 pieces of seed-cleaning equipment (see sidebar p 15). The time and expense of processing seeds down to naked utricles may not be the most economical approach for a commercial seed grower or retail seed outlet. The ease of planting naked seeds, however, may justify the higher cost of fully processed winterfat seed.

Processed seeds are packaged in cloth sacks and stored under ambient conditions in a well-insulated building. The low relative humidity of south-central Montana and the cool conditions of the dark insulated building are some of the best possible storage conditions without a completely controlled environment. Germination tests of Open Range win-

terfat seeds stored at Bridger PMC showed that seed viability drastically drops off during the third year of storage (Table 1). Most of the 1- and 2-y-old seeds will germinate in 48 h.

Springfield (1968) found little loss of viability in winterfat seeds stored up to 3 y. Hilton (1941) found germination of current year seeds to be 97%, then dropping to 87%, 24%, and negligible after 1, 2, and 3 y of storage, respectively. Studies are underway at Bridger PMC to compare the viability of processed and unprocessed seeds stored in ambient, cool storage (5 °C [41 °F]) and freezer (–18 °C [0 °F]) conditions.

Open Range Tested Class germplasm of winterfat was released as a Pre-varietal release by the USDA NRCS Bridger, Montana, PMC. The new Pre-varietal release option is a means of releasing germplasm quicker than the standard Cultivar option, but it sacrifices the extensive field testing prior to the release of a Cultivar. G_1 seeds (1 generation past the crossing block) of Open Range winterfat are available to commercial seed growers through the Montana Foundation Seed Program at Montana State University-Bozeman and Wyoming Seed Certification-Powell.

TABLE 1

Germination rates of 1- to 6-y-old Open Range winterfat seeds stored under ambient conditions at Bridger PMC.

Age (Years)	Germination (%)
1	97
2	96
3	15
4	13
5	0
6	0

Steps in processing winterfat seeds down to naked utricles (Bridger PMC)

Step 1. Three-screen Fanning Mill
(reduces bulk by 50%)

- top screen 24/64 in (9.4 mm) round (removes large stems)
- middle screen 22/64 in (8.7 mm) round
- bottom screen 9/64 in (3.6 mm) round (removes leaves and small weed seeds)

Step 2. Hammermill (to thresh seed)

- 12/64 in (4.8 mm) screen 750 rpm

Step 3. Three-screen Fanning Mill
(remove pulverized stems and leaves)

- top screen 18/64 in (7.1 mm) round
- middle screen 17/64 in (6.7 mm) round
- bottom screen 1/23 in (1.1 mm) round

Step 4. Hammermill
(completes threshing process)

- 8/64 in (3.2 mm) screen 750 rpm

Step 5. Two-screen Fanning Mill

- top screen 8/64 in (3.2 mm) (removes stems)
- bottom screen 1/22 in (1.2 mm) (removes dust and chaff)

Step 6. Indent Cylinder Cleaner
(#11 indent; removes small pieces of stem)

Step 7. Gravity Table
(removes immature flower bodies and light seed)

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