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# Registration of 'Homestead' Canada Wildrye

K. P. Vogel,\* R. B. Mitchell, D. D. Baltensperger, K. D. Johnson, and I. T. Carlson

## ABSTRACT

'Homestead' (Reg. No. CV-255, PI 655522) Canada wildrye (*Elymus canadensis* L.) was developed cooperatively by USDA-ARS and the University of Nebraska and was released in 2008 for use in the Great Plains and the Midwest USA, a region for which no adapted cultivars were previously available. It was developed by means of the Ecotype Selection Breeding System from a collection made in a remnant prairie in Eastern Nebraska USA. Homestead, which was tested as NE3, is adapted to Plant Adaptation Region (PAR) 251-5 (Temperate Prairie Parkland–Plant Hardiness Zone 5), which is its origin, and in which it has been evaluated in both space-transplanted and sward trials. This region is equivalent to USDA Plant Hardiness Zone 5 of the tallgrass-prairie ecoregion of the Midwest, USA. When grown in its area of adaptation, it produces more forage than the previously available, unadapted cultivar of the species and its forage has higher *in vitro* dry matter digestibility than another adapted experimental strain to which it was compared in sward forage yield trials. Its primary use will be as a native cool-season grass component of conservation, roadside, and grassland seeding mixtures.

CANADA WILDRYE is a cool-season ( $C_3$ ) grass that is native to most of the continental USA (Hitchcock, 1971; Barkley, 1986). It was one of the prevalent cool-season grasses in the tallgrass prairie region of the USA. It is a tetraploid species ( $2n = 4x = 28$ ) and is largely self-pollinated (Sanders and Hamrick, 1980; Jensen et al., 1990). Virginia wildrye (*Elymus virginicus* L.) is a related native cool-season grass that also was found in most continental USA states except for California, Oregon, and Nevada (Hitchcock, 1971; Barkley, 1986). Virginia wildrye was typically found in moist, low ground along woods and streams, while Canada wildrye was found on upland areas. Canada wildrye has long awns (2 to 3 cm) and Virginia wildrye has short awns (about 1

cm in length) on their lemmas. Prior to the release of the cultivar Homestead, only one cultivar each of Canada wildrye and Virginia wildrye had been released or developed. 'Mandan' Canada wildrye was developed from collections made near Mandan, ND (Alderson and Sharp 1994), and it is not well adapted to the Central Great Plains and Midwest, USA (Vogel et al., 2006). Omaha wildrye is a privately developed Virginia wildrye cultivar that is produced by Stock Seed Farms, Murdock, NE. It originates from plant material collected in eastern Nebraska. To date, these grasses have been used primarily in conservation, roadside, or prairie restoration plantings.

Plant Adaptation Regions (PAR) for native perennials were developed by Vogel et al. (2005) by overlaying the USDA Plant Hardiness Zone (HZ) (Cathey, 1990) map with Bailey's Ecoregion map (Bailey 1995, 1997). The resulting PAR Map (Vogel et al., 2005) can be used to define adaptation regions of both native and introduced perennial plants and will be used in this report to describe the testing and adaptation region for Homestead. Homestead was developed to provide an adapted cultivar for PAR 251-5 (Temperate Prairie Parkland—HZ 5). This PAR is equivalent to HZ 5 of the former tallgrass prairie region of presettlement USA. Mandan is based on plant materials collected near Mandan, ND. Mandan, ND, is located near the boundary of PAR 331-4 (Great Plains-Palouse Dry Steppe Eco-region-HZ 4) and PAR 331-3.

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**Abbreviations:** CWR, Canada wildrye; HZ, Plant Hardiness Zone; IVDMD, *in vitro* dry matter digestibility; PAR, Plant Adaptation Region.; WR, Virginia wildrye.

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## Methods

The Ecotype Selection breeding system (Vogel and Pedersen, 1993) was used to develop Homestead. In 1989, collections of Canada and Virginia wildrye were made from remnant Midwest prairies (Vogel et al., 2006). Seedheads were collected and bulked to form an accession from each prairie. Homestead was collected from Nine-mile Prairie, a 97-ha native prairie located west of Lincoln, NE, that is owned by

the University of Nebraska Foundation (Vogel et al., 2006). Homestead was evaluated and tested under the experimental strain designation NE3. The collected accessions were evaluated in replicated, space-transplanted germplasm evaluation trials at Mead, NE, Ames, IA and West Lafayette, IN, during the period 1990 through 1992 (Vogel et al., 2006).

On the basis of the results of the germplasm evaluation trial, seed of two of the accessions, NE3 and NE5, were each increased in space-transplanted nurseries that contained over 400 plants. NE5 was collected from a remnant prairie located about 50 km north of Lincoln, NE. The seed from the increase nurseries was used to plant replicated plots in cool-season grass evaluation trials and later to plant a 0.1-ha seed increase field for NE3. The trials were part of a multilocation, multispecies cool-season grass adaptation trial in which released cultivars and experimental strains of 15 different species were evaluated (Robins et al., 2007). The Canada and Virginia wild rye strains included in the trials at Mead and Sidney, NE, were NE3, NE5, and Omaha. Mandan was not included because of its poor performance in the previous germplasm evaluation trial (Vogel et al., 2006). All plots were seeded at rate of 430 pure live seeds (PLS)  $m^{-2}$ . The Mead trial was planted on 21 and 22 Sep. 1999 and the Sidney trial was planted on 27 Sep. 1999. All trials were planted into clean, tilled seedbeds. At the Mead site (Lat 40°51'N Long 96°45'W), the soil was a Sharpsburg silt loam (fine, montmorillonitic, mesic Typic Argiudoll), while at Sidney (41°23'N, 103°0'W), the soil was a Duroc loam (fine-silty, mixed, superactive, mesic, Pachic Haplustoll).

Seeded plots were 4.5 m in length and 1.5 m wide. The field experimental design was a randomized complete block with 4 replicates. No herbicides or fertilizer was applied the establishment year. At Mead, the plots were fertilized in late April or early May with  $NH_4NO_3$  in each harvested year at a rate of 112 kg N  $ha^{-1}$ . At Sidney, a single application of  $NH_4NO_3$  at a rate of 130 kg N  $ha^{-1}$  was made in May of 2001. Herbicides were used for weed control the first post-establishment year at Mead and Sidney. At Sidney, a spring application of 1.1 kg a.i.  $ha^{-1}$  of 2,4-D [(2,4-dichlorophenoxy)acetic acid] low volatile ester was applied while at Mead a spring application of 1.1 kg a.i.  $ha^{-1}$  of metolachlor [2-chloro-*N*-(2-ethyl-6-methylphenyl)-*N*-(2-methoxy-1-methylethyl) acetamide] application was applied for annual warm-season grass weed control, and in late July after Harvest 1, an application of 2.2 kg a.i.  $ha^{-1}$  metolachlor and triasulfuron [3-(6-methoxy-4-methyl-1,3,5-triazin-2-yl)-1-[2-chloroethoxy]-phenylsulfonyl]-urea (25g a.i.  $ha^{-1}$ ) was applied for control of fall germinating annual grasses and broadleaf weeds. Stand counts were taken in the spring of the year or after the first harvest by means of a frequency grid (Vogel and Masters, 2001). Date of heading was taken at Mead in 2001. Disease estimates were taken prior to harvest. Disease percentages are the estimated percentage of the plant tissue in a plot that was infested with a foliar disease.

At Mead, NE, plots were harvested after plants were fully headed. At Sidney, NE, plots were harvested after plants were fully headed (2001 and 2003) or after the end of the growing season (2002). The harvest was delayed in 2002 because of the effects of drought. Harvest 2 or regrowth har-

vests were made at Mead, NE, in 2001 and 2002. Regrowth harvests were not made in 2000 and 2003 because a lack of rainfall limited sufficient regrowth to warrant a harvest. If regrowth was not harvested, the accumulated growth was removed the following spring by mowing. Prior to harvest, plots were cut to a uniform plot length of 3 m. A flail type forage harvester was used to harvest a 0.91-m-wide swath lengthwise down the center of each plot (harvested area was 3 m  $\times$  0.91 m or 2.7  $m^2$ ) at a 10-cm cutting height. Subsamples were collected by sampling tillers throughout each plot with hand sickles prior to harvest. Collected samples were dried in a forced-air oven at 50°C to a constant weight and dry weight determined. Plot yields were adjusted to a dry weight basis and included sample weights.

Dried samples were ground to pass a 2-mm screen in a Wiley mill and a 1-mm screen in a cyclone mill and scanned on a near-infrared reflectance spectrophotometer (NIRS; Model 6500, Silver Spring, MD). Calibration samples to develop NIRS prediction equations were chosen by cluster analysis of the reflectance data (Shenk and Westerhaus, 1991) with samples from all species in the trials. Calibration samples were analyzed in triplicate for in vitro dry matter digestibility (IVDMD) with the ANKOM Rumen Fermenter (ANKOM Technology Corp., Fairport, NY) on the basis of the procedures described by Vogel et al. (1999). Nitrogen (N) concentration was determined by the LECO combustion method (Model FP 428 and FP 2000, LECO Corp., St. Joseph, MI) (Watson and Isaac, 1990; Bremner, 1996). Laboratory means were used to develop NIRS prediction by partial least squares (Shenk and Westerhaus, 1991). These prediction equations were used to predict IVDMD and N of all samples for both locations.

All data were analyzed with SAS software (SAS Institute, 1999). Analysis of variance was conducted by location for individual years and for plot means averaged over years. Average mean forage yield over years is the most important forage yield trait for perennial grasses. For this reason, forage yields and quality are reported as means averaged over years. Stands are reported for the initial year of harvest and for the last year of harvest.

## Characteristics

### Agronomic and Botanical Description

Homestead is a mixture of largely homozygous but morphologically similar genotypes. The uniformity of Homestead (NE3) was evaluated by collecting data from 130 spaced plants in the initial seed increase nursery at Mead, NE, in 1996 on 3-yr-old plants. Mean and standard deviation (in parenthesis) for the following traits were heading date 197(7) day-of-year, plant height 130(15) cm, flag leaf height 106(15) cm, flag leaf length 22.7(3.5) cm, flag leaf width 15(2) mm, head length 161(22) mm, head width 17(3) mm, and awn length 30(7) mm.

### Field Performance

In the replicated, space-transplanted germplasm evaluation trials at Mead, NE, Ames, IA, and West Lafayette, IN, during the period 1990 through 1992 (Vogel et al., 2006) Homestead (NE3) had 60% greater forage yield than that

of Mandan averaged over all locations. Heading date for Homestead was 11 d later than that for Mandan in these trials (Vogel et al., 2006). NE3 (Homestead) and NE5 had the highest yields of the accessions collected from Nebraska and South Dakota. The adaptation of Homestead to PAR 251-5 was demonstrated by its performance in these trials, which represented the full east to west range of PAR 251-5.

The sward plots at Mead and Sidney, NE, were used to evaluate the yield, forage quality, and persistence performance of the Canada Wildrye experimental strains and Omaha Virginia wildrye under forage production conditions. During the period 2000 to 2003, Homestead and NE5, had 35% higher forage yields at Mead, NE, than Omaha Virginia wildrye (Table 1), and they had significantly greater stand persistence (Table 2). Omaha wildrye simply did not persist after 3 yr of forage harvest at Mead, NE. Homestead had equivalent forage yield to NE5 at Mead, but it had significantly greater Harvest 1 IVDMD. Homestead had numerically lower disease percentages than NE5 in the two years that disease ratings were taken (Table 2). Harvest 2 yields were low at Mead, NE, and the Canada wildrye strains did not differ for Harvest 2 forage yield or for forage quality traits. At the Sidney, NE, site, which is in PAR 331-4, the Canada wildrye strains did not differ for forage yield or quality traits (Table 3). Neither NE3 nor NE5 had adequate persistence at this site that has significantly lower annual precipitation than PAR 251-5 sites but their persistence was still significantly better than Omaha's (Table 3). In the Mead trial, both smooth brome (*Bromus inermis* Leyss.) and intermediate wheatgrass [*Thinopyrum intermedium* (Host) Barkworth & D.R. Dewey] cultivars had stand frequency percentages of 100% at the end of the trial (data not shown), indicating that they have superior persistence under forage production conditions than Canada wildrye.

## Discussion

### Area of Adaptation and Use

Homestead Canada wildrye is adapted to PAR 251-5 (Temperate Prairie Parkland—Plant Hardiness Zone 5), which is its origin and in which it has been evaluated in both space-transplanted and sward trials. This region is equivalent to USDA Plant Hardiness Zone 5 of tallgrass prairie ecoregion of the Midwest, USA. It is likely also adapted to the lower half of PAR 251-4, since the principal test location at Mead,

NE, is adjacent to a section of PAR 251-4, but additional testing will be needed to verify its adapted to this region. When grown in its area of adaptation, it produces more forage than the previously available cultivar of the species, and its forage has higher in vitro dry matter digestibility than another adapted experimental strain to which it was compared in sward forage yield trials. Its primary use will be as a native cool-season grass component in conservation, roadside, and grassland seeding mixtures. Homestead Canada wildrye is not recommended for use in pure stands for forage production or pastures because it does not persist as well as smooth brome under forage production conditions in this region.

## Availability

Seed increase procedures for Homestead are those that are required for certification of other self-pollinated grasses. Breeder seed will be jointly maintained by USDA-ARS and the University of Nebraska-Lincoln. Foundation seed production of Homestead will be managed by the Nebraska Foundation Seed Division, University of Nebraska-Lincoln, Lincoln, NE 68583. Foundation seed will be made available for certified seed production on a non-exclusive basis to seed producers who contractually agree to produce and market the seed only as certified seed under the cultivar name Homestead. A technology development and transfer fee will be assessed by the University of Nebraska. Seed of this release will be deposited in the National Plant Germplasm System where it will be available for research purposes.

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**Table 1. Mean forage yield and quality traits for Canada (CWR) and Virginia (VWR) strains in the sward evaluation trial conducted near Mead, NE, during 1999 through 2003. DOY is day of the year.**

Cultivar	Species	Harvest 1 (2000–2003)				Harvest 2 (2001 and 2002)		
		Yield	IVDMD <sup>†</sup>	N <sup>‡</sup>	Head date (2001)	Yield	IVDMD	N
		Mg ha <sup>-1</sup>	g kg <sup>-1</sup>		DOY	Mg ha <sup>-1</sup>	g kg <sup>-1</sup>	
Homestead (NE3)	CWR	9.4	627	14.0	183	0.3	747	14.5
NE5	CWR	9.8	610	13.3	183	0.4	735	13.6
Omaha	VWR	6.9	648	16.1	183	0.7	702	15.8
SE <sup>§</sup>		0.2	3	0.3	2	0.1	8	0.7
LSD 0.05		0.5	9	0.8	ns	0.3	23	2.0

<sup>†</sup>IVDMD = in vitro dry matter digestibility.

<sup>‡</sup>N g kg<sup>-1</sup> × 6.25 = protein concentration.

<sup>§</sup>SE = standard of the mean; ns = not significant.

**Table 2. Mean stand frequencies and disease ratings for Canada (CWR) and Virginia (VWR) strains in the sward evaluation trial conducted near Mead, NE, during 1999 through 2003.**

Cultivar	Species	Stand frequency <sup>†</sup>		Disease <sup>‡</sup>	
		2000	2003	2001	2003
Homestead (NE3)	CWR	98	68	13	18
NE5	CWR	98	81	18	26
Omaha	VWR	98	8	48	70
SE <sup>§</sup>		5	6	3	3
LSD 0.05		14	15	9	9

<sup>†</sup>Stand frequencies determined by frequency grid (Vogel and Masters, 2001).

<sup>‡</sup>Disease percentage is the percentage of plant tissue that was visually infested with disease prior to harvest.

<sup>§</sup>SE = standard of the mean.

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**Table 3. Mean forage yield and quality traits for Canada (CWR) and Virginia (VWR) strains in the Northern Plains cool-season grass evaluation trial conducted near Sidney, NE, during 1999 through 2003.**

Cultivar	Species	Harvest 1 (2000–2003)			Stand frequency <sup>†</sup>	
		Yield	IVDMD <sup>‡</sup>	N	2001	2003
Homestead (NE3)	CWR	3.1	721	21.1	72	31
NE5	CWR	2.8	719	19.6	72	28
Omaha	VWR	2.8	707	18.7	72	9
SE <sup>§</sup>		0.2	10	1.0	8	8
LSD 0.05		0.6	ns <sup>†</sup>	2.7	21	22

<sup>†</sup>ns = no significant difference among entries in trial.

<sup>§</sup>SE = standard of the mean.

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