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Registration of 'Prevail' Hard Red Spring Wheat

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Abstract

Grower and end-user acceptance of new hard red spring wheat (HRSW; *Triticum aestivum* L.) cultivars largely depends on satisfactory agronomic performance, end-use quality potential, and disease resistance levels. Additional characteristics, such as desirable plant height, can also contribute to grower acceptance. The objective of this research was to release a short-statured HRSW cultivar with competitive grain yield and acceptable levels of end-use quality characteristics and Fusarium head blight (FHB) resistance. 'Prevail' (Reg. No. CV-1121; PI 672486) HRSW was developed at South Dakota State University (SDSU) and released by the South Dakota Agricultural Experiment Station (SDAES) in early 2014. The cross SD3720/MN98389-A was completed during fall 2002, and the resulting population was advanced via an early-generation bulk-testing program where $F_{6:8}$ seed was included in the 2008 preliminary yield trial and the line was designated as SD4178. SD4178 also was tested in the advanced yield trial from 2009 through 2013. Prevail was released primarily for its combination of high yield potential and desirable plant height that is significantly shorter than most other HRSW cultivars developed by the SDSU-HRSW breeding program.

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To maximize acceptance by both growers and end-users, new hard red spring wheat (HRSW; *Triticum aestivum* L.) cultivar releases require competitively high agronomic performance and end-use quality potential as well as acceptable levels of resistance to prevalent diseases. Other characteristics can also contribute favorably to grower acceptance. With recent widespread adoption of more intensive HRSW management practices in northern South Dakota, for example, grower preference has shifted toward producing cultivars that are shorter in stature than those generally released by the South Dakota State University (SDSU) HRSW breeding program. The objective of this research was to release a short-statured HRSW cultivar with competitive grain yield and acceptable grain volume weight (GVW), end-use quality characteristics, and Fusarium head blight (FHB) resistance [caused by *Fusarium graminearum* Schwabe (telomorph *Gibberella zeae* (Schwein.) Petch). 'Prevail' (Reg. No. CV-1121; PI 672486) HRSW was developed and tested as both population 26046 and SD4178 at South Dakota State University (SDSU) and released by the South Dakota Agricultural Experiment Station (SDAES) in early 2014. Prevail possesses a regionally competitive combination of high grain yield potential and desirable plant height when compared to most other HRSW cultivars developed by the SDSU-HRSW breeding program. Although not as highly resistant to FHB infection as 'Brick' (Glover et al., 2010), Prevail was generally not significantly more susceptible than trial averages.

Prevail was derived as an $F_{6:8}$ line from within the population SD3720/MN98389-A which was created in the HRSW breeding greenhouse at Brookings, SD, during fall 2002 and designated as population 26046. The female parental line SD3720 is an unreleased experimental breeding line developed

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Abbreviations: AYT, advanced yield trial; DON, deoxynivalenol; FDK, Fusarium-damaged kernel; FHB, Fusarium head blight; GPC, grain protein content; GVW, grain volume weight; HRSW, hard red spring wheat; PYT, preliminary yield trial; RCBD, randomized complete block design; SDSU, South Dakota State University.

by the SDSU-HRSW breeding program with the pedigree N92-0434/SD3415//SD3236, where N92-0434, SD3415, and SD3236 were derived from, 'Dalen' (PI 552812)/HS85-0476, ADB-SCAB, and SD3100/SD8061, respectively. ADB-SCAB is a composite population originally formed in the early 1990s as a source of FHB resistance, and SD3415 was an $F_{4:6}$ yield trial plot selection made in 1996. The male parent of Prevail was MN98389-A, an unreleased experimental breeding line developed by the University of Minnesota HRSW breeding program with the pedigree 'Oxen' (PI 596770)/'McVey' (PI 612966).

Population 26046 was advanced via an early-generation bulk-testing program until 2007, when the single $F_{6:8}$ experimental breeding line selection, designated as SD4178, was tested in the 2008 preliminary yield trial (PYT). SD4178 also was tested in the SDSU-HRSW breeding program advanced yield trial (AYT) from 2009 through 2013 and a cooperative multistate trial in 2011 and 2012.

Methods

Early Generation Population Development

Prior to derivation for inclusion in replicated statewide and regional performance trials, population 26046 was advanced using an early-generation bulk-testing breeding method. Approximately 30 F_1 seeds created in fall 2002 were sown in a single 2-m row at an off-season nursery near Yuma, AZ, during winter 2003–2004. Single F_2 yield trial plots measuring 1.5 by 4.6 m consisting of seven rows (21.4 cm row spacing) were sown with seed from Arizona during spring 2004 at Aurora and South Shore, SD. Through mixing with winter wheat, additional seed of 26046 was spaced-planted at Aurora in an independent observation plot measuring 1.5 by 12.2 m. After 2004 yield trial plot harvest, heads from 20 plants within the corresponding spaced-planted plot were hand harvested and individually threshed. Seed from the 20 heads was used to sow independent 2-m $F_{2:3}$ headrows at the off-season nursery near Yuma during winter 2004–2005 where nine of the headrows were selected for further consideration. Seed of the nine selections, along with 304 others, was used for sowing individual $F_{2:4}$ yield trial plots measuring 1.5 by 4.6 m at Aurora and South Shore during spring 2005. Prior to harvest of F_4 yield trial plots, 20 individual plant selections were made by hand harvesting heads from within three of the nine 26046 plots at Aurora. Selected heads were threshed singly and sown as 2-m $F_{4:5}$ headrows at the Arizona nursery during winter 2005–2006. Of the 60 headrows representing population 26046, 13 were selected for advancement. Seed of the sister lines, along with 332 additional selections, was used for sowing independent $F_{4:6}$ yield trial plots measuring 1.5 by 4.6 m at Aurora and South Shore during 2006. At this point of development within the breeding program, desirable $F_{4:6}$ lines are typically forwarded to PYTs. After plot heading during the 2006 growing season, however, it was noted that some population 26046 plots remained heterogeneous for plant height. Therefore, another round of individual off-season nursery row selection was performed by again selecting 20 heads from two of the population 26046 $F_{4:6}$ yield trial plots. Seed from the 40 $F_{6:7}$ population 26046 head reselections was sown as rows at an off-season nursery located near Christchurch, New Zealand, during winter 2006–2007. Of the 40 rows, 10 were chosen for harvest and, for convenience, inserted as $F_{6:8}$ lines into the 2007 version of the $F_{4:6}$ yield trial for further consideration along with 224 additional lines. Again, this trial was sown at Aurora and South Shore and plots measured 1.5 by 4.6 m.

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, or at least acceptable, levels of leaf disease and FHB infection were primary selection criteria used during the 2004 growing season. Similar criteria were considered with ensuing growing seasons except that GVW (approved method 55-10; AACC, 2000), grain protein content (GPC) (approved method 39-10; AACC, 2000), and several dough mixing characteristics acquired via computerized mixograph (approved method 45-40A; AACC, 2000) were also collected from each plot. Selections at off-season nurseries were primarily based on desirable plant height and uniformity within rows displaying minimal lodging.

Line Selection and Evaluation

Agronomic performance and disease resistance data as described above were gathered similarly from among the population 26046 $F_{6:8}$ lines as well as the 224 $F_{4:6}$ lines during the 2007 growing season, and GVW, GPC, and dough mixing characteristics were collected after harvest. Among the 10 $F_{6:8}$ sister lines of population 26046 grown in 2007, 2 were selected for advancement. Bulked $F_{6:9}$ seed gave rise to two experimental lines designated as SD4178 and SD4179, which were included in one of two replicated PYTs during 2008. Two check cultivars, 'Russ' (PI 592785) and 'Oxen' (PI 596770), along with 32 $F_{4:7}$ and the two $F_{6:9}$ (i.e., SD4178 and SD4179) experimental lines selected from the 2007 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 were gathered from each location during the 2008 growing season, and GVW and GPC were again collected after harvest. 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 end-use quality analysis using AACC approved methods (AACC, 2000). On the basis of agronomic, disease resistance, and end-use quality data collected from 2008 PYT entries, SD4179 was discarded and SD4178 was among 17 others selected from among the two PYTs for inclusion in the 2009 AYT.

Through methods described for PYT selection from growing season 2008, SD4178 was perpetuated in the three-replication RCBD AYTs from 2009 through 2013. Agronomic performance data from AYTs were consequently collected from 30 location-years over the five seasons. All AYT entries were subjected to molecular marker analysis at the USDA-ARS Cereal Crops Research Unit in Fargo, ND. SD4178 was also tested in cooperative multistate trials during 2011 and 2012 at 21 locations in Minnesota, Montana, North Dakota, and South Dakota. Multistate trial plot size and row spacing varied with nursery cooperators, although all were conducted as a RCBD

composed of three replicates that included five checks. All field plots within PYT, AYT, and South Dakota locations of the multistate trial 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 prior to heading.

Seed Purification and Increase

Purification of SD4178 was begun in 2009 with its initial AYT inclusion. Each AYT entry was sown as four 1.5- by 6.0-m increase and purification plots at Brookings that were trimmed to a length of 4.5 m prior to heading. On several occasions around heading and immediately prior to physiological maturity, early-heading, late-heading, tall, and late-maturing plants were manually removed. The same procedures took place in 2010; however, as physiological maturity approached, some straw-color heterogeneity was observed. Consequently, heads from 50 individual plants selected for light straw color were sown as rows at the New Zealand off-season nursery during winter 2010–2011. Twenty of the 50 headrows were chosen to be returned to South Dakota on the basis of straw color as well as similarities for plant height and maturity. Two 70-g samples were collected from each of the 20 seed packages for use in sowing yield trial and observation plots during 2011 at Aurora and Brookings. SD4178 from growing season 2010 was included for purposes of comparison, and based on grain yield, GVW, GPC, height and heading date, none were considered vastly different. Remnant seed from each of the 20 seed packages was then used to sow 1.5- by 15.0-m drill strips at the New Zealand nursery during winter 2011–2012. Prior to harvest, each of the drill strips was examined for uniformity within and similarity to one another. Fifteen strips were ultimately harvested and bulked to produce nearly 500 kg of breeder seed that was sown on 3.5 ha near Brookings in 2012.

Statistical Analysis

Statistical analyses for all parameters were performed using SAS-JMP version 12.0.1 (SAS Institute, 2015). Agronomic data from AYTs were collected on all replicate plots at each location-year. Similar data from multistate trials, end-use quality data from AYTs, and DON concentration values were available only as location means within years. Mixed model formulations were utilized for all analyses. Entries were treated as fixed effects. Locations, years, replications within location-years (where available), and appropriate interactions with entries were considered random effects. Only entries common over years were included in the analyses that took place after first testing for heterogeneity of variance using Levene's test (Levene, 1960). It was determined that location-year variances for grain yield were heterogeneous. Initial analyses were therefore performed where data were square root transformed to test for significance of effects prior to conducting secondary analyses on nontransformed data used for presentation of entry means. Entry effect mean separation was performed on nontransformed data using an F-protected LSD with $P \leq 0.05$.

Characteristics

Agronomic and Botanical Description

Through 5 yr of AYT observation (30 location-years), plant height of Prevail (82.9 cm) was significantly ($P < 0.05$) shorter than most of the 11 remaining comparison cultivars except 'Advance' (Glover et al., 2015; 82.1 cm), 'Knudson' (PI 619609; 83.8 cm), and Oxen (82.3; Table 1). Heading date of Prevail (22.7 d > 1 June) was similar to Oxen (22.9 d) and 'Granger' (Glover et al., 2006; 22.9) but significantly ($P < 0.05$) earlier or later than the remaining comparison cultivars (Table 1).

Table 1. Agronomic, Fusarium head blight, and bacterial leaf streak resistance data for Prevail and 11 additional wheat cultivars tested in South Dakota State University advanced yield trials, 2009–2013.

Cultivar	Grain yield	Grain volume weight	Grain protein content	Heading date	Plant height	Lodging†	Disease index‡	Fusarium-damaged kernels	DON§	Bacterial leaf streak¶
	kg ha^{-1}	kg m^{-3}	g kg^{-1}	d > 1 June	cm	1–5	%	%	μg g^{-1}	AUDPC
Advance	3203	742	147.6	23.5	82.1	1.8	27.3	22.5	6.1	621.1
Brick	2994	753	150.9	19.9	87.5	1.7	20.8	13.2	2.5	680.4
Briggs	3037	735	152.8	21.0	85.7	1.9	24.7	25.5	5.3	703.6
Faller	3304	724	147.4	25.2	87.5	1.6	26.0	15.6	6.5	612.3
Forefront	3075	749	154.4	21.9	93.4	1.7	22.1	16.5	3.7	622.6
Granger	2939	733	153.8	22.9	91.1	–	27.0	27.2	6.0	626.8
Knudson	3122	737	147.7	24.1	83.8	–	28.4	26.3	6.8	632.5
Oxen	3000	701	149.0	22.9	82.3	–	30.2	24.5	3.8	679.7
Prevail	3195	741	147.5	22.7	82.9	1.6	24.9	17.1	4.9	599.9
Select	3082	742	150.4	20.2	87.9	1.7	25.3	20.9	4.1	803.4
Steele-ND	3024	737	154.8	23.6	88.2	–	28.0	16.7	7.3	663.2
Traverse	3225	698	147.0	22.2	90.1	1.7	26.6	25.1	4.8	652.6
Mean	3100	733	150	23	87	1.7	26	21	5	658.2
LSD (0.05)	82.7	4.4	1.7	0.3	1.1	0.1	3.1	5.0	1.5	198.0
CV %	3.6	2.3	2.0	6.9	4.2	5.0	10.2	23.3	27.6	8.4
Environments	35	35	35	30	30	18	10	10	6	2

† Lodging scores collected from South Dakota State University crop performance testing trials, 2011–2013.

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

§ DON, deoxynivalenol.

¶ Bacterial leaf streak resistance scores collected in 2012 and 2013. AUDPC, area under the disease progress curve.

Among the multistate trial entries, plant height of Prevail (78.2 cm; measured at 20 locations) was significantly ($P < 0.05$) shorter than 'Glenn' (Mergoum et al., 2006; 83.2 cm) and 'Select' (Glover et al., 2011; 81.0 cm) but significantly taller than RB07 (Anderson et al., 2009; 75.5 cm; Table 2). The mean heading date of Prevail (24.0 d > 1 Jun; measured at 19 locations) was significantly earlier ($P < 0.05$) than 'Faller' (Mergoum et al., 2008; 27.0) and 'Verde' (Busch et al., 1996; 24.0 d) but significantly later than Select (21.6 d; Table 2).

Prevail 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 middense, tapering, and erect heads with awns and white glabrous medium-length glumes, with acuminate beaks, and elevated medium-width shoulders. Kernels are hard-textured, red-colored, ovate-shaped, and not collared, with angular cheeks, a long brush, a midsized germ, and a largely smooth surface texture.

Phenotypic uniformity and stability of Prevail was closely monitored from the 2009 through 2013 growing seasons. Three variant plant types are known to occur, two of which are present at frequencies of about 50 in 10,000 plants. The first variant is up to 10 cm taller than the canopy, but otherwise very similar to Prevail. The second is up to 10 cm taller than the canopy and also very similar to Prevail, with the exception being that it reaches maturity later than typical Prevail plants. The third variant appears at a frequency of approximately 20 in 10,000 plants and is indistinguishable until senescence is nearly complete when its red-chaff color becomes apparent.

Disease Resistance

Although Prevail was not specifically tested for resistance to leaf rust (caused by *Puccinia triticina* Eriks.), analysis of molecular marker csLV34 (Lagudah et al., 2006) revealed that it possesses the slow rusting gene *Lr34*. Prevail was evaluated for FHB resistance in inoculated nurseries at Brookings throughout its development (data not shown) where artificial inoculation and overhead mist-irrigation techniques (Rudd et al., 2001) were utilized to promote disease development. While tested in AYTs, screening of Prevail for FHB resistance was continued each year at Brookings and near Volga, SD. On the basis of these 10 trials, average FHB disease index ratings (Stack et al., 1997) of Prevail (24.9%) were significantly ($P < 0.05$) higher than Brick (20.8%), significantly lower than Knudson (28.4), Oxen (30.2), and Steele-ND (Mergoum et al., 2005; 28.0%), and similar to the remaining cultivars (Table 1). The mean Fusarium-damaged kernel (FDK) percentage of Prevail (17.1%) was significantly ($P < 0.05$) less than those of Advance (22.5%), Briggs (25.5%), Granger (27.2%), Knudson (26.3%), Oxen (24.5%), and Traverse (25.1%), though similar to the remaining cultivars (Table 1). Deoxynivalenol concentration of Prevail (4.9 $\mu g\ g^{-1}$) was significantly ($P < 0.05$) higher than that of Brick (2.5 $\mu g\ g^{-1}$), significantly less than Advance (6.1), Faller (6.5), Knudson (6.8), and Steele-ND (7.3 $\mu g\ g^{-1}$), and similar to the remaining cultivars (Table 1). Analysis of the single nucleotide polymorphism marker *Xsnp3BS-usda*, as well as microsatellite marker Barc186, revealed that Prevail does not possess the *Fhb1* (Pumphrey et al., 2007) or *Qfhs.ifa-5A* (Buerstmayr et al., 2002) quantitative trait loci for FHB resistance.

Entries within the multistate trial were also evaluated in artificially inoculated and mist-irrigated FHB resistance screening nurseries in 2011 and 2012 where disease index and FDK percentages were collected at five environments. The average disease index rating of Prevail (28.4%) was not significantly better or worse than the other cultivars; however, average FDK percentage of Prevail (8.8%) was less than Verde (16.0%) and similar to the others (Table 2).

Routine annual testing of AYT entries for resistance to bacterial leaf streak, caused by *Xanthomonas campestris* pv. *translucens* (Jones, Johnson, & Reddy) Dye, was initiated within the breeding program in 2012 using methods described by Kandel et al. (2012). Combined results from trials conducted in 2012 and 2013 indicate that the area under the disease progress curve (AUDPC) rating of Prevail (599.9) was lowest among all comparison cultivars, although significantly ($P < 0.05$) lower only than Select (803.4; Table 1).

Field Performance

Over 30 AYT location-years from 2009 through 2013, average grain yield of Prevail was 3195 kg ha^{-1}, which was significantly less than Faller (3304 kg ha^{-1}), similar to Advance (3203), Knudson (3122), and 'Traverse' (PI 642780; 3225 kg ha^{-1}), but significantly higher than the remaining cultivars

Table 2. Agronomic and Fusarium head blight resistance data for Prevail and five additional wheat cultivars tested in 2011 and 2012 multistate hard red spring wheat trials.

Cultivar	Grain yield	Grain volume weight	Grain protein content	Heading date	Plant height	Disease index†	Fusarium-damaged kernels
	kg ha^{-1}	kg m^{-3}	g kg^{-1}	d > 1 June	cm	%	%
Faller	3108	731	149.0	27.0	78.9	17.4	14.0
Glenn	2907	769	158.7	23.7	83.2	24.0	8.2
Prevail	3367	741	148.4	24.0	78.2	28.4	8.8
RB07	3102	738	154.2	24.3	75.5	36.8	14.7
Select	3167	758	148.7	21.6	81.0	21.8	9.1
Verde	3152	733	149.2	26.4	78.2	32.6	16.0
Mean	3134	745	151.4	24.5	79.1	26.8	11.8
LSD (0.05)	202.9	9.6	2.6	0.7	1.7	14.5	7.1
CV %	4.7	2.0	2.8	8.0	3.3	26.8	29.4
Environments	21	21	13	19	20	5	5

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

(Table 1). Grain volume weight of Prevail (741 kg m^{-3}) within the same trials was significantly ($P < 0.05$) less than Brick (753 kg m^{-3}) and 'Forefront' (Glover et al., 2013; 749 kg m^{-3}), similar to Advance (742 kg m^{-3}), 'Briggs' (Devkota et al., 2007; 735 kg m^{-3}), Knudson (737 kg m^{-3}), Select (742 kg m^{-3}), and Steele-ND (737 kg m^{-3}), and significantly greater than the remaining cultivars (Table 1). Grain protein content of Prevail (147.5 g kg^{-1}) was similar to Advance (147.6), Faller (147.4), Knudson (147.7), Oxen (149.0), and Traverse (147.0 g kg^{-1}) but significantly lower ($P < 0.05$) than the remaining cultivars (Table 1). Plant lodging scores were collected immediately before plot harvest at six locations each year from 2011 to 2013 by the SDSU crop performance testing group. Scores ranged from 1 to 5, where 1 indicates that plants are completely erect and 5 indicates that plants are completely flat. Over the 18 crop performance testing location-years, Prevail and Faller were each assigned a score of 1.6, indicating that they were significantly less prone to lodging than the remaining cultivars (Table 1).

Within the multistate trials where grain yield was collected at 21 environments, the average of Prevail was 3367 kg ha^{-1}, which was similar to that of Select (3167 kg ha^{-1}) and significantly higher ($P < 0.05$) than the remaining cultivars (Table 2). Grain volume weight of Prevail (741 kg m^{-3}) within the same trials was significantly lower than Glenn (769 kg m^{-3}) and Select (758 kg m^{-3}) and significantly higher than Verde (733 kg m^{-3}; Table 2). Grain protein content of multistate trial entries, collected at 13 environments, revealed that Prevail (148.4 g kg^{-1}) was significantly less ($P < 0.05$) than Glenn (158.7 g kg^{-1}) but similar to the remaining cultivars (Table 2).

End-Use Quality

Grain samples collected from AYT harvests from 2009 to 2013 were submitted for milling and bread baking evaluation by the USDA-ARS Hard Spring Wheat Quality Laboratory in Fargo, ND. Table 3 reveals that Prevail was not significantly ($P < 0.05$) better or worse than trial averages for any of the traits that were measured. Although not vastly different than the average for all traits, a noticeable characteristic may be its flour ash value (3.57 g kg^{-1}), which was lowest among all comparison entries (Table 3).

Availability

Protection for Prevail will be sought under the US 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 Prevail has been deposited in the USDA 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 Prevail contributes to the development of new germplasm or cultivars.

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Table 3. Milling and baking characteristics of Prevail and 11 additional wheat cultivars tested in South Dakota State University advanced yield trials, 2009–2013.

Cultivar	1000 kernel weight	Flour protein	Flour extraction	Flour ash	Envelope peak time	Envelope peak value	Mixograph score	Bake mix time	Bake water absorbance	Loaf volume
	g	——— g kg^{-1} ———			min	%	1–8†	min	g kg^{-1}	mL
Advance	28.2	132.4	613.0	3.97	6.8	62.6	6.0	3.0	56.1	193.9
Brick	28.1	135.6	613.6	3.90	7.7	66.9	6.6	3.5	57.4	189.6
Briggs	30.2	137.0	627.6	3.88	4.0	64.9	4.7	1.9	56.2	185.5
Faller	31.7	132.9	647.0	4.11	5.3	64.4	5.6	2.4	56.8	189.8
Forefront	29.2	138.2	617.6	3.58	5.7	65.1	6.0	2.6	57.5	201.1
Granger	34.1	137.9	620.5	4.00	4.3	69.8	6.1	2.3	57.9	189.3
Knudson	29.2	133.1	629.1	4.17	8.0	67.3	7.0	3.5	57.7	184.3
Oxen	25.3	133.4	631.8	3.81	6.0	68.7	6.8	2.9	57.3	188.9
Prevail	29.6	131.2	635.4	3.57	5.4	64.0	5.7	2.4	56.0	185.8
Select	27.9	135.6	606.4	4.25	5.6	66.1	6.2	2.8	57.8	188.8
Steele-ND	29.4	142.1	626.6	3.90	4.7	69.2	6.4	2.5	57.7	196.4
Traverse	28.1	132.5	599.2	4.39	3.0	65.5	3.4	1.6	56.0	180.3
Mean	29.2	135.2	622.3	4.0	5.6	66.2	5.9	2.6	57.0	189.5
LSD (0.05)	1.7	4.4	13.5	0.2	1.1	3.1	0.6	0.3	0.7	6.4
CV %	7.4	2.4	2.1	6.2	26.3	3.4	16.5	22.0	1.3	3.0
Environments	25	25	25	25	25	25	25	25	25	25

† Mixograph score scale: 8 = outstanding, 1 = unacceptable.

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