NOTICE OF RELEASE OF

‘TRAILHEAD II’ BASIN WILDRYE

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ABSTRACT

‘Trailhead II’ basin wildrye (*Leymus cinereus* (Scribn. & Merr.) Á. Löve [Poaceae]) is a tetraploid basin wildrye release for use in re-vegetation efforts on rangelands of western North America. Trailhead II is the result of 2 cycles of recurrent selection within the basin wildrye cultivar ‘Trailhead’ for rapid seedling emergence from deep seeding. Trailhead II is genetically distinct from Trailhead. Additionally, in comparisons between Trailhead II and Trailhead, Trailhead II possessed higher total emergence and more rapid emergence from deep seeding (7.6 cm [3 in]) and exhibited higher seedling establishment at 3 of 5 field sites where it was evaluated in Nevada, Utah, and Wyoming. The release of Trailhead II basin wildrye improves this native germplasm to enhance the success of conservation and re-vegetation plantings in the Intermountain West and Northern Great Plains areas of the US and Canada.

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KEY WORDS
Leymus cinereus, rangeland re-vegetation, seedling establishment, Poaceae

NOMENCLATURE
USDA NRCS (2015)

Photos by Joseph G Robins

Species: *Leymus cinereus* (Scribn. & Merr.) Á. Löve
Common name: basin wildrye
Accession name: Experimental basin wildrye population

The USDA Agricultural Research Service approved the release of 'Trailhead II' basin wildrye on 9 March 2016. Trailhead II is a cultivar developed for rangeland revegetation.

JUSTIFICATION

Successful establishment of basin wildrye (*Leymus cinereus* (Scribn. & Merr.) Á. Löve [Poaceae]) is limited by poor germination and seedling vigor, such that full establishment often requires at least 3 y. Basin wildrye plant materials that possess higher germination rates and more rapid and successful seedling establishment in re-vegetation settings are needed.

DESCRIPTION

Basin wildrye, also referred to as Great Basin wildrye, is a perennial cool-season grass native to the western US and Canada. Basin wildrye is large-statured, caespitose, and is often found in, although not restricted to, wetland or riparian areas. Basin wildrye provides a feed source for livestock and wildlife in early spring and in winter, because of its large stature, but it is not persistent under repeated, close grazing (Winslow 2012).

Basin wildrye evaluation at Blue Creek, Utah.

Basin wildrye exists at 2 ploidy levels: tetraploid (2n = 4x = 28) and octoploid (2n = 8x = 56). The tetraploid level is predominant in the Intermountain and northern plains of the US and Canada (Jones and others 2009). 'Trailhead' (Cash and others 1998) is the only cultivar of tetraploid basin wildrye, although 'Tetra' and 'Washoe' germplasms are also tetraploid. Trailhead was developed by the USDA Natural Resources Conservation Service in conjunction with the Montana and Wyoming Agricultural Experiment Stations. The base seed of Trailhead was collected in Musselshell County, Montana, and evaluated in the northern Great Plains and Intermountain regions (Figure 1). Trailhead was released based on increased biomass production and stand longevity. While Trailhead provided an improved source of basin wildrye, it establishes and persists less than other common rangeland re-vegetation grasses (Robins and others 2013). A possible reason for the limited success of basin wildrye seeding establishment is because of the difficulty germinated seedlings have breaking through soil crusts. Thus, selection for increased seedling vigor may provide a means for increasing stand establishment. The evaluation of seedling emergence and vigor from a deep seeding depth (Asay and Johnson 1980) allows the identification of plant materials with improved seedling vigor for re-vegetation projects.

METHOD OF SELECTION

During winter 2005, 2500 C_0 (cycle 0) seeds of Trailhead basin wildrye were seeded at a 7.6 cm (3 in) depth in a sand bench in a Logan, Utah, greenhouse. One plant breeding cycle includes the genotypic and/or phenotypic evaluation of plant materials, the selection of desirable plant materials based on results of the

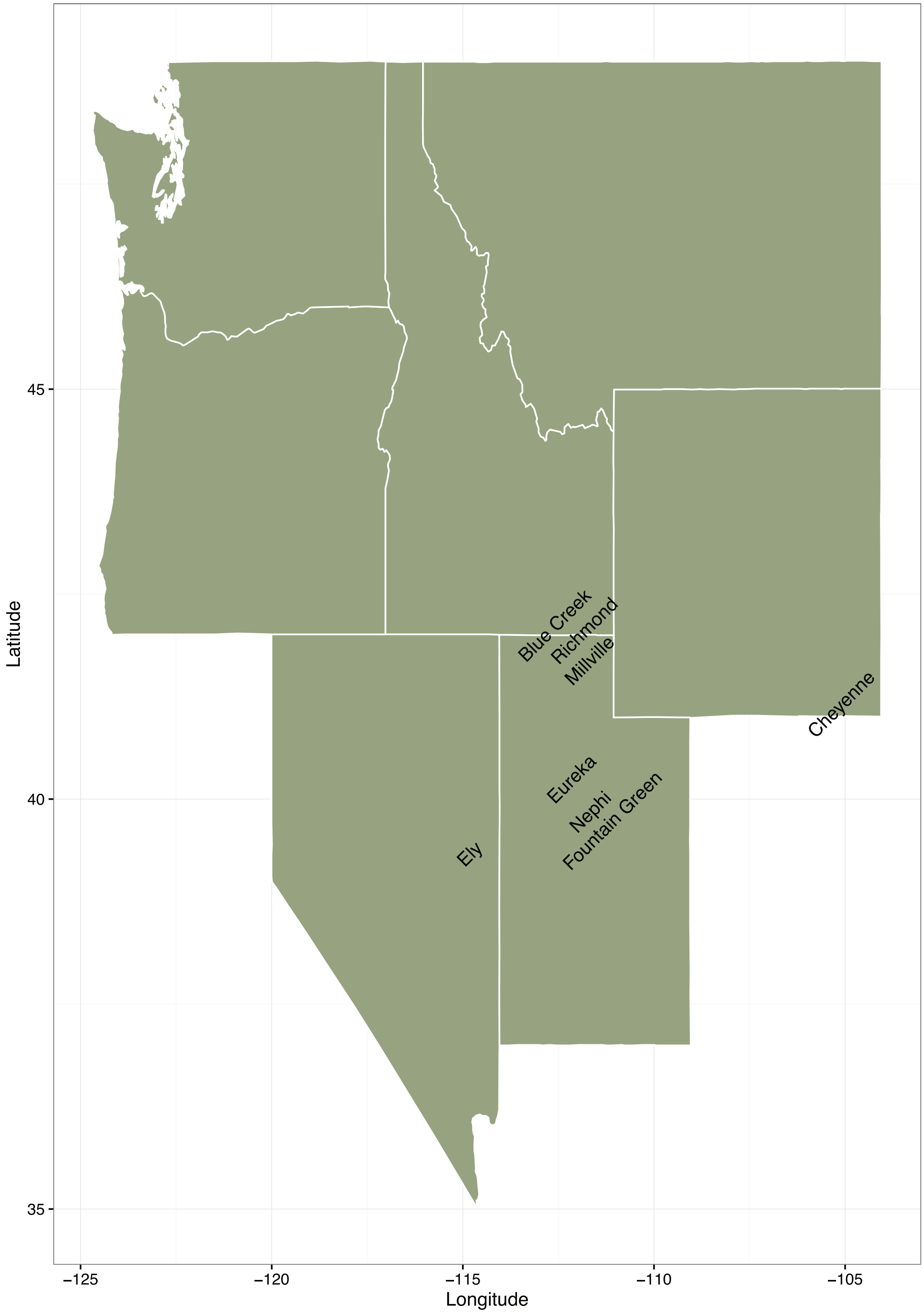

Figure 1. Map of the Intermountain and western Great Plains regions of the US. The map marks the area of adaptation of 'Trailhead II' and includes the location of the test sites (names) used during its development and evaluation.

evaluations, and hybridization among the selected plant materials with subsequent seed production. Within 10 d, 111 C_0 (4%) seedlings emerged from the deep seeding. These seedlings were retained, and the seeds that emerged at a slower rate were discarded. Fifty of the remaining 111 seedlings (overall 2% selection intensity) were then selected, based on visual vigor, to be the parental genotypes of the C_1 (cycle 1) generation. In spring 2005, the 50 selected C_0 plants were transplanted to a Millville, Utah, crossing block. In 2006, following open pollination and seed maturation, the C_1 seed was harvested and bulked from each C_0 genotype.

The same deep seeding selection was repeated on the C_1 seed during winter and spring 2007. Two thousand five hundred C_1 seeds were seeded at a 7.6 cm depth in a sand bench in a Logan, Utah, greenhouse. The same selection intensity (2%) was used to select 50 C_1 genotypes to become the parents of the C_2 (cycle 2) generation. In spring 2007, the 50 selected C_1 genotypes were transplanted to a Millville, Utah, crossing block. In 2008, following pollination and seed maturation, the C_2 seed was harvested and bulked from each C_1 genotype. The resulting C_2 seed was designated as the breeder seed of Trailhead II basin wildrye.

GENETIC AND PHENOTYPIC EVALUATION OF TRAILHEAD II

Molecular Characterization

Amplified fragment length polymorphic (AFLP) DNA markers (Vos and others 1995), generated on the ABI3730 (Applied Biosystems, Foster City, California), were used to compare the genetic diversity of Trailhead II to its parental Trailhead seed source. Five selective AFLP primers (E-agg/M-cac, E-act/M-cac, E-act/M-ctc, E-agg/M-cac, E-agg/M-ctg) were genotyped to generate 866 markers among 50 plants from Trailhead, the C_1 plants, and the C_2 (Trailhead II) plants. A genotyping error rate of 3.2% was observed through the inclusion of duplicate DNA samples in the AFLP analysis. From the resulting AFLP markers the average similarity within each cultivar (Leonard and others 1999), and the pairwise Φ(phi)-st genetic differences between cultivars from analysis of molecular variance (Peakall and Smouse 2006) were estimated.

Based on the resulting pairwise Φ(phi)-st values, Trailhead II was found to be genetically distinct from its parental population at a Φ-st of 0.019 ($P < 0.001$). Seventeen AFLP markers were significant in discriminating the two lines ($P < 0.01$). Additionally, a marginal, yet significant, increase in within-population genetic similarity from 68.7% for Trailhead to 69.1% for Trailhead II ($P < 0.05$) was identified.

Phenotypic Characterization

The phenotypic performance of Trailhead II and Trailhead were compared under greenhouse and field evaluations. All resulting data were analyzed using mixed model procedures with the R software package (R Core Team 2015).

Greenhouse evaluations of total emergence percentage and emergence rate from deep seeding (7.6 cm) were conducted in 2009 and 2012. The experimental design in each year was a randomized complete block design with 2 complete blocks in 2009 and 4 complete blocks in 2012. Four soil treatments were also included in the 2012 evaluation: 100% native sand, 100% native clay, 33% sand : 67% clay, and 67% sand : 33% clay. In each complete block, 50 pure live seeds (PLS) of each accession were planted at a rate of 2 PLS per inch. Following seeding in each year, emerged seedlings were counted on a daily basis for 4 wk. At the end of 4 wk, the counted seedling values were totaled and divided by the total possible number of seedlings (50) to determine the total emergence percentage. The total counts were also converted to a rate of seedlings emerged per day (Table 1). Trailhead II possessed a greater mean seedling emergence rate (3.0 vs. 1.2 seedlings/d) and greater mean total emergence (60 vs. 26%) than Trailhead ($P < 0.0001$).

Multi-location field trials were used to compare the mean establishment of Trailhead II to that of Trailhead. Field trials were conducted at Eureka, Utah (established 2014); Fountain Green, Utah (established 2014); Nephi, Utah (established 2012); Ely, Nevada (established 2014); and Cheyenne, Wyoming (established 2009). At each site, the trials were dormant seeded in November of the establishment year at a 1.3 cm (0.5 in) depth and a rate of 2 seeds per inch. The experimental design at each location was a randomized complete block design with 4 complete blocks. Establishment was measured the spring after seeding (May or June) by counting the number of emerged seedlings in each plot using the methods of Vogel and Masters (2001). Values were then converted to percent of established seedlings for further data analysis (Table 2). Trailhead II established better than Trailhead at Fountain Green, Utah, in 2015 (36 vs. 15%, $P = 0.03$); and Eureka, Utah, in 2010 (48 vs. 22%; $P = 0.002$); and marginally at Cheyenne, Wyoming, in 2010 (75 vs. 63%, $P = 0.12$). Trailhead II and Trailhead establishment did not differ at Ely, Nevada, in 2015

TABLE 1

Mean emergence rate and total emergence from deep seeding (7.6 cm) of 'Trailhead II' and 'Trailhead' basin wildrye cultivars, and the P *value corresponding to the contrast between the values of the 2 cultivars.*

Cultivar	Emergence rate (seed/d)	Total emergence (%)
'Trailhead II'	3.0	60
'Trailhead'	1.2	26
P value	< 0.0001	< 0.0001

TABLE 2

Mean stand establishment (%) values with corresponding least significant differences (5%) for 'Trailhead II' and 'Trailhead' basin wildrye cultivars and germplasms at 5 western US locations.

	Stand establishment (%)				
Cultivar	Cheyenne, WY	Ely, NV	Eureka, UT	Fountain Green, UT	Nephi, UT
'Trailhead II'	74	34	48	36	20
'Trailhead'	63	33	23	15	28
LSD 5%	14	11	16	18	13

(34 vs. 33%; $P = 0.88$) or Nephi, Utah, in 2013 (20 vs. 28%; $P = 0.24$).

Morphological characteristics of Trailhead II and Trailhead were evaluated based on data collected from Blue Creek, Utah (2014) and Eureka, Utah (2015) field sites. Fifteen culms were collected from each of 4 replications at each location. Each culm was then measured for plant height, flag leaf height, flag leaf length, flag leaf width, and spikelet length. The values for the 15 culms from each replication were then averaged to create a plot mean for data analysis (Table 3). At Blue Creek, Trailhead II and Trailhead differed for mean plant height (129 vs. 119 cm; $P = 0.09$) and mean flag leaf height (104 vs. 92 cm; $P = 0.02$), respectively, but did not differ for mean flag leaf length, mean flag leaf width, or mean spikelet length. At Eureka, Trailhead II exhibited longer mean flag leaf length (10.4 vs. 7.6 cm; $P = 0.08$) and mean spikelet length (12.7 vs. 11.4 cm; $P = 0.07$) than Trailhead, but there was no difference between them for mean plant height, mean flag leaf height, or mean flag leaf width.

The 2 cycles of stringent selection for seedling vigor within Trailhead resulted in Trailhead II basin wildrye. Trailhead II

'Trailhead II' basin wildrye foundation seed production at Richmond, Utah.

TABLE 3

Mean values of plant characteristics of 'Trailhead II' and 'Trailhead' basin wildrye cultivars collected from Blue Creek, Utah (2014) and Eureka, Utah (2015) field sites, and the corresponding P *value associated with the contrast.*

	Blue Creek, UT					Eureka, UT				
Cultivar	PH	FH	FL	FW	SL	PH	FH	FL	FW	SL
'Trailhead II'	129	104	117	3	14.5	78.9	61.6	10.4	3.0	12.7
'Trailhead'	119	92	141	4	13.8	77.6	62.1	7.6	2.9	11.4
P value	0.09	0.02	0.29	0.09	0.14	0.50	0.80	0.08	0.90	0.07

Notes: Plant height = PH (cm); flag leaf height = FH (cm); flag leaf length = FL (cm); flag leaf width = FW (mm); and spikelet length = SL (cm).

Basin wildrye seedheads and pollen.

possesses increased seedling vigor and stand establishment when compared to Trailhead. Aside from the increased seedling vigor, the selection process had minimal effect on other traits. This was evidenced by the limited morphological differences between the 2 cultivars and the miniscule increase in the genetic similarity of Trailhead II compared to Trailhead. Thus, Trailhead II serves as an apt replacement for Trailhead in re-vegetation by combining increased potential for stand establishment with only minor decrease in genetic variation.

ANTICIPATED CONSERVATION USE

Because of its increased total establishment percentage and rate of establishment, Trailhead II is an improved source of tetraploid basin wildrye and should be used as a replacement for Trailhead basin wildrye for conservation and re-vegetation plantings. We expect Trailhead II to be used by land management agencies and private landowners as part of USDA conservation programs.

ANTICIPATED AREA OF ADAPTATION

Trailhead II is expected to be adapted to areas of the Intermountain West, including the Great Basin (MLRA 25, 28A, 28B), Snake River Plain (MLRA 11, 12, 13), Columbia Plateau (MLRA 7, 8, 9, 10), and Rocky Mountains (43A, 43B, 47) where the cultivar Trailhead has traditionally been used.

AVAILABILITY OF PLANT MATERIALS

The release of Trailhead II provides an improved basin wildrye with increased total seedling establishment and rate of seedling establishment for revegetation projects in the Intermountain and Northern Great Plains areas of the US. Breeder, foundation, registered, and certified seed classes of Trailhead II are recognized. Foundation seed of Trailhead II will be maintained at the USDA ARS Forage and Range Research Laboratory, Logan, Utah. The Utah Crop Improvement Association will make foundation seed available to commercial growers for production of registered and certified seed classes. Small quantities of seed will be made available to researchers upon request. Appropriate recognition should be made if this material contributes to the development of a new breeding line or cultivar.

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