CULTIVAR

Registration of 'Brick' Wheat

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ABSTRACT

Fusarium head blight (FHB) [caused by *Fusarium graminearum* Schwabe; telomorph *Gibberella zeae* (Schwein.) Petch], is a major constraint to spring wheat (*Triticum aestivum* L.) production. The objective of this research was to release a hard red spring wheat (HRSW) cultivar with enhanced FHB resistance. 'Brick' (Reg. No. 1043, PI 657697) HRSW was developed at South Dakota State University (SDSU) and released by the South Dakota Agricultural Experiment Station to Registered seed producers in March 2009. The cross ND2897/SD3219//SD3414 was created in spring 2000. ND2897 is an unreleased experimental line developed by the North Dakota State University HRSW breeding program, and SD3219 and SD3414 are both unreleased experimental lines developed by the SDSU–HRSW breeding program. The population was advanced via an early-generation bulk-testing program where $F_{4:6}$ seed was included in the 2004 preliminary yield trial, and the line was designated SD3851. SD3851 also was tested in the advanced yield trial from 2005 through 2008. Brick was released for its high level of resistance to FHB when compared to other HRSW cultivars developed by the SDSU–HRSW breeding program as well as its high yield potential and grain volume weight in South Dakota and the northern Great Plains. Additionally, Brick is moderately resistant to leaf rust (caused by *Puccinia triticina* Eriks.) and has an early heading date compared with HRSW cultivars currently in production.

Fusarium head blight (FHB) [caused by *Fusarium graminearum* Schwabe; telomorph *Gibberella zeae* (Schwein.) Petch] is a major constraint to spring wheat (*Triticum aestivum* L.) production in the northern Great Plains. The objective of this research was to release a hard red spring wheat (HRSW) cultivar with enhanced levels of FHB resistance. 'Brick' (Reg. No. 1043, PI 657697) HRSW was developed and tested as both population 22643T and SD3851 at South Dakota State University (SDSU). It was released by the South Dakota Agricultural Experiment Station to Registered seed producers in March 2009. Brick was released for its high level of resistance to FHB when compared to other HRSW cultivars developed by the SDSU-HRSW breeding program as well as its high yield potential and grain volume weight (GVW) in South Dakota and the northern Great Plains. Additionally, Brick is moderately resistant to leaf rust (caused by *Puccinia triticina* Eriks.) and has an early heading date compared with HRSW cultivars currently in production. The cultivar was given its name to honor Mr. Robert Essick, late grandfather of Dr. Glover, a bricklayer before retirement, and because of its typically high GVW and deep red colored kernels.

Brick was selected as an $F_{4:6}$ line from within the three-parent population ND2897/SD3219//SD3414. Population 22643T was created in the spring wheat breeding greenhouse at Brookings, SD, during spring 2000. Both SD3219 and SD3414 are unreleased experimental lines developed by the SDSU–HRSW breeding program. The pedigree of SD3219 is SD3078/'Grandin' (PI 531005). The pedigree of SD3078 is 'Prospect' (PI 491568)/'Butte' (CItr 17681). The pedigree of SD3414 is 'Sharp' (PI 540401)/'Karl' (PI 527480)//'2375' (PI 601477; syn. Pioneer 2375). The pedigree of ND2897 is ND2710 (PI 633976)/3/Grandin*2//'Klein Lucero' (CItr 14047)/Butte. Population 22643T was advanced via an early-generation bulk-testing program until 2004 when the single $F_{4:7}$ experimental breeding line selection, designated SD3851, was tested in the preliminary yield trial (PYT). SD3851 also was tested in the SDSU–HRSW breeding

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Abbreviations: AYT, advanced yield trial; FDK, Fusarium-damaged kernels; FHB, Fusarium head blight; GPC, grain protein content; GVW, grain volume weight; HRSW, hard red spring wheat; PYT, preliminary yield trial; SDSU, South Dakota State University; URHRSWN, Uniform Regional Hard Red Spring Wheat Nursery.

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program advanced yield trial (AYT) from 2005 through 2008 and the Uniform Regional Hard Red Spring Wheat Nursery (URHRSWN) during 2005 and 2006.

Methods

Early-Generation Population Development

Before final line derivation for inclusion in replicated statewide and regional performance trials, population 22643T was advanced using an early-generation bulk-testing breeding method. Approximately 30 F_1 seeds created in spring 2000 were sown in a single 2-m row at an off-season nursery near Yuma, AZ, during winter 2000–2001. Single F_2 yield trial plots measuring 1.5 by 4.6 m consisting of 7 rows (21.4-cm row spacing) were sown with this seed during spring 2001 at Aurora and South Shore, SD. Through mixing with winter wheat, additional seeds of 22643T were spaced-planted at Aurora in an independent observation plot measuring 1.5 by 12.2 m. After 2001 yield trial plot harvest, heads from 20 plants within the corresponding spaced-planted plot were hand-harvested and individually threshed. All 20 heads were used to sow independent 2-m F_3 head-rows at the Arizona nursery during winter 2001–2002. A single head-row was selected from among the 20, and seed was used for sowing individual $F_{3:4}$ yield trial plots measuring 1.5 by 4.6 m at Aurora and South Shore during spring 2002. Before harvest of F_4 yield trial plots, 20 individual plant selections were made by hand-harvesting heads from within the plot at Aurora. Selected heads were threshed singly and sown as 2-m F_5 head-rows in Arizona during winter 2002–2003. Two rows among the 20 within population 22643T were selected, and seed from each sister line was used for sowing independent $F_{4:6}$ yield trial plots measuring 1.5 by 4.6 m at Aurora and South Shore during 2003. Grain yield relative to uniformly interspersed checks, visual estimates of plot uniformity, plant height (height from soil surface to tip of spikes, excluding awns), heading date, (number of days to 50% heading after 1 June), and low levels of leaf disease and FHB infection were primary selection criteria used during the 2001 growing season. The same criteria were considered with ensuing growing seasons except that GVW (approved method 55-10; American Association of Cereal Chemists, 2000), grain protein content (GPC) (approved method 39-10; AACC, 2000), and several dough mixing characteristics acquired using a computerized mixograph (approved method 45-40A; AACC, 2000) were also collected from each plot. Selections at the off-season nursery were based primarily on desirable plant height and uniformity within rows displaying low levels of lodging.

Line Selection and Evaluation

Agronomic performance and disease resistance data as described above were gathered during the 2003 growing season, and GVW, GPC, and dough mixing characteristics were collected after harvest. Among the two $F_{4:6}$ sister lines of population 22643T grown in 2003, one was selected for advancement. Bulked $F_{4:7}$ seed gave rise to the experimental line designated SD3851, which was included in one of two replicated PYTs during 2004. Two check cultivars, 'Russ' (PI 592785) and 'Oxen' (PI 596770), along with a total of 34 experimental lines selected from the 2003 growing season were included within the PYT, which was arranged as a randomized complete block design (RCBD) composed of two replications grown at five South Dakota locations. Agronomic performance and disease resistance data as described above were gathered from each location during the 2004 growing season, and after harvest GVW and GPC were again collected. Additionally, composite grain samples of each PYT entry from all locations were provided to the USDA–ARS Hard Spring Wheat Quality Laboratory in Fargo, ND, for complete milling and baking analysis using AACC approved methods (AACC, 2000). On the basis of data collected from 34 PYT entries grown in 2004, SD3851 was one of nine selected from within the second of two PYTs for inclusion in 2005 AYTs.

Through methods described for PYT selection from growing season 2004, SD3851 was perpetuated in the three-replication RCBD AYTs from 2005 through 2008. Nine check cultivars were included each year within the 36-entry AYT, which was sown at eight South Dakota locations in each year as well as one Nebraska location in 2005 and 2006. Hail and wind damage prevented harvest of grain from one location in 2005 and 2006 and two locations in 2008. Data were consequently collected from 30 location-years over the four seasons. Two years of simultaneous independent testing of SD3851 were initiated in 2005 with inclusion in the URHRSWN. The URHRSWN was grown at 18 and 20 locations in the United States (Minnesota, Montana, North Dakota, South Dakota, Washington, and Wyoming) and Canada (Manitoba and Saskatchewan) during the 2 yr. Plot size and row spacing varied with nursery cooperators, although all locations were conducted as a RCBD composed of three replicates that included five checks. The number of entries tested within the URHRSWN was 39 and 40 in 2005 and 2006, respectively. All field plots within PYT, AYT, and South Dakota locations of the URHRSWN trials were sown as 1.5- by 6.0-m plots composed of seven rows (21.4-cm row spacing). All plots were trimmed to 4.5 m before heading.

Seed Purification and Increase

Purification of SD3851 was initiated in 2005. Each AYT entry was sown as four 1.5- by 6.0-m increase and purification plots at Brookings that were trimmed to 4.5 m before heading. On several occasions coinciding with heading and immediately before physiological maturity, early-heading, late-heading, tall, late-maturing, and other questionable variants were manually removed from each plot. Purified seed was again sown in 2006 increase plots where rouging procedures similar to 2005 were performed. The same procedures were used in 2007 except that eight increase plots were sown. After harvest 2007, approximately 12 kg of Breeder seed was provided to South Dakota Foundation Seed Stocks Division for further increase. Breeder seed was increased during winter 2007–2008 at an off-season nursery located near Brawley, CA, as a 0.4-ha increase block. Foundation seed was produced during 2008 by sowing approximately 20 ha near Brookings.

Statistical Analysis

Statistical analyses were performed using SAS-JMP version 7.0.2 (SAS Institute, Cary, NC). Grain yield, GVW, GPC, heading date, plant height, lodging scores, FHB disease index (Stack et al., 1997), Fusarium-damaged kernels (FDK) and several end-use quality parameters from 4 yr of AYT and 2 yr of URHRSWN inclusion were subjected to ANOVA. All agronomic data from AYTs were collected on each replicate at each location-year. Agronomic data from URHRSWN trials as well as end-use quality data from both AYT and URHRSWN were available only as location means within years. Mixed model formulations were utilized for all analyses. Entries were always treated as fixed effects. Locations, years, replications within location-years (where available), and the appropriate interactions with entries were always considered random effects. Only entries common over years were included in the analyses. Entry effect mean separation was performed using an *F*-protected LSD at $P \leq 0.05$.

Characteristics

Agronomic and Botanical Description

Through 4 yr of AYT observation (30 location-years), plant height of Brick (82.7 cm) was significantly ($P < 0.05$) shorter than 'Granger' (PI 636134; Glover et al., 2006) (89.0 cm), Russ (86.2 cm), 'Steele-ND' (PI 634981; Mergoum et al., 2005) (84.1 cm), and 'Traverse' (PI 642780) (86.5 cm) but significantly taller than 'Alsen' (PI 615543; Frohberg et al., 2006) (79.1 cm), 'Briggs' (PI 632970; Devkota et al., 2007) (82.4 cm), 'Knudson' (PI 619609) (80.9 cm), Oxen (77.3 cm), and 'Reeder' (PI 613586) (76.9 cm; Table 1). Heading date (30 location-years) of Brick (18.7 d after 1 June) was significantly ($P < 0.05$) earlier than all comparison cultivars (Table 1). Lodging scores (six location-years), where a rating of 1 = fully upright and 9 = completely flat, were not significantly different among cultivars (Table 1).

Seven URHRSWN entries were common among seasons 2005 and 2006. Plant height observations of Brick (85.2 cm) and the six additional entries were collected at all 38 location-year combinations. Mean plant height measurements over the years ranged from 78.9 to 103.4 cm, and Brick was found to be intermediate in height among the entries. It was significantly ($P < 0.05$) taller than 'Verde' (PI 592561; Busch et al., 1996) (78.9 cm) but similar to 2375 (82.9 cm) and 'Faller' (PI 648350; Mergoum et al., 2008) (83.7 cm). It was significantly shorter than 'Chris' (CItr 13751) (100.3 cm), 'Keene' (PI 598224) (97.5 cm), and 'Marquis' (CItr 3641) (103.4 cm). The mean heading date (38 location-years) for Brick (19.9 d > 1 June) was significantly earlier ($P < 0.05$) than the other six URHRSWN entries (Table 2). Lodging scores were collected at eight and four locations in 2005 and 2006, respectively (12 location-years). Brick (1.1) was significantly ($P < 0.05$) less prone to lodging than Chris (3.5) and Marquis (2.5) but performed similarly to the remaining entries (Table 2).

Brick was observed to have an intermediately prostrate early plant growth habit with no anthocyanin pigmentation. At the boot stage, plants are green in color and flag leaves are inclined, not waxy, and partially twisted. After heading, plants possess mid-dense, tapering, and inclined heads with awns and white glabrous medium length glumes, with acuminate beaks, and square medium width shoulders. Kernels are medium to large-sized, red, and hard in texture with semi-rounded to sharp cheeks, a midsized brush, and a largely smooth surface texture. The germ is rounded, and the width of the crease measures 40 to 50% of kernel width.

Phenotypic uniformity and stability of Brick was closely monitored from 2005 through 2008. Three variant plant types are known to appear in Brick at a combined

Table 1. Agronomic and Fusarium head blight resistance data for 'Brick; and nine additional wheat cultivars tested in South Dakota State University advanced yield trials from 2005 through 2008.

Cultivar	Grain yield	Grain vol. wt.	Grain protein content	Heading date	Plant height	Lodging score	Disease index†	FDK‡
	kg ha^{-1}	kg m^3	g kg^{-1}	d > 1 June	cm	1–9§	%	
Alsen	2996	743	153.8	23.1	79.1	1.1	23.7	10.0
Brick	3366	766	142.4	18.7	82.7	1.3	15.9	7.3
Briggs	3428	748	148.9	20.5	82.4	1.2	27.5	6.6
Granger	3458	752	143.7	22.9	89.0	1.3	32.2	9.2
Knudson	3377	745	150.1	20.6	80.9	1.2	28.9	7.7
Oxen	3066	715	142.5	21.6	77.3	1.2	38.4	19.2
Reeder	2784	714	142.7	23.8	76.9	1.1	38.9	15.5
Russ	3198	722	142.4	22.4	86.2	1.2	34.8	8.2
Steele-ND	3502	751	150.6	22.5	84.1	1.2	36.3	12.5
Traverse	3581	720	138.1	21.3	86.5	1.1	25.9	30.3
Mean	3276	738.1	145.5	21.7	82.5	1.2	30.3	12.7
$LSD_{0.05}$	258.9	10.2	3.1	0.6	0.9	ns¶	9.0	11.4

†Disease index described by Stack et al. (1997).

‡FDK, Fusarium-damaged kernels.

§Lodging score, where 1 = fully upright and 9 = completely flat.

¶ns, not significant.

Table 2. Agronomic and Fusarium head blight resistance data for 'Brick' and six additional wheat cultivars tested in the Uniform Regional Hard Red Spring Wheat Nursery during 2005 and 2006.

Cultivar	Grain yield	Grain vol. wt.	Grain protein content	Heading date	Plant height	Lodging score	Disease index†	FDK‡
	kg ha^{-1}	kg m^3	g kg^{-1}	d > 1 June	cm	1–9§	——— % ———	
2375	3744	766	140.7	23.6	82.9	1.4	23.7	7.2
Brick	3977	791	142.3	19.9	85.2	1.1	15.7	4.7
Chris	2771	741	150.9	25.7	100.3	3.5	28.3	36.4
Faller	4025	750	140.6	25.3	83.7	0.9	23.5	4.4
Keene	3258	758	143.5	24.8	97.5	1.6	31.2	10.2
Marquis	2599	736	143.2	26.4	103.4	2.5	29.7	24.8
Verde	3736	750	144.1	24.8	78.9	1.2	33	14.6
Mean	3444	756	143.6	24.4	90.2	1.7	26.4	14.6
$LSD_{0.05}$	398.0	14.5	4.2	0.9	2.8	0.7	11.1	18.2

†Disease index described by Stack et al. (1997).

‡FDK, Fusarium-damaged kernels.

§Lodging score, where 1 = fully upright and 9 = completely flat.

frequency of about 1 in 100. Characteristics of the variants are as follows: (i) a taller variant (approximately 10 cm above the canopy), (ii) a second taller variant (approximately 15 cm above the canopy) with a generally lighter plant color and less tapered head, and (iii) an awnless variant comprised of a range of heights but similarly tapered heads.

Disease Resistance

On the basis of adult plant stem rust (caused by *Puccinia graminis* Pers.:Pers. f. sp. *tritici* Eriks. & E. Henn.) screening tests conducted on URHRSWN entries in 2005, Brick was evaluated as resistant to races that prevailed in the northern Great Plains. Reactions to leaf rust inoculations collected on the same URHRSWN entries in 2005 showed that Brick was resistant to races Pt-FKBJ, -MFBJ, -MHDS, -MJBJ, -MCDS, and -TNRJ but moderately susceptible to Pt-THBJ. These results indicate that Brick likely possesses resistance genes *Lr2a* and *Lr16*.

Brick was evaluated for FHB resistance at several points throughout development, and through molecular marker analysis using UMN10 (Liu et al., 2008), Brick is thought to possess the major FHB resistance quantitative trait locus, *Fhb1* (Pumphrey et al., 2007). While included in AYT, Brick was screened each year in a FHB field evaluation nursery at Brookings where artificial inoculation and overhead mist-irrigation techniques (Rudd et al., 2001) were used to promote disease development. These tests (four location-years) indicated that average FHB disease index ratings (Stack et al., 1997) of Brick (15.9%) were significantly ($P < 0.05$) lower than all other cultivars tested except Alsen (23.7%; Table 1). The mean FDK rating for Brick (7.3%) was also low, although significantly ($P < 0.05$) lower than only the 19.2 and 30.3% observed for Oxen and Traverse (Table 1).

Entries within the URHRSWN were also evaluated in artificially inoculated and mist-irrigated FHB resistance screening nurseries at two locations in both 2005 and 2006 (four location-years). Both mean disease index and FDK ratings were collected; however, mean FDK ratings among entries were not significantly different over location-years. Disease index rating of Brick (15.7%) was lowest but not significantly different than Faller (23.5) and 2375 (23.7). Verde (33.0), Keene (31.2), Marquis (29.7), and Chris (28.3) were all significantly ($P < 0.05$) more diseased than Brick (Table 2).

Field Performance

Over 30 AYT location-years from 2005 through 2008, Brick averaged 3366 kg ha^{-1}, similar to Briggs (3428 kg ha^{-1}), Granger (3458 kg ha^{-1}), Knudson (3377 kg ha^{-1}), Russ (3198 kg ha^{-1}), Steele-ND (3502 kg ha^{-1}), and Traverse (3581 kg ha^{-1}) and significantly ($P < 0.05$) higher than Alsen (2966 kg ha^{-1}), Oxen (3066 kg ha^{-1}), and Reeder (2784 kg ha^{-1}; Table 1). Grain volume weight of Brick (766 kg m^3) within the same trials was significantly ($P < 0.05$) higher than all other cultivars (Table 1). Grain protein content of Brick (142.4 g kg^{-1}) was significantly less ($P < 0.05$) than Alsen (153.8 g kg^{-1}), Briggs (148.9 g kg^{-1}), Knudson (150.1 g kg^{-1}), and Steele-ND (150.6 g kg^{-1}), similar to Granger (143.7 g kg^{-1}), Oxen (142.5 g kg^{-1}), Reeder (142.7 g kg^{-1}), and Russ (142.4 g kg^{-1}), and significantly greater ($P < 0.05$) than Traverse (138.1 g kg^{-1}; Table 1).

Mean grain yield of Brick (3977 kg ha^{-1}) collected over 38 URHRSWN location-years was significantly ($P < 0.05$) higher than Chris (2771 kg ha^{-1}) and Marquis (2599 kg ha^{-1}) but similar to the remaining cultivars (Table 2). Grain volume weight of Brick (791 kg m^3) within the same trials was significantly ($P < 0.05$) higher than all other cultivars (Table 2). Grain protein content of URHRSWN cultivars, collected at 11 locations in both 2005 and 2006 (22 location-years) showed that Brick (142.3 g kg^{-1}) produced significantly less protein than Chris (150.9 g kg^{-1}) but was similar to the remaining cultivars (Table 2).

End-Use Quality

Composite grain samples collected from 2005 to 2008 AYT and 2005 and 2006 URHRSWN harvests were submitted for milling and bread baking evaluation by the USDA–ARS Hard Spring Wheat Quality Laboratory in

Fargo, ND. Table 3 shows that among AYT comparison cultivars, Brick was near average in terms of thousand-kernel weight (30.5 g), bake water absorbance (583.2 g kg^{-1}), and loaf volume (186 mL). Brick was lower than average for values associated with percentage large kernels (53.8), flour protein, flour extraction, and ash content (126.1, 603, and 3.6 g kg^{-1}, respectively), as well as mixograph envelope peak value (58.6%). Values associated with percent small kernels (8.1), mixograph envelope peak time (8.0 min), mixograph score (5.9), and bake mix time (3.5 min) were higher than the average of comparison cultivars (Table 3). Performance of Brick relative to the mean of other tested URHRSWN cultivars for milling and baking characters were largely similar to those presented for AYT comparisons (Table 4) and are generally within the range of acceptability for the domestic milling and baking industries.

Availability

Protection for Brick will be sought under the U.S. Plant Variety Protection (PVP) Act (P.L. 910577) for Foundation, Registered, and Certified seed. All seed requests should be sent to the corresponding author during the period of protection by the PVP certificate. Seed of Brick has been deposited in the National Plant Germplasm System, where it will be available after PVP expiry for research purposes, including development and commercialization of new cultivars. It is requested that appropriate recognition be made if Brick contributes to the development of new germplasm or cultivars.

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Table 3. Milling and baking characteristics of 'Brick' and nine additional wheat cultivars tested in South Dakota State University advanced yield trials from 2005 through 2008.

Cultivar	1000 kernel wt.	Percent large kernels†	Percent small kernels‡	Flour protein	Flour extraction	Flour ash	Mix. peak time§	Mix. peak value	Mix. score	Bake mix time	Bake water abs.§	Loaf vol.
	g	%		g kg^{-1}			min	%		min	g kg^{-1}	mL
Alsen	29.2	56.5	6.9	137.9	594.0	3.9	5.8	63.8	6.1	2.6	594.2	195.5
Brick	30.5	53.8	8.1	126.1	603.0	3.6	8.0	58.6	5.9	3.5	583.2	186.0
Briggs	31.7	67.0	3.8	133.4	618.5	3.6	3.9	58.4	4.1	2.0	577.0	189.1
Granger	36.9	74.7	4.1	126.6	614.3	3.7	4.4	61.8	5.5	2.3	586.7	185.5
Knudson	32.0	66.0	4.0	132.9	608.7	3.6	3.7	59.5	4.5	1.7	573.4	189.9
Oxen	26.5	40.0	12.0	123.4	653.4	3.6	6.8	60.3	5.9	3.1	582.9	185.7
Reeder	27.5	45.9	10.0	127.7	595.2	3.6	5.0	57.4	4.9	2.4	576.9	188.2
Russ	30.4	61.7	6.1	124.0	619.3	3.9	5.3	65.1	5.7	2.8	597.9	186.2
Steele-ND	31.4	70.4	4.1	136.8	616.5	3.8	5.0	63.1	6.0	2.3	591.4	200.8
Traverse	30.9	55.1	8.0	119.9	588.1	4.0	3.3	56.0	2.9	1.5	559.3	170.6
Mean	30.7	59.1	6.7	128.8	611.1	3.7	5.1	60.4	5.2	2.4	582.3	187.8
$LSD_{0.05}$	1.1	4.9	2.0	3.9	8.6	0.2	0.6	2.9	0.6	0.3	6.8	6.8

†Percent kernels unable to pass through 2.92-mm sieve.

‡Percent kernels able to pass through 1.54-mm sieve.

§Mix., mixograph; abs., absorbance.

Table 4. Milling and baking characteristics of Brick and six additional cultivars tested in the Uniform Regional Hard Red Spring Wheat Nursery during 2005 and 2006.

Cultivar	1000 kernel wt.	Percent large kernels†	Percent small kernels‡	Flour protein	Flour extraction	Flour ash	Mix. peak time§	Mix. peak value	Mix. score
	g	%		g kg^{-1}			min	%	
2375	32.8	57.1	7.2	132.9	572.9	3.8	4.5	54.2	4.6
Brick	30.7	55.1	8.2	133.0	569.2	3.6	7.9	56.2	5.6
Chris	25.4	41.0	11.8	148.1	560.4	3.8	3.7	57.9	5.0
Faller	31.7	62.8	7.1	132.1	595.5	4.0	5.8	55.1	5.2
Keene	27.7	38.2	12.4	137.1	560.2	3.8	4.7	59.6	5.3
Marquis	26.9	44.6	10.6	138.2	555.9	4.0	4.8	53.0	4.5
Verde	30.1	61.1	6.3	134.0	600.0	3.9	4.7	56.4	4.3
Mean	29.3	51.4	9.1	136.5	573.4	3.8	5.1	56.1	4.9
$LSD_{0.05}$	1.3	6.2	2.9	2.7	8.7	0.3	1.1	2.2	0.3

†Percent kernels unable to pass through 2.92-mm sieve.

‡Percent kernels able to pass through 1.54-mm sieve.

§Mix., mixograph.

Panhandle Research and Extension Center in Scottsbluff for coordinating, growing, and harvesting 2005 and 2006 AYTs in Nebraska.

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