# Registration of 'Byrd' Wheat

Scott D. Haley,* Jerry J. Johnson, Frank B. Peairs, John A. Stromberger, Emily E. Hudson, Scott A. Seifert, Rebecca A. Kottke, Victoria A. Valdez, Jeff B. Rudolph, Guihua Bai, Xianming Chen, Robert L. Bowden, Yue Jin, James A. Kolmer, Ming-Shun Chen, and Bradford W. Seabourn

**ABSTRACT**

'Byrd' (Reg. No. CV-1073, PI 664257) hard red winter wheat (*Triticum aestivum* L.) was developed by the Colorado Agricultural Experiment Station and released in August 2011 through a marketing agreement with the Colorado Wheat Research Foundation. In addition to researchers at Colorado State University (CSU), USDA-ARS researchers at Manhattan, KS, St. Paul, MN and Pullman, WA participated in its development. Byrd was selected from the cross 'TAM 112'/CO970547-7 made in 2002 at Fort Collins, CO. TAM 112 (PI 643143) is a hard red winter wheat cultivar released by Texas A&M University in 2005. CO970547-7 is an experimental line from CSU with the pedigree 'Ike' (PI 574488)/'Halt' (PI 584505). Byrd was selected as an $F_{3:4}$ line in July 2006 and assigned experimental line number CO06424. Byrd was released because of its superior grain yield under nonirrigated and irrigated production conditions in eastern Colorado, its resistance to stripe (caused by *Puccinia striiformis* Westend. f. sp. *tritici* Eriks.) and stem rust (caused by *Puccinia graminis* Pers.:Pers f. sp. *tritici* Eriks. & E. Henn.), and its superior milling and bread-baking quality attributes. The name Byrd was chosen in honor of former CSU wheat breeder and director of the CIMMYT Global Wheat Program, Dr. Byrd C. Curtis.

'Byrd' (Reg. No. CV-1073, PI 664257) hard red winter wheat (*Triticum aestivum* L.) was developed by the Colorado Agricultural Experiment Station and released in August 2011 through a marketing agreement with the Colorado Wheat Research Foundation. In addition to researchers at Colorado State University (CSU), USDA-ARS researchers at Manhattan, KS, St. Paul, MN, and Pullman, WA participated in its development. Byrd was selected from the cross 'TAM 112'/CO970547-7 made in 2002 at Fort Collins, CO. TAM 112 (PI 643143) is a hard red winter wheat cultivar released by Texas A&M University in 2005. CO970547-7 is an experimental line from CSU with the pedigree 'Ike' (PI 574488)/'Halt' (PI 584505). Byrd was selected as an $F_{3:4}$ line in July 2006 and assigned experimental line number CO06424. Byrd was released because of its superior grain yield under nonirrigated and irrigated production conditions in eastern Colorado, its resistance to stripe (caused by *Puccinia striiformis* Westend. f. sp. *tritici* Eriks.) and stem rust (caused by *Puccinia graminis* Pers.:Pers f. sp. *tritici* Eriks. & E. Henn.), and its superior milling and bread-baking quality attributes. The name Byrd was chosen in honor of former CSU wheat breeder and director of the CIMMYT Global Wheat Program, Dr. Byrd C. Curtis.

S.D. Haley, J.J. Johnson, J.A. Stromberger, E.E. Hudson, S.A. Seifert, R.A. Kottke, and V.A. Valdez, Soil and Crop Sciences Dep., Colorado State Univ., Fort Collins, CO 80523; F.B. Peairs and J.B. Rudolph, Bioagricultural Sciences and Pest Management Dep., Colorado State Univ., Fort Collins, CO 80523; G. Bai, R.L. Bowden, and M.-S. Chen, USDA-ARS, Hard Winter Wheat Genetics Research Unit, Kansas State Univ., 4008 Throckmorton Hall, Manhattan, KS 66506; X. Chen, USDA-ARS, Wheat Genetics, Quality, Physiology and Disease Research Unit, Washington State Univ., Pullman, WA 99164; Y. Jin and J.A. Kolmer, USDA-ARS, Cereal Disease Lab., Univ. of Minnesota, 1551 Lindig St., St. Paul, MN 55108; B.W. Seabourn, USDA-ARS, Center for Grain and Animal Health Research, 1515 College Ave., Manhattan, KS 66502. Registration by CSSA. Received 21 Dec. 2011.
*Corresponding author (scott.haley@colostate.edu).

**Abbreviations:** CSU, Colorado State University; GI, germination index.

Published in the Journal of Plant Registrations 6:1–4 (2012).
doi: 10.3198/jpr2011.12.0672crc
Posted online 3 July 2012.


## Methods

Byrd was developed using a modified bulk-breeding method. All early-generation population and line development was done in the greenhouse or at an irrigated field-testing location at Fort Collins, CO. The cross, designated as population X021178, was made in the greenhouse in fall 2002. The $F_1$ seed was harvested in January 2003 and planted in a field nursery in mid-February 2003. The $F_1$ plants were hand harvested in bulk in July 2003, and the $F_2$ seed was planted in an unreplicated field nursery in September 2003. In July 2004, the $F_2$ population was harvested in bulk with a small-plot combine. A subsample of the grain was sieved with a Ro-Tap Test Sieve Shaker (W.S. Tyler, Mentor, OH) to select larger kernels, which were then planted in September 2004 in an unreplicated $F_3$ field nursery under sprinkler irrigation at Fort Collins, CO and under nonirrigated conditions at Akron, CO. In July 2005, the bulk population was randomly sampled for approximately 200 spikes at maturity. The spikes were threshed individually and planted in a sprinkler-irrigated headrow nursery in September 2005. Based on visual observations of uniformity and agronomic appearance, Byrd was selected as an $F_{3:4}$ line in July 2006 and assigned experimental number CO06424.

Byrd was evaluated in eastern Colorado in unreplicated preliminary yield trials in 2007, the Advanced Yield Nursery in 2008, the CSU Elite Trial from 2009 to 2011, statewide nonirrigated and irrigated variety trials in 2010 and 2011, the Regional Germplasm Observation Nursery in 2010 and 2011, and the Southern Regional Performance Nursery in 2011. The Advanced Yield Nursery and CSU Elite Trial were arranged in latinized row-column designs with two replications, and the state variety trials were arranged in latinized row-column designs with three replications. Seed purification of Byrd began in the 2009 crop year with the removal of tall and red-chaffed off-types from a small strip increase (1.5 by 9.8 m) grown under irrigation at Fort Collins, CO. A subsample of grain harvested from the increase in 2009 was used to plant a larger strip increase (1.5 by 189 m) for breeder-seed production in 2010. This increase was rogued as in 2009 and was used to plant a 4.9-ha foundation-seed increase near Fort Collins, CO in 2011. This increase was rogued as in previous years.

All statistical analyses were performed with SAS-JMP Pro Version 9.0.2 (SAS Institute, Cary, NC). Agronomic, disease resistance, and end-use quality data were analyzed by the Student's paired *t* test procedure. Yield and grain volume weight data from the CSU Elite Trial and statewide variety trials were subjected to combined analyses of variance across years and locations using a mixed model with genotypes as fixed factors and location-year combinations and replications within location-year combinations as random factors. Only entries common to the trials across all location-years were included. Tukey's Honestly Significant Difference test ($\alpha$ = 0.05) was used to compare the least squares means for the genotype effects.

# Characteristics

## General Description

Byrd is an awned, white-glumed, hard red winter wheat. Byrd has medium maturity, 150.7 d to heading from 1 January, which is 0.8 d earlier ($P < 0.05$; $n = 59$) than 'Hatcher' (PI 638512; Haley et al., 2005) and 0.7 d later ($P < 0.05$) than 'Ripper' (PI 644222; Haley et al., 2007). Byrd is medium-tall (80.6 cm; $n = 115$), 3.8 cm taller than ($P < 0.05$) Hatcher and 4.6 cm taller than Ripper. The coleoptile length (evaluated according to Hakizimana et al., 2000) of Byrd (67.9 mm; $n = 7$) is similar to ($P < 0.05$) that of Hatcher (66.1 mm) and shorter than ($P < 0.05$) that of Ripper (82.3 mm). Byrd's straw strength is good (3.6 score, $n = 22$; 1–9 scale, where 1 = erect and 9 = flat), similar to ($P > 0.05$) that of Hatcher (4.0) but less than ($P < 0.05$) that of Ripper (2.3). Preharvest sprouting tolerance of Byrd, assessed through determination of a germination index (GI; Mares et al., 2005) from field-grown samples, is moderate (GI = 0.42; $n = 10$), similar to ($P > 0.05$) that of Hatcher (GI = 0.42) and Ripper (GI = 0.40), and greater than ($P < 0.05$) that of 'Thunder CL' (PI 655528; Haley et al., 2009) (GI = 0.60) and TAM 112 (GI = 0.64). No objective data are available for winter hardiness of Byrd, but field observations and performance under dry soil conditions during recent winters in Colorado suggest that it is at least adequate for successful production in the central Great Plains region.

## Disease and Insect Resistance

Byrd has been characterized for disease and insect resistance in Colorado and through cooperative evaluations of the USDA Regional Testing Program. In greenhouse seedling evaluations at St. Paul, MN, Byrd was susceptible to moderately susceptible to stem rust races MCCFC, QFCSC, QTHJC, RCRSC, SCCSC, TPMKC, and TTTTF and resistant to moderately resistant to stem rust races RKQQC, QCCSM, TTKSK, TTKST, TTTSK, and TRTTF. Field adult-plant evaluations at St. Paul, MN and Njoro, Kenya, have confirmed that Byrd is generally susceptible to the North American races of stem rust but resistant to those found in Kenya (*Ug-99* and derivatives). Greenhouse seedling evaluations with leaf rust (caused by *Puccinia triticina* Eriks.) have shown that Byrd is susceptible to most common leaf rust races in the United States (TMGJ, TDBG, MFPS, MHDS, 10US1-1 MLDS, TNRJ, 10US3-1 TFBJ, and KFBJ). In 2011, under natural field infection with unknown leaf rust races, Byrd showed a susceptible reaction at St. Paul, MN (50% severity, susceptible infection type) and Castroville, TX (100% severity, susceptible infection type). In greenhouse seedling evaluations under a low diurnal temperature cycle that gradually changed from 4°C at 0200 h to 20°C at 1400 h (Chen and Line, 1995), Byrd was susceptible (infection type 8–9 on a 0–9 scale, where 0 = resistant and 9 = susceptible) to races PST-37, PST-45, PST-100, PST-114, and PST-127 of stripe rust (Chen et al., 2010). In greenhouse adult-plant tests under a high diurnal temperature cycle gradually changing from 10°C at 0200 h to 30°C at 1400 h (Chen and Line, 1995; Chen, 2005), Byrd was resistant (infection type 2–3) to races PST-100, PST-114, and PST-127. The standard low- and high-temperature profiles were used to simulate early- and late-season growing conditions and to distinguish usable high-temperature adult-plant resistance from all-stage resistance (also called seedling resistance; Chen, 2005). In artificially inoculated field tests at Rossville, KS in 2011, Byrd showed a moderate resistant reaction (infection type 3–4, severity 15–60%; $n = 3$), and the susceptible check KS89180B-2 had infection type 9 and 90–95% severity. Field observations of stripe rust severity at Laurel Springs, NC in 2011 were similar to those at Rossville, KS, whereas field observations at four locations in Washington suggested a higher degree of susceptibility to races in that region. Under natural field infection in Colorado in 2010, Byrd was moderately resistant (4.4 score on 1–9 scale, where 1 = resistant and 9 = susceptible; $n = 12$), slightly less resistant than Hatcher (2.3, $P < 0.05$), and more resistant than Ripper (8.3, $P < 0.05$). The susceptibility of seedlings at low temperatures and resistance of adult-plants in greenhouse and field tests at higher temperatures suggest that Byrd has high-temperature adult-plant resistance to stripe rust.

Other evaluations in Colorado or through the USDA Regional Testing Program have shown that Byrd is moderately resistant to *Barley yellow dwarf virus* and *Wheat soilborne mosaic virus* and moderately tolerant of acid soils. Byrd is susceptible to *Triticum mosaic virus*; its reaction to *Wheat streak mosaic virus* is not known, though it lacks the DNA markers associated with *Wsm1* (Qi et al., 2007) and *Wsm2* (Lu et al., 2012). Byrd is susceptible to a collection of endemic biotypes of the Hessian fly [*Mayetiola destructor* (Say)] (Chen et al., 2009), susceptible to greenbug Biotype E [*Schizaphis graminum* (Rondani)], and susceptible to Russian wheat aphid (*Diuraphis noxia* Kurdjumov) Biotypes 1 and 2.

## Field Performance

Byrd was tested at 29 trial locations of the CSU Elite Trial during 2009 (12 locations), 2010 (9 locations), and 2011 (8 locations). In the combined analysis across years, the grain yield of Byrd was the highest in the trial (4344 kg ha$^{-1}$), similar to ($P > 0.05$) that of 'Denali' (PI 664256; Haley et al., 2012) (4027 kg ha$^{-1}$) and greater than ($P < 0.05$) that of Ripper (3987 kg ha$^{-1}$), 'Bill Brown' (PI 653260; Haley et al., 2008) (3945 kg ha$^{-1}$), TAM 112 (3851 kg ha$^{-1}$), and Hatcher (3773 kg ha$^{-1}$). In these trials, Byrd had above-average grain volume weight (777 kg m$^{-3}$), which was similar to ($P > 0.05$) that of TAM 112 (782 kg m$^{-3}$), Denali (781 kg m$^{-3}$), Bill Brown (774 kg m$^{-3}$), and Hatcher (770 kg m$^{-3}$) and greater than ($P < 0.05$) that of Ripper (754 kg m$^{-3}$).

Byrd was tested at 15 trial locations of the nonirrigated Colorado Uniform Variety Performance Trial during 2010 (9 locations) and 2011 (6 locations). In the combined analysis across years, the grain yield of Byrd was the highest in the trial (4183 kg ha$^{-1}$), similar to ($P > 0.05$) that of Denali (3973 kg ha$^{-1}$) and greater than ($P < 0.05$) that of 'Settler CL' (PI 653833; Baenziger et al., 2011) (3842 kg ha$^{-1}$), Hatcher (3789 kg ha$^{-1}$), Bill Brown (3754 kg ha$^{-1}$), Ripper (3724 kg ha$^{-1}$), and TAM 112 (3639 kg ha$^{-1}$). In these trials, Byrd had an average grain volume weight (772 kg m$^{-3}$), which was less than ($P < 0.05$) that of Denali (784 kg m$^{-3}$), similar to ($P > 0.05$) that of TAM 112 (777 kg m$^{-3}$), Bill Brown (775 kg m$^{-3}$), and Hatcher (774 kg m$^{-3}$), and greater than ($P < 0.05$) that of Ripper (754 kg m$^{-3}$).

Byrd was tested at six trial locations of the Colorado Irrigated Variety Performance Trial during 2010 (three locations) and 2011 (three locations). In the combined analysis across years, the grain yield of Byrd was the highest in the trial (6945 kg ha$^{-1}$), similar to ($P > 0.05$) that of Settler CL (6707 kg ha$^{-1}$), Denali (6581 kg ha$^{-1}$), and Ripper (6514 kg ha$^{-1}$) and greater than ($P < 0.05$) that of Hatcher (6223 kg ha$^{-1}$) and Thunder CL (6044 kg ha$^{-1}$). In these trials, Byrd had the highest grain volume weight in the trial (796 kg m$^{-3}$), similar to ($P > 0.05$) that of Denali (789 kg m$^{-3}$), Thunder CL (784 kg m$^{-3}$), Settler CL (783 kg m$^{-3}$), and Hatcher (782 kg m$^{-3}$), and greater than ($P < 0.05$) that of Ripper (769 kg m$^{-3}$).

Byrd was tested in the 2011 Southern Regional Performance Nursery. Averaged across the hard winter wheat region (25 locations), Byrd was the highest-yielding entry in the trial (3698 kg ha$^{-1}$; 34 total entries).

## End-Use Quality

The milling and bread-baking characteristics of Byrd and the common check entries were determined using approved methods of the American Association of Cereal Chemists (AACC, 2000) in the CSU Wheat Quality Laboratory. Multiple location-year samples from the 2008, 2009, and 2010 growing seasons were available to enable comparison between Byrd and Hatcher, Ripper, and 'Above' (PI 631449; Haley et al., 2003) as check entries. The three check varieties have overall good milling properties, whereas the overall baking properties for Hatcher and Ripper are good and Above is poor. The values for milling-related variables were generally superior for Byrd compared with those of the check entries (Table 1). A significantly lower kernel weight and kernel diameter (obtained with the single kernel characterization system, SKCS 4100, Perten Instruments, Springfield, IL) were observed for Byrd compared with the checks. Values for flour extraction (with the Brabender Quadrumat Senior, C.W. Brabender, South Hackensack, NJ) and flour ash (obtained with a Foss-Tecator NIR Systems Model 6500, Foss North America, Eden Prairie, MN) were generally superior for Byrd, suggesting that its reduced kernel size does not adversely affect experimental milling performance. Values for baking-related variables were generally superior for Byrd compared with the checks (Table 1). In Mixograph (National Manufacturing, Lincoln, NE 68508) tests

**Table 1. Milling, dough-mixing, and bread-baking characteristics of Byrd and check entries across multiple evaluations from the 2008, 2009, and 2010 growing seasons in Colorado.**

| Trait (unit of measurement) | Samples | Byrd | Hatcher | Ripper | Above |
|---|---|---|---|---|---|
| SKCS† kernel weight (mg) | 36 | 27.1 | 30.4* | 31.7* | 31.3* |
| SKCS kernel diameter (mm) | 36 | 2.52 | 2.63* | 2.69* | 2.68* |
| SKCS kernel hardness (units) | 36 | 68.5 | 69.4 ns | 67.6 ns | 72.3* |
| Grain protein (g kg$^{-1}$) | 34 | 125 | 129* | 135* | 127 ns |
| Grain ash (g kg$^{-1}$) | 34 | 14.3 | 14.7* | 14.7* | 15.1* |
| Flour extraction (g kg$^{-1}$) | 23 | 708 | 673* | 674* | 648* |
| Flour ash (g kg$^{-1}$) | 33 | 4.2 | 4.4* | 4.5* | 4.5* |
| Mixograph peak time (min) | 32 | 6.3 | 4.4* | 3.2* | 2.8* |
| Mixograph tolerance (score)‡ | 24 | 5.2 | 3.8* | 3.2* | 2.1* |
| Bake mix time (min) | 24 | 6.3 | 4.2* | 3.1* | 2.6* |
| Bake water absorption (g kg$^{-1}$) | 24 | 628 | 630 ns | 643* | 615* |
| Loaf volume (L) | 24 | 1.06 | 0.92* | 0.90* | 0.84* |
| Crumb grain (score)‡ | 24 | 4.8 | 3.9* | 2.8* | 3.4* |

*Significance of the difference between Byrd and the check cultivar based on a Student's paired *t* test procedure at the 0.05 probability level; ns, not significant.

†SKCS, single-kernel characterization system.

‡Scale for mixograph tolerance and crumb grain scores: 6 = outstanding, 0 = unacceptable.

optimized for water absorption, Byrd had a significantly longer mixing time and greater Mixograph tolerance than the checks. In straight-dough pup-loaf baking tests, Byrd had comparable bake water absorption with a significantly longer bake mix time, greater loaf volume, and higher crumb grain score than the checks (Table 1). DNA marker assays for high molecular weight glutenin subunits (Butow et al., 2004; Liu et al., 2008) have shown that Byrd carries the 2* subunit (*Glu-A1b* allele) at the *Glu-A1* locus and the 7+8 subunits (*Glu-B1b* allele) at the *Glu-B1* locus. Marker assays for alleles at the *Glu-D1* locus have suggested that Byrd is heterogeneous for the 2+12 (*Glu-D1a* allele) and 5+10 (*Glu-D1d* allele) subunits. Byrd does not carry either the T1BL-1RS or T1AL-1RS translocation.

## Availability

The Colorado Agricultural Experiment Station will maintain breeder seed of Byrd. Multiplication and distribution rights of other classes of certified seed have been transferred from the Colorado Agricultural Experiment Station to the Colorado Wheat Research Foundation, 4026 South Timberline Road, Suite 100, Fort Collins, CO, 80525. Byrd has been submitted for U.S. Plant Variety Protection (PVP) under Public Law 91–577 with the Certification Only option. Recognized seed classes will include the Foundation, Registered, and Certified. Small quantities of seed for research purposes may be obtained from the corresponding author for at least 5 yr from the date of publication. Seed of Byrd has been deposited with the National Plant Germplasm System, where it will be available for distribution upon expiration of PVP, 20 yr after publication.

## Acknowledgments

This research was supported in part by the Colorado Wheat Administrative Committee and Wheat Research Foundation, USDA-CSREES Special Research Grants Nos. 2009-34205-19960, 2008-34205-19341, 2006-34205-17358, 2005-34205-16334, 2003-34205-13636, and the National Research Initiative of USDA's Cooperative State Research, Education and Extension Service CAP Grant No. 2006-55606-16629. Mention of trade names or commercial products in this publication is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture. USDA is an equal opportunity provider and employer.

## References

American Association of Cereal Chemists (AACC). 2000. Approved methods. 10th ed. Am. Assoc. Cereal Chem., St. Paul, MN.

Baenziger, P.S., R.A. Graybosch, L.A. Nelson, T. Regassa, R.N. Klein, D.D. Baltensperger, D.K. Santra, A.M.H. Ibrahim, W. Berzonsky, J.M. Krall, L. Xu, S.N. Wegulo, M.L. Bernards, Y. Jin, J. Kolmer, J.H. Hatchett, M.-S. Chen, and G. Bai. 2011. Registration of 'NH03614 CL' wheat. J. Plant Reg. 5:75–80. doi:10.3198/jpr2010.02.0084crc

Butow, B.J., K.R. Gale, J. Ikea, A. Juhasz, Z. Bedo, L. Tamas, and M.C. Gianibelli. 2004. Dissemination of the highly expressed Bx7 glutenin sub-unit (*Glu-B1al* allele) in wheat as revealed by novel PCR markers and RP-HPLC. Theor. Appl. Genet. 109:1525–1535. doi:10.1007/s00122-004-1776-8

Chen, M.S., E. Echegaray, R.J. Whitworth, H. Wang, P.E. Sloderbeck, A. Knutson, K.L. Giles, and T.A. Royer. 2009. Virulence analysis of Hessian fly (*Mayetiola destructor*) populations from Texas, Oklahoma, and Kansas. J. Econ. Entomol. 102:774–780. doi:10.1603/029.102.0239

Chen, X.M. 2005. Epidemiology and control of stripe rust [*Puccinia striiformis* f. sp. *tritici*] on wheat. Can. J. Plant Pathol. 27:314–337. doi:10.1080/07060660509507230

Chen, X.M., and R.F. Line. 1995. Gene action in wheat cultivars for durable high-temperature adult-plant resistance and interactions with race-specific, seedling resistance to stripe rust caused by *Puccinia striiformis*. Phytopathology 85:567–572. doi:10.1094/Phyto-85-567

Chen, X.M., L. Penman, A.M. Wan, and P. Cheng. 2010. Virulence races of *Puccinia striiformis* f. sp. *tritici* in 2006 and 2007 and development of wheat stripe rust and distributions, dynamics, and evolutionary relationships of races from 2000 to 2007 in the United States. Can. J. Plant Pathol. 32:315–333. doi:10.1080/07060661.2010.499271

Hakizimana, F., S.D. Haley, and E.B. Turnipseed. 2000. Repeatability and genotype × environment interaction of coleoptile length measurements in winter wheat. Crop Sci. 40:1233–1237. doi:10.2135/cropsci2000.4051233x

Haley, S.D., J.J. Johnson, F.B. Peairs, J.S. Quick, J.A. Stromberger, J.D. Butler, H.R. Miller, E.E. Heaton, J.B. Rudolph, B.W. Seabourn, G. Bai, Y. Jin, J. Kolmer, and X. Chen. 2008. Registration of 'Bill Brown' wheat. J. Plant Reg. 2:218–223. doi:10.3198/jpr2008.03.0133crc

Haley, S.D., J.J. Johnson, F.B. Peairs, J.S. Quick, J.A. Stromberger, S.R. Clayshulte, J.D. Butler, J.B. Rudolph, B.W. Seabourn, G. Bai, Y. Jin, and J. Kolmer. 2007. Registration of 'Ripper' wheat. J. Plant Reg. 1:1–6. doi:10.3198/jpr2006.10.0689crc

Haley, S.D., J.J. Johnson, F.B. Peairs, J.A. Stromberger, E.E. Hudson, S.A. Seifert, R.A. Kottke, V.A. Valdez, J.B. Rudolph, G. Bai, and X. Chen. R.L. Bowden, Y. Jin, J.A. Kolmer, M.-S. Chen, and B.W. Seabourn. 2012. Registration of 'Denali' wheat. J. Plant Reg. 6:XXX–XXX. doi: 10.3198/jpr2011.12.0675crc

Haley, S.D., J.J. Johnson, P.H. Westra, F.B. Peairs, J.A. Stromberger, E.E. Heaton, S.A. Seifert, R.A. Kottke, J.B. Rudolph, G. Bai, R.L. Bowden, M.-S. Chen, X. Chen, Y. Jin, J.A. Kolmer, and B.W. Seabourn. 2009. Registration of 'Thunder CL' wheat. J. Plant Reg. 3:181–184. doi:10.3198/jpr2008.12.0727crc

Haley, S.D., M.D. Lazar, J.S. Quick, J.J. Johnson, G.L. Peterson, J.A. Stromberger, S.R. Clayshulte, B.L. Clifford, T.A. Pester, S.J. Nissen, P.H. Westra, F.B. Peairs, and J.B. Rudolph. 2003. 'Above' winter wheat. Can. J. Plant Sci. 83:107–108. doi:10.4141/P02-014

Haley, S.D., J.S. Quick, J.J. Johnson, F.B. Peairs, J.A. Stromberger, S.R. Clayshulte, B.L. Clifford, J.B. Rudolph, B.W. Seabourn, O.K. Chung, Y. Jin, and J. Kolmer. 2005. Registration of 'Hatcher' wheat. Crop Sci. 45:2654–2655. doi:10.2135/cropsci2005.0030

Liu, S., S. Chao, and J.A. Anderson. 2008. New DNA markers for high molecular weight glutenin subunits in wheat. Theor. Appl. Genet. 118:177–183. doi:10.1007/s00122-008-0886-0

Lu, H., R. Kottke, R. Devkota, P. St. Amand, A. Bernardo, G. Bai, P. Byrne, T.J. Martin, S.D. Haley, and J. Rudd. 2012. Consensus-mapping and identification of markers for marker-assisted selection of *Wsm2* in wheat. Crop Sci. 52:720–728.

Mares, D., K. Mrva, J. Cheong, K. Williams, B. Watson, E. Storlie, M. Sutherland, and Y. Zou. 2005. A QTL located on chromosome 4A associated with dormancy in white- and red-grained wheats of diverse origin. Theor. Appl. Genet. 111:1357–1364. doi:10.1007/s00122-005-0065-5

Qi, L.L., B. Friebe, P. Zhang, and B.S. Gill. 2007. Homoeologous recombination, chromosome engineering and crop improvement. Chromosome Res. 15:3–19. doi:10.1007/s10577-006-1108-8